GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

REGIONAL IRRIGATED LAND AND WATER USE MAPPING IN THE GOULBURN MURRAY IRRIGATION DISTRICT

TECHNICAL REPORT

VICTORIA State Government | Environment, Land, Water and Planning

AGRICULTURE VICTORIA

NORTH CENTRAL Catchment Management Authority
Connecting Rivers, Landscapes, People

Murray DAIRY

Dairy Australia
Your Levy at Work

GOULBURN-MURRAY WATER

HMC PropertyGroup

This Technical Report and an Executive Summary can be found at www.gbcma.vic.gov.au

This project was co-funded by the following stakeholders:

- Goulburn Broken Catchment Management Authority (GB CMA)
- Department of Environment, Land, Water and Planning (DELWP)
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- Goulburn-Murray Water (GMW)
- Goulburn-Murray Water (Connections)
- North Central Catchment Management Authority (NCCMA)

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1 Introduction

The GMID (Figure 1) is the largest irrigation system in Victoria, supporting a range of agricultural commodities produced from industry types such as dairy, cropping, horticulture, beef and sheep. The GMID covers 9,950 square kilometres or 995,000 hectares (ha) (GMW 2015), approximately 830,000ha of which are classified as irrigation properties. At the time of the project surveys (2015/16) 258,117ha identified as being actively irrigated. The properties classified as non-irrigation include land urban centres and conservation areas.

Seasonal fluctuations (including the Millennium drought), climate change and commodity prices along with changes in water and planning policy (i.e. implementation of the Murray-Darling Basin Plan) have seen significant land and water use change in the GMID over the past decade. The Regional Irrigated Land and Water Use Mapping in the GMID project sought to investigate the dynamic nature of land use and industry change, to provide strategic direction for government and industry.

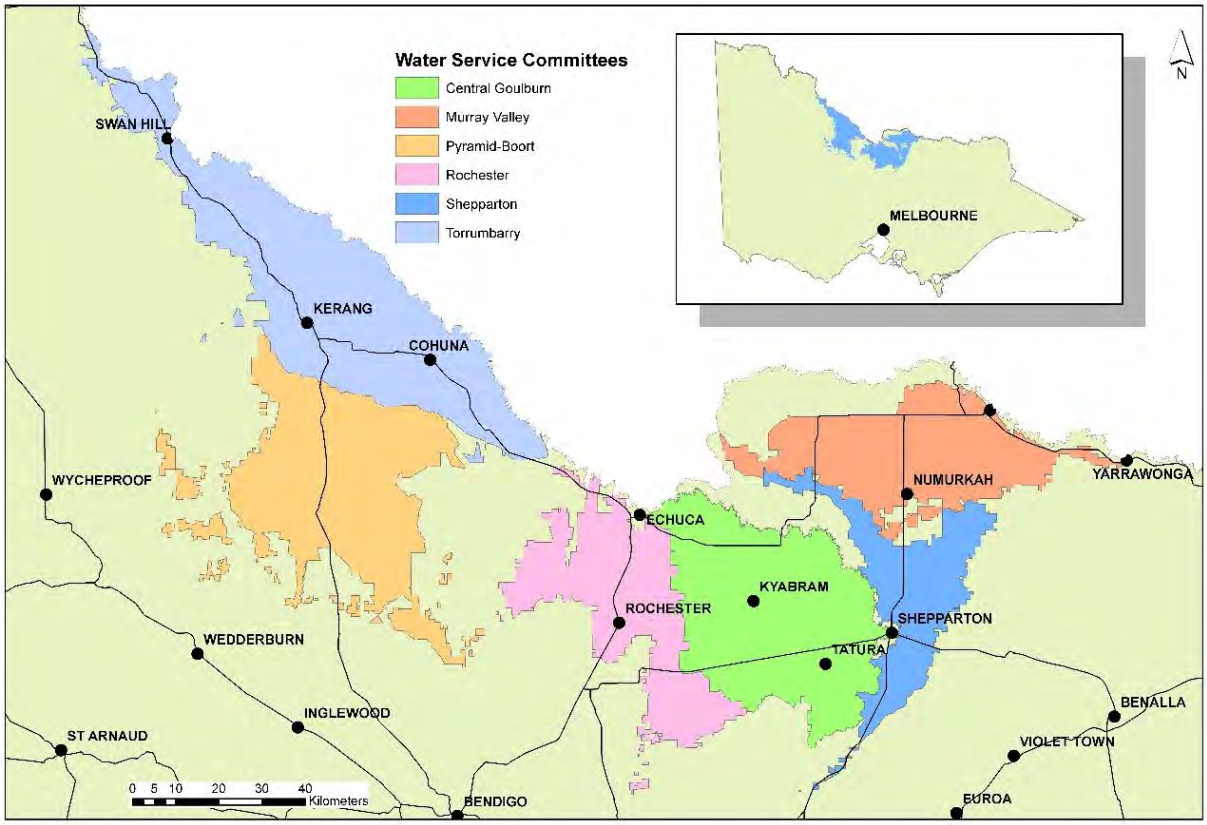


Figure 1: The project area, the Goulburn Murray Irrigation District (GMID)

This project was undertaken in stages during the 2015/16 irrigation season:

Stage 1 (Surveying): The collection of data describing the land use, irrigation methods, modernisation and production infrastructure for every irrigation classified property (13,230) in the GMID between January 2016 to May 2016. Note: Properties are defined as land parcels or titles. Many farm enterprises operate over two or more properties.

Stage 2 (Interviews): Detailed interviews with a representative sample of 384 irrigators in the GMID, stratified from each of the key land use activities in the region.

This project was made possible through collaboration between stakeholder organisations. A steering committee representing participating organisations provided funding and technical expertise to oversee the project (Appendix 1). This project was also run in conjunction with Local Government revaluation inspection programs across the GMID.

The project objectives were to:

- Renew through on-farm surveying and spatial analysis, the land and water use data for all irrigated properties in the GMID (Stage 1);
- Interview a randomly selected subset of irrigators to enhance the land and water use information dataset (Stage 2);
- Conduct a comparative analysis between the 2015/16 and 2009/10 irrigation seasons, and/or with annual data as available from that point (Stage 1);
- Draw comparisons between the 2015/16 data and 2004/05 data (Stage 2); and,
- Communicate key messages to inform regional, national and state water policy.

The expected project outcomes included:

- Spatial and excel dataset comprising land and water use data for all irrigated properties in the GMID (Stage 1);
- Development of a questionnaire to enable detailed interviews across a representative sample of irrigators in the GMID (Stage 2);
- Development of criteria to inform random irrigator selection to interview (Stage 2);
- Collection of data using the sample data frame and based on the selection criteria (Stage 2);
- Compilation of interview data from the irrigator subset to verify the land and water use information dataset (Stage 2);
- Share applicable datasets with Local Governments, HMC Property Group, Agriculture Victoria and Goulburn-Murray Water, to enable linkage and provision of enterprises to assist survey completion and accuracy of data;
- Analyse the data collected with existing spatial data from previous irrigator interviews (2004/05) and land use mapping (2009/10); and,
- Develop a project report outlining technical findings and analysis.

The undertaking of this project for 2015/16 is considered the first phase in continued assessing and reporting on land use, industry and water use change to inform regional, national and state water policy.

This project builds upon a range of existing data that has been compiled over many decades, such as irrigators farm surveys, the last of which was undertaken in 2004/05 (GMW 2006), and land use mapping surveys, the last of which was undertaken in 2009/10 (HMC Property Group 2010).

Further information on this project including an executive summary can be found at www.gbcma.vic.gov.au

2 Methodology

Specifically the study comprised a two stage approach

Stage 1: The collection of data describing the land use, irrigation methods, modernisation and production infrastructure for every irrigated property (13,230) in the GMID, between January 2016 to May 2016.

Stage 2: Detailed interviews with a representative sample of 384 irrigators in the GMID, stratified from each of the key land use activities in the region.

2.1 Stage 1 Methodology - Land and Water Use Surveys

2.1.1 Stage 1 survey objectives

The objective of the project's first stage was the collection of data describing the land use, irrigation methods, modernisation and production infrastructure for every irrigated property (13,230) in the GMID, between January 2016 to May 2016 in order to:

- Renew through on-farm surveying and spatial analysis, the land and water use data for all irrigated properties in the GMID;
- Conduct a comparative analysis between the 2009/10 (HMC Property Group 2010) dataset and the 2015/16 irrigation season dataset; and,
- Communicate key messages to inform regional, national and state water policy.

This was achieved by capturing the following data:

- General data (e.g. land size and structural improvements such as working dairies and configuration);
- Land use (cropping, grazing, livestock production – dairy cattle, mixed farming, perennial horticulture and annual horticulture);
- Land cover/usage (e.g. pasture mix, horticulture, market gardens or fodder crops);
- Irrigation methods (e.g. gravity channel irrigation or pipes and risers);
- Modernisation of on-farm irrigation infrastructure (e.g. whether modernised irrigation technology was present on the property or part thereof); and,
- Australian Property Codes for each property (e.g. domestic livestock grazing, crop production, livestock production or orchard).

2.1.2 Population and sampling frame

Population is the aggregate or collection of units about which the survey will be conducted. The target population for Stage 1 surveying included irrigators in the GMID. Dryland properties or residential properties were excluded from the process. The distribution of properties surveyed for Stage 1 is shown in Table 1, according to the number of properties inspected across each local government municipality.

Table 1: Distribution of properties surveyed for Stage 1 assessments

Municipality	Properties Inspected
Campaspe	4,241
Gannawarra	1,488
Loddon	844
Moira	2,258
Greater Shepparton	2,918
Swan Hill	1,481
Total Inspections	**13,230**

2.1.3 Data capture

On behalf of the Steering Committee, HMC Property Group (the valuers) were engaged by the Goulburn Broken CMA to undertake the data capture and irrigators interviews, which was then interpreted and analysed by the Steering Committee. This included the development of a custom application for the specific purpose of conducting the land use investigations. GPS tracking enabled valuers to pinpoint and identify target properties and assess and edit the associated data. Inspection information and data amendments were stored separately from the original data, facilitating export and upload to excel and the host SQL Server database. Figure 2 shows a de-identified example of data capture.

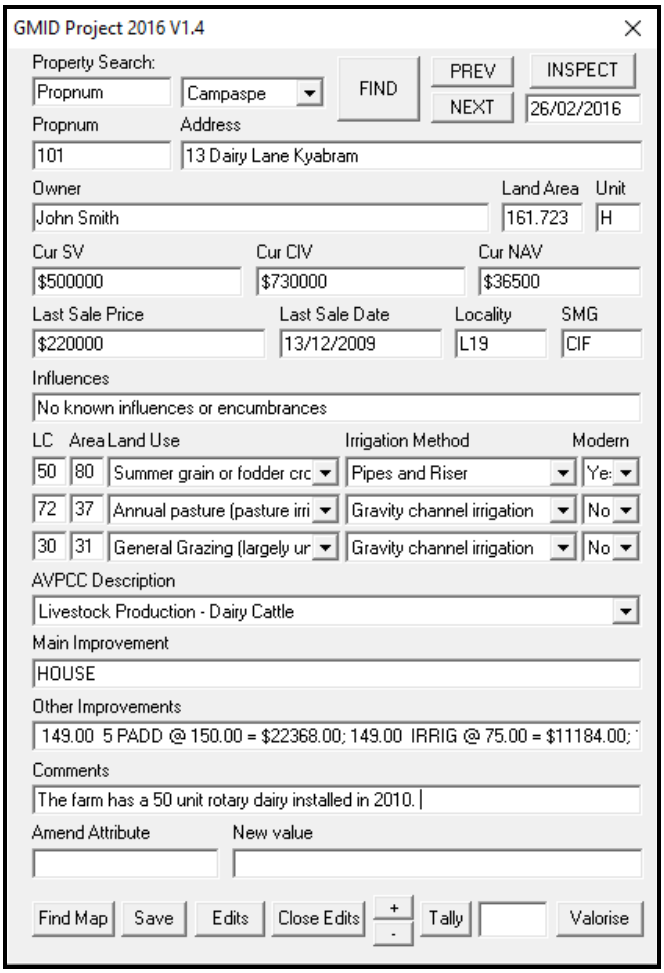


Figure 2: De-identified example of a custom process application

Stage 1 surveys were run in conjunction with revaluation general inspections, which were undertaken for Greater Shepparton, Campaspe, Moira, Loddon and Gannawarra Shire Councils. This collaboration enables efficiency benefits for all involved including improved data sets and inspection of all rural properties.

Valuers were able to confirm the land classification, primary land use, land cover (e.g. pasture/crop type) and irrigation methods. Details of existing structural improvement were verified as standard with council inspections; and a determination was made as to whether the current Australian Valuation Property Classification Code (AVPCC) was appropriate.

GMID land use data was secured and stored using SQL Server RDBMS and accessible via the valuers web-enabled property data system. This system provided for further editing along with exportation in a number of recognised formats to provide data to the Steering Committee for interpretation and analysis.

2.1.4 Land use mapping

A desktop assessment of land use prior to the undertaking of the 2015/16 field assessments was undertaken by HMC Property Group and the Steering Committee. The purpose of the desktop assessment was to act as a guide and to show existing land use data prior to the assessments.

Desktop assessment involved overlaying existing land use data with existing structural improvements, and satellite thermal imagery that showed irrigation activity by land cover, from the previous irrigation season (2014/15). Data from the previous irrigation season was used as a guide only, and then verified on inspection by the valuers from January to May 2016. Table 2 shows the range of land cover classification and descriptions that were applied to ascertain the land cover that was then categorised (as outlined in Table 3).

Table 2: Land cover classification methodology

Land Cover Classification[1]	Description
20: Spring Active	Vegetation green and active (i.e. have access to water) in spring. This is usually winter crops and pastures finishing.
30: Summer Active	Crops green and irrigated in summer (December to February) – e.g. maize and tomatoes.
40: Autumn Active	Crops green and irrigated in autumn (March to May). Winter crops and pastures being irrigated.
50: Perennially Active	Crops and pastures green and irrigated season-long (September to May). Perennial pastures, some Lucerne and perennial horticulture.
71: Spring to Summer Active	Green and irrigated from September to February. Often pastures that have been dried off after Christmas.
72: Spring and Autumn Active	Crops and pastures green and irrigated in both spring (September to November) and autumn (March to May). Winter crops and pasture.
73: Summer to Autumn Active	Crops and pastures green and irrigated December to May. Often extended summer crops that run through to March – often tomatoes.

1. The land classification process could be affected by rainfall (particularly codes 20 and 40) and may not always be an indicator of irrigation activities.

This dataset was segmented to compile the top three land cover classifications (by area) for each property. Combined with HMC Property Groups existing datasets and spatial information, this provided a base-line for the valuers to confirm or modify land use, land cover and improvement information during their inspections.

Figure 3 shows a land cover mapping example representing different irrigation activity. The dark green areas were watered from spring through to autumn (perennially active) in the 2014/15 irrigation season. Other colours represent differing irrigation activity. These maps (as well as recent high resolution aerial images) were utilised by the valuers to assist in identification of various pastures and crops (land usage) during the survey period as outline in Table 3.

A limitation in this methodology is that where areas were progressively dried off during the 2015/16 irrigation season (and therefore the survey period), they presented as perennially active at the beginning of the inspections program (e.g. January 2016), however did not meet this category by the end of the season. This has been modified in the data where possible, to represent the land cover classification most representative of the property for the period of survey.

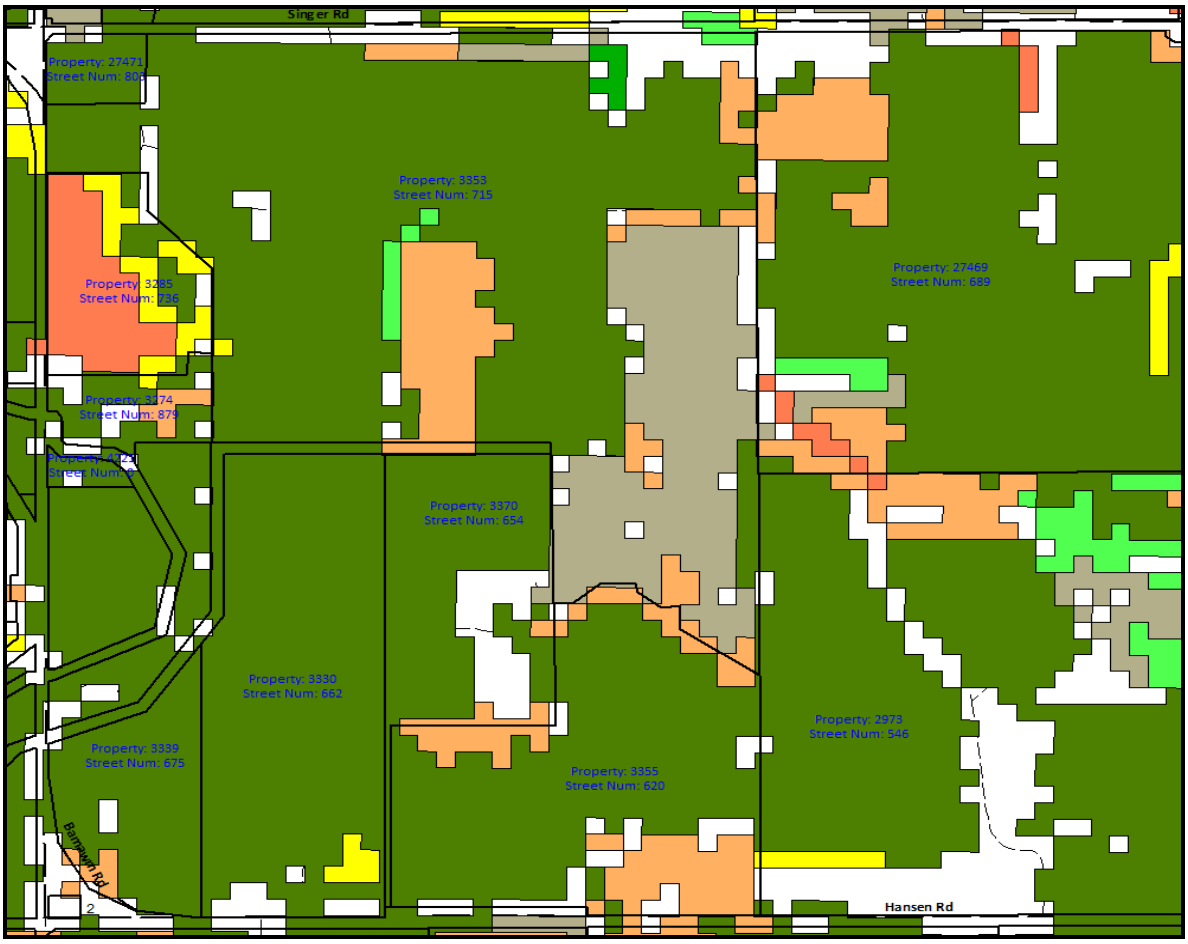


Figure 3: Land use mapping example representing different irrigation activity

Note: (the dark green is perennially active – land classification code 50)

The surveying also focused on all aspects of irrigation across the GMID and identified mobile irrigation infrastructure in addition to gravity channel systems, such as centre pivots, annual horticulture plantings (such as transient large scale tomato enterprises), new horticultural plantings, recent investments in modernised irrigation infrastructure and structural improvements (e.g. new dairies). This data was included in the data capture (Figure 2) under improvements and comments.

2.1.5 Land cover outputs/land usage

Using the methodology outlined above, each property received up to three land cover classification codes with relevant area extent, which was confirmed by visual inspection. Each land cover classification was then associated with the land use, as shown in Table 3. The hectares of each irrigated land cover was then calculated for the purposes of this report.

Table 3: Land cover/usage

Land cover/usage
Perennial pasture (pasture irrigated through to summer)
Annual pasture (pasture irrigated in spring and/or autumn)
Irrigated lucerne
Unirrigated lucerne
Winter grain or fodder crop (e.g. wheat, barley, canola, faba beans, oats)
Summer grain or fodder crop (e.g. maize, millet, sorghum, soybean)
Any other irrigated crops or irrigated fallow
Tomatoes
Other vegetables and annual fruit crops (e.g. melon, lettuce)
Grapevines
Citrus fruits of all types
Stone fruit (e.g. apricot, peach, nectarine)
Pome fruit (e.g. apples, pears)
Other permanent orchard species (e.g. Kiwi fruit, berries, avocados, nuts)
Irrigated wood lots (not shelter belts)
Other irrigated plantings (please specify)
Laneways, sheds, dairy and areas of the property not irrigated for the survey period
Turned and rested paddock/orchard
Poor block (weeds only)
General grazing (largely unirrigated)
Native timber/bush/plantation
Inactive

2.1.6 Irrigation method options

The irrigation method for each individual area of land usage identified within a property was recorded as per the methods identified in Table 4.

Table 4: Irrigation methodology recorded on each property

Irrigation Method [1]
Gravity channel irrigation
Pipes and riser
Furrow irrigation
Travelling irrigators, centre pivots/linear move
Fixed sprinkler systems with knocker type action
Micro and mini-sprinklers
Drip or trickle irrigation
Other
Not irrigated

1. Multiples can apply

2.1.7 Water use change

An important part of this study has been to integrate the council property view of land use with information from GMW, DEDJTR and the Victorian Water Register. This has been achieved through the linking of datasets such as water use to the Land Victoria VicMap parcel dataset. This is further discussed below in *Section 2.1.14*.

2.1.8 Modernised

A "yes" or "no" response was recorded (as per Figure 2 template) as to whether the irrigation method had been modernised or not. This identified properties that had undergone modernisation of on-farm irrigation methods regardless of whether these works were part of government-funded on-farm efficiency works or had been carried out independently. This was determined on the basis of the irrigation method observable by the valuer as at the date of inspection. It enabled identification of both areas within a property that had been modernised (i.e. maize crop under a centre pivot) and the irrigation method of other areas within the same property that had not been modernised.

Note: 'Modernised' in this instance does not distinguish as to whether the property is connected to the main delivery channel (commonly referred to as the backbone), but rather that the irrigation technology had been modernised.

2.1.9 Australian Valuation Property Classification Code (AVPCC)

The target population for land use mapping was all irrigation classified properties in the GMID. Broadly defined by land use, the AVPCC codes are standards that can be used to categorise irrigated properties. A selection of primary available codes applicable to properties within the GMID were applied to each property included in the survey; and then further grouped to refine the classifications (Table 5).

Table 5: Australian Valuation Property Classification Code (AVPCC) and categorisations used

AVPCC	Categorisation for this project
Domestic livestock grazing	Grazing non-dairy
Livestock production - beef cattle	
Livestock production - sheep	
Crop production - fodder crops	Cropping
Crop production - mixed/other	
General cropping	
Cattle feed lot	Intensive animal
Piggery	
Poultry (broiler or egg production)	
Horse stud/training facilities/stables	Horses
Livestock production - dairy cattle [1]	Properties with dairy Associated with dairy Dairy cattle agistment/fodder
Market garden - vegetables	Annual horticulture
Mixed farming and grazing	Mixed
Orchards, groves and plantations	Perennial horticulture
Vineyards	
Rural residential [2]	Lifestyle

1. Categorised as either 'Properties with dairy' where a functioning dairy was present; or 'Associated with dairy' where a dairy enterprise relationship was identified; or 'Dairy cattle agistment/fodder' where no functioning dairy or association was identified but dairy livestock were present. This also applied to any of the other AVPCC codes where applicable.
2. Included for the purposes of this report and to ensure capture of this land use.

2.1.10 Comparisons with prior data

Data collected for the 2015/16 irrigation season has been expanded to include the Swan Hill municipal area comprising 13,230 inspections, to cover all of the GMID. Data collected in 2009/10 as part of a similar project, did not include Swan Hill but provided a comprehensive database. This enabled a comparative analysis of land use to be undertaken following 2015/16 data capture, specifically for dairy (e.g. 'Properties with dairy', 'Associated with dairy' and 'Dairy cattle agistment/fodder') to compare 2000-2004, 2009/10 and 2015/16 data. Although comparative analyses of other land use types were not conducted as part of this project, the database collated provides opportunity for this to be resourced in the future.

2.1.11 Qualifications/Limitations

Land use mapping data and the field inspection program were completed by visual inspection and, in some cases, by direct interaction with landholders or property managers. The process has some inherent challenges in interpretation, as outlined below.

- Properties that were inspected after significant rain events (of which there were a number in the later parts of the survey period), had the potential to increase the uncertainty of the irrigation classification, land cover classification and therefore the land use category.
- The determination of whether a dairy is in production or not is not transparent, as some dairies may have been temporarily not operating but still fully functional and capable of returning to a functioning dairy.
- Comparisons with prior data (e.g. 2000-2015/16), has limitations including seasonality issues and context (e.g. results are a snapshot in time).
- There are difficulties in drawing definitive comparisons between the Stage 1 and 2 survey data for land cover/usage. This is driven in differences between the Stage 1 inspection and Stage 2 survey dates which emphasised seasonal and water availability variations effecting the ability to interpret what was irrigated annual cropping after the period of January to June and what constituted perennial pasture during January to June. In particular there were a number of significant rainfall events in January 2016 across the GMID that may have distorted the outcomes in areas being actively inspected at that time.
- Integrating datasets such as the council property view of land use with information from GMW, DEDJTR and the Victorian Water Register, to the Land Victoria VicMap parcel dataset, can result in data mismatches. All attempts to correct data inconsistencies has occurred during the linking of datasets.
- Limitations exist in the accuracy of determining AVPCC codes and sub-categorisation to the 'Dairy cattle agistment/fodder'. For example, properties could be categorised as linked to dairy in one of three ways:
    - 'Properties with dairy' – are defined as council rated properties that have a functioning dairy shed;
    - 'Associated with dairy' – have been linked to 'Properties with dairy' through customer data and therefore form part of a dairy enterprise; or,
    - 'Dairy cattle agistment/fodder – defined as former dairy properties that either still service the dairy industry or are in transition (but have not been linked to a dairy property or enterprise). The properties may belong to another AVPCC code such as cropping or mixed farming; or a link may exist with a dairy enterprise but was not found through integration with existing datasets. The decision was made to group these together as 'Dairy cattle/agistment fodder' and document the methodology, to enable future investigation.

Auditing and quality assurance of the inspection program was undertaken on an ongoing basis to improve confidence in the data-set, that the data-set was meeting expectations and to determine the risk rating of some property classifications. For example, 400 properties with working dairies were selected at random for detailed quality assurance review to confirm dairy configuration and whether its current status (e.g. in production, in hiatus or in a 'disused' state) was being accurately and consistently captured.

Table 6 highlights some of the managed risks or uncertainties within the survey for 2015/16.

Table 6: Risk matrix for surveying

Issue	Risk	Risk Rating
Modernisation	Incorrect assessment	Medium
Land Usage	Categorisation inaccurate	Low
Land Classification	Rainfall masking	High
Land Cover	Interim (in season) changes to irrigation method due to price fluctuations	Medium
Dairy	In production accuracy	Low
Dairy	Configuration incorrect	Low
Dairy	AVPCC classification	Medium

Therefore the use of this data needs to occur with an understanding of the methodology and its limitations, to ensure it is used for the purposes intended.

2.1.12 Period of study

The period of the survey (Stage 1) was from January 2016 through to May 2016, with further validation, quality assurance checks and peer review of the data running into July 2016. The data was validated against other available sources, to ensure consistency of interpretation.

2.1.13 Data integration

The assessment and data capture process described in the previous section provides a description of land use and property features at the council property scale.

An important part of this study has been to integrate the council property view of land use with information from GMW, DEDJTR and the Victorian Water Register. This has been achieved through the linking of datasets to the Land Victoria VicMap parcel dataset. The land parcel is identified by the parcel_spi (standard parcel identifier) and provides the smallest spatial unit to which all other information in this study is linked.

The integration process undertaken attaches council property and water use license identifiers to the parcel dataset. This then supports the integration of:

- Council land use assessments as provided by the valuer;
- Water use, entitlement and customer information through GMW and the Victorian Water Register; and,
- Other ancillary information such as satellite based land cover and horticulture plantings as provided by Agriculture Victoria (DEDJTR).

Customer information utilised by this project is private and has been used for the purposes of linking council properties into enterprises and will not be distributed beyond the project team. Irrigated enterprises will only be identified by a generic identification. Further information on privacy of information is provided below.

2.1.14 Privacy of information

The Goulburn Broken CMA and partnering organisations value and respect the personal information collected in the course of undertaking this project and are committed to complying with information privacy legislation including the *Privacy and Data Protection Act (Vic) 2014*. Measures are in place to protect the personal information held from misuse and loss and from unauthorised access, modification or disclosure. These measures include secure storage and retrieval systems, access protocols for staff and encrypted electronic communications. Personnel are trained in their obligations to protect privacy and personal information, and to take reasonable steps, including appropriate technological and organisational steps, to ensure the security and quality of the information. Data may be shared with relevant government organisations or other agencies involved, for the sole purpose of administering the project(s) for which the information was collected, however all data (that is not otherwise publically available) is de-identified and protected.

2.2 Stage 2 Survey Methodology – Irrigation Interviews

2.2.1 Stage 2 survey objectives

The objective of this stage of the project was to:

- Interview a representative sample of irrigators (384) in the GMID, stratified from each of the key land use activities in the region;
- Draw comparisons between the 2015/16 data and 2004/05 data; and,
- Communicate key messages to influence national, regional and state water policy.

This was achieved by capturing the following data:

- Land use;
- Irrigation infrastructure and water use;
- Modernisation of irrigation systems;
- Changes to irrigation practices;
- Irrigators' views on allocation trade;
- Management practices (e.g. natural resource management); and,
- Irrigators' outlook on farming in the region.

2.2.2 Population and sampling frame

Population is the aggregate or collection of units about which the survey will be conducted. There are two sub-sets of population for this project:

- Target population - the target population for this project was GMID irrigators across the range of land uses; and,
- Survey population - the survey population for this project was randomly selected individuals who were involved in the face-to-face interviews.

A sampling frame which refers to the complete list of non-overlapping sampling units, for this survey was developed from Local Government Valuation Property Classification. This consisted of 11,749 irrigation properties from within GMID covering the municipal areas of Greater Shepparton, Moira, Campaspe, Loddon and Gannawarra (excluding Swan Hill). The Local Government Valuation Property Classification frame was adopted to retain its consistency with Stage 1 data analysis. Frames provide the means of accessing the population and therefore their quality is important. Potential problems include duplicates, deaths, typographical errors, error in definitions (e.g. GMW and Local Government rate frame may define a 'dairy farmer' differently) and frames that are out of date.

2.2.3 Sample size

Stratified sampling based on farming industry of 600 irrigation properties across the GMID (minus Swan Hill Shire area representing 1,481 properties) were selected from an estimated parent sampling frame of 11,749 properties. Swan Hill Shire area were not part of the sampling frame for Stage 2 due to their being in a different Council valuation area and resourcing constraints.

Stratification is the process of dividing the population (irrigators in the GMID) into mutually exclusive sub-populations, which are then sampled independently. The strata used for the study are: dairy, cropping, orchard, mixed farming and livestock production. The study used proportional allocation of sample, that is 31.5% of the population were related to the dairy industry, and hence 31.5% of the sample consisted of those related to dairy industry.

The survey adopted the Local Government Valuation Property Classification frame (people who own the irrigated land parcel/s) for the sampling purpose. The sample selection unit was the farm parcel and the reporting unit was the farmer. For each farm unit selected, the farmer was identified and the Goulburn-Murray Water client frame was used to identify the ownership of other farm units.

All the farm units belonging to a farm enterprise were used as a reporting unit and questions were asked at the enterprise level. For example, if a landholder owns three parcels of land, then the survey questions were related to all three parcels of land (the enterprise). This was regardless of geographical distance between the parcels. The interviewers were provided with an aerial photograph showing the enterprise of the landholder.

Since the farm selection unit (parcel of land) was different to the reporting unit (enterprise level consisting of one or several parcels of land), the total sample size was revised to 384 enterprises across the GMID. The approximate location of the 384 irrigator interviewees for Stage 2 is shown in Figure 4.

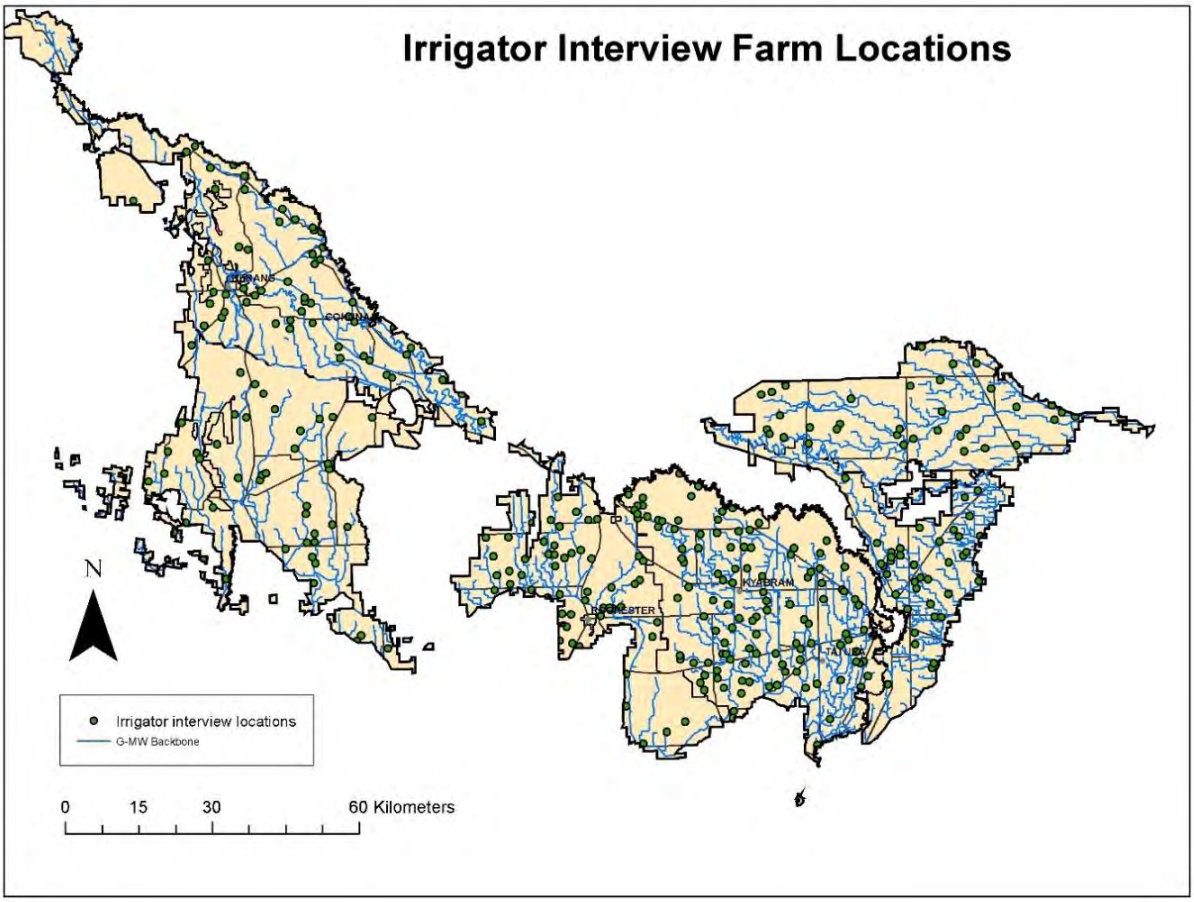


Figure 4: Approximate location of the 384 irrigator interviews for Stage 2

Sample size is affected by:

- Level of variation in the population;
- Desired precision of the results;
- Confidence level at which that precision is calculated;
- Population size;
- Sampling methods used; and,
- Resources available.

The sample size of 384 (Table 7) was obtained so that we can be 95% confident that the results in the population will be same as in the sample (plus or minus the sampling error of five percent). A key determinant of sample size is the need to look separately at different sub groups and make sure that there are sufficient numbers in each (de Vaus, 2002). In this survey, five industry sub-groups, namely dairy, cropping, orchard, mixed farming and livestock production were identified. All the sub-groups except for orchard had at least 50 cases. The orchard sub-group had only 22 cases, thus requiring care when inferring to its population.

Table 7: Sample size with land use stratification

Industry	Sample size based on Land unit [1]	Sample size based on enterprise unit [1]
Dairy	165 (27.5)	121 (31.5)
Cropping	185 (30.8)	121 (31.5)
Orchard	50 (8.3)	22 (5.7)
Mixed farming	100 (16.7)	61 (15.9)
Livestock production	100 (16.7)	59 (15.4)
Total	600 (100)	384 (100)

1. Figures in parenthesis () indicate percentages

2.2.4 Errors in statistical data

There are two main types of error: sampling error and non-sampling error. Sampling errors relate to the manner of obtaining the sample. It is mostly quantifiable. Factors that affect it include sample size, sampling design and population variability.

Non-sampling errors are other errors in the estimate which can occur at any stage. These include processing errors, response errors, non-response errors and incorrect response. This error is difficult to quantify. It is important that all types of errors should be minimised so that the results are realistic and the survey is successful.

2.2.5 Period of study

This study focused on responses from irrigators for the irrigation season of August 2015 to May 2016, with the interviews (Stage 2) conducted during May and June 2016.

2.2.6 Questionnaire design

The standardised questionnaire (Appendix 2) was prepared based on questions asked during the 2004/05 Irrigation Farm Survey (GMW 2006). In the 2015/16 study some additional questions were added that related to water allocation trade that were not in the 2004/05 survey. This attempt to standardise the questionnaire will enable some comparisons between results, with acknowledgement of different contexts (e.g. seasonal conditions) in which the surveys were undertaken.

The 2015/16 questionnaire was divided into eight sections, including:
1) land use pattern;
2) types of irrigation systems;
3) farm context and understanding of social issues around farming in the region;
4) irrigation modernisation issues;
5) changes to irrigation practices;
6) water allocation trade;
7) the dairy industry; and,
8) farm management practices.

2.2.7 Data collection and analysis

Data was collected through a face-to-face interview process conducted by consultants from LG Valuations. The interview took approximately 35-40 minutes depending on the length of responses from irrigators. It was highlighted during the interview process that the information collected would remain confidential with no identifiers provided external to the collecting authorities and that details obtained from the survey would be made available as aggregated information.

Prior to data analysis the interview data was processed and cleaned by an evaluation specialist. This involved:

- Entering data from the interview sheets (paper form) into an Excel spreadsheet and checking data for errors; and,
- Data was coded numerically where appropriate and any missing data identified.

The cleaned data set was then analysed. Analysis of data for this report was undertaken using Microsoft Excel and Statistical Package for Social Scientists (SPSS).

The statistical analysis applied in the report mostly included mean, median and frequency. Analysis of Variance (ANOVA) and T-test were used to compare mean differences between variables. Chi-square test and co-relation analysis were also used to examine associations and relationship between variables.

This survey was planned, conducted and analysed in a manner that provided a reliable estimate of the population parameter. 'Standard error' was used to define sampling error which provided the difference between the estimate obtained from a particular sample and the value that would be obtained if the whole survey population were enumerated. Australian Bureau of Statistics (2013) emphasise the importance of considering sampling error when publishing survey results, as it gives an indication of the accuracy of the estimate and therefore reflects the importance that can be placed on interpretations.

2.2.7.1 Standard error of mean

For the mean value, 95% confidence intervals were calculated using Standard Error formula. Using the formula, there is 95% confidence that, if multiple similar samples were taken, the true value of the mean would fall between$\pm\ 1.96\ \times \sigma/\sqrt{n}$, where σ is the standard deviation and n is sample size and $\sigma/\sqrt{n}$ is the standard error of the mean.

2.2.7.2 Standard error of proportion

The standard error of the proportion or percentage can make a close estimate using the formula:

$$= 1.96\ \times \sqrt{p(100-p)}/\sqrt{n}$$

Where, 'p' is the observed percentage and 'n' is the sample size.

A 95% confidence interval for a percentage is defined by a range of about two standard deviations either side of the observed percentage. This interval estimate will be little larger than a more sophisticated estimate that takes account of the stratified sample structure.

Throughout this report, confidence intervals are shown as part of the results. A confidence interval is a measure of how confident we can be in the results. More accurately it tells us the boundaries between which the value of a given variable would be 95% likely to fall if we repeated the survey multiple times with a similar sample. In general, confidence is higher if there is a large sample size and little deviation in scores. Confidence is lower if there is a small sample size and high deviation.

In this report, figures with bar indicate the percentage value. The black line indicates error bar with upper and lower bounds of 95% confidence interval. Confidence intervals can be used to help identify if a difference is likely to be significant or not. If the confidence intervals of two values don't overlap, it is highly likely here is a significant difference between them.

2.2.7.3 Comparisons with prior data

Prior to 1993, irrigator interviews were conducted annually. Since 1993, the interviews were undertaken approximately four-yearly by GMW in partnership with Catchment Management Authorities to gain an understanding of its customer base. The last interviews conducted were in 2004/05 (GMW 2006). Following 2015/16 data capture, a comparative analysis between the 2004/05 and 2015/16 irrigation season was undertaken.

2.2.7.4 Case studies

Nine case studies looking at different aspects of irrigator responses were collated from the raw data collected. These are included in the discussion section of this report to exemplify some of the key findings. Names were changed for all case studies and no locations were recorded to de-identify the respondent.

2.2.8 Limitations

All surveys have limitations. The following important limitations should be noted when reading this report and drawing conclusions from it.

Missing data: Not all respondents answered every question they were asked in the survey(s). Missing data imputation can be used to estimate what respondents might have said. In the analysis of results presented in this report no imputation has been undertaken. This means that results may differ compared to any further analyses of the survey data that do impute missing data.

Results are a snapshot in time: The results are influenced by the issues of the day. The data was collected during May and June 2016. Between these dates a downturn in dairy milk price was announced by some milk processing companies.

The interviews were undertaken during a period when communities were debating and discussing the Murray-Darling Basin Plan (MDBP) water recovery target. The first half of 2015/16 was drier and warmer than the previous season and our data suggests that those relying on allocation trade were uneasy about the price of water which peaked at $250/ML in May 2016 during the interview period (Victorian Water Trade data 2016). The volume weighted average price for the 2015/16 season was $220/ML (Aither 2016). These factors could have impacted on how irrigators responded to the interview.

Non-sampling errors: Non-sampling errors occur in any data collection. Sources of non-sampling error include non-response, errors in reporting by respondents or recording of answers by interviewers and errors in coding and processing the data.

Non-sampling errors are difficult to quantify in any data collection. However, every effort has been made to reduce non-sampling error by careful design of questionnaire, proper data collection, data entry and extensive editing and quality control procedures at all stages of data processing.

Sample frame: A sampling frame refers to the complete list of non-overlapping sampling units. For this project, individual irrigated parcels of land across the GMID adopted from the Local Government Valuation Property Classification was used as the sampling frame.

Stratified random sampling based on farming industry of irrigated properties across the GMID, was selected from an estimated parent sampling frame of 11,749 properties (excluded Swan Hill). This sampling frame was used to retain its consistency with Stage 1 of the project that focused on Land Use Mapping data analysis.

As there were irrigators who own more than one parcel of irrigated property, the sample size has been reduced from the original expectation of 600 irrigators to 384 irrigators. This resulted in the increase in sampling error from four percent to five percent at 95% confidence level. Care should be taken in the development of the sampling frame in future studies.

Also, the reliability of a sample can be markedly improved by using multiple frames in a way that enables one frame to validate the information in others.

3 Data Summary - Results

3.1 Overview of Results

The following section presents the data that was collected during the 2015/16 Regional Irrigated Land and Water Use Mapping in the GMID project. This includes two main stages:

Stage 1: The collection of data describing the land use, irrigation methods, modernisation and production infrastructure for every irrigated property (13,230) in the GMID, between January to May 2016.

Stage 2: Detailed interviews with a representative sample of 384 irrigators in the GMID, stratified from each of the key land use activities in the region.

3.1.1 Stage 1 results

3.1.1.1 Land use

This project classified land use for irrigation classified properties across the GMID (829,282 hectares) (ha), according to standard land classification values including: 'Cropping', 'Grazing non-dairy', 'Properties with dairy', 'Associated with dairy' 'Dairy cattle agistment/fodder' (where no functioning dairy or association with dairy was identified), 'Lifestyle', 'Intensive animal', 'Horses', 'Mixed farming', 'Perennial horticulture' and 'Annual horticulture'. Associated with dairy are defined as former dairy properties that either still service the dairy industry or are in transition (but have not been linked to a dairy property or enterprise).

Figure 4 illustrates the land use categories across the GMID and Table 8 tabulates the data. Cropping was identified as the most extensive land use across the GMID, with 2,326 properties covering 261,774ha, which is more than a quarter of the total land area of 829,382ha. The distribution of cropping was scattered throughout the GMID but concentrated toward the west in the Pyramid Boort water service area.

Dairy was also extensive throughout the GMID, with 'Properties with dairy' and 'Associated with dairy' the second most extensive land use, with a combined total of 1,907 properties, totalling 180,665ha. A further 54,853ha (759 properties) were categorised as 'Dairy cattle agistment/fodder' which represent former dairy properties that either still service the dairy industry (but have not been linked to a dairy property with a functioning dairy) or are in transition. As discussed in the limitation section of this report, it is acknowledged that these areas could therefore be associated with other land uses such as mixed farming.

'Mixed' farming accounted for 1,640 properties and 118,116ha and was predominantly associated geographically near 'Cropping' and 'Grazing non-dairy' properties. 'Grazing non-dairy', which includes livestock production such as beef and sheep, accounted for 1,265 properties covering 133,890ha.

There were 948 'Perennial horticulture' properties identified in the GMID, covering 29,129ha. There were pockets of perennial horticulture, particularly near Cobram, Shepparton, Bunbartha, Ardmona, Tatura and Kyabram in the east; and Swan Hill, Lake Boga and Boort in the west. A number of large (extent) 'Annual horticulture' properties (e.g. tomatoes) covered 10,040ha and were identified north of Boort, however they were found predominantly in the Rochester and Central Goulburn Water Service areas.

Fifty-six 'Intensive animal' properties were identified, covering 5,310ha and were predominantly located in the west of the GMID. 'Horses' accounted for 102 properties, totalling 5,337ha. 'Lifestyle' (30,268ha) had the highest number of properties of all land use categories, with 4,112 properties. The distribution of each of these land uses is illustrated below (Figure 5).

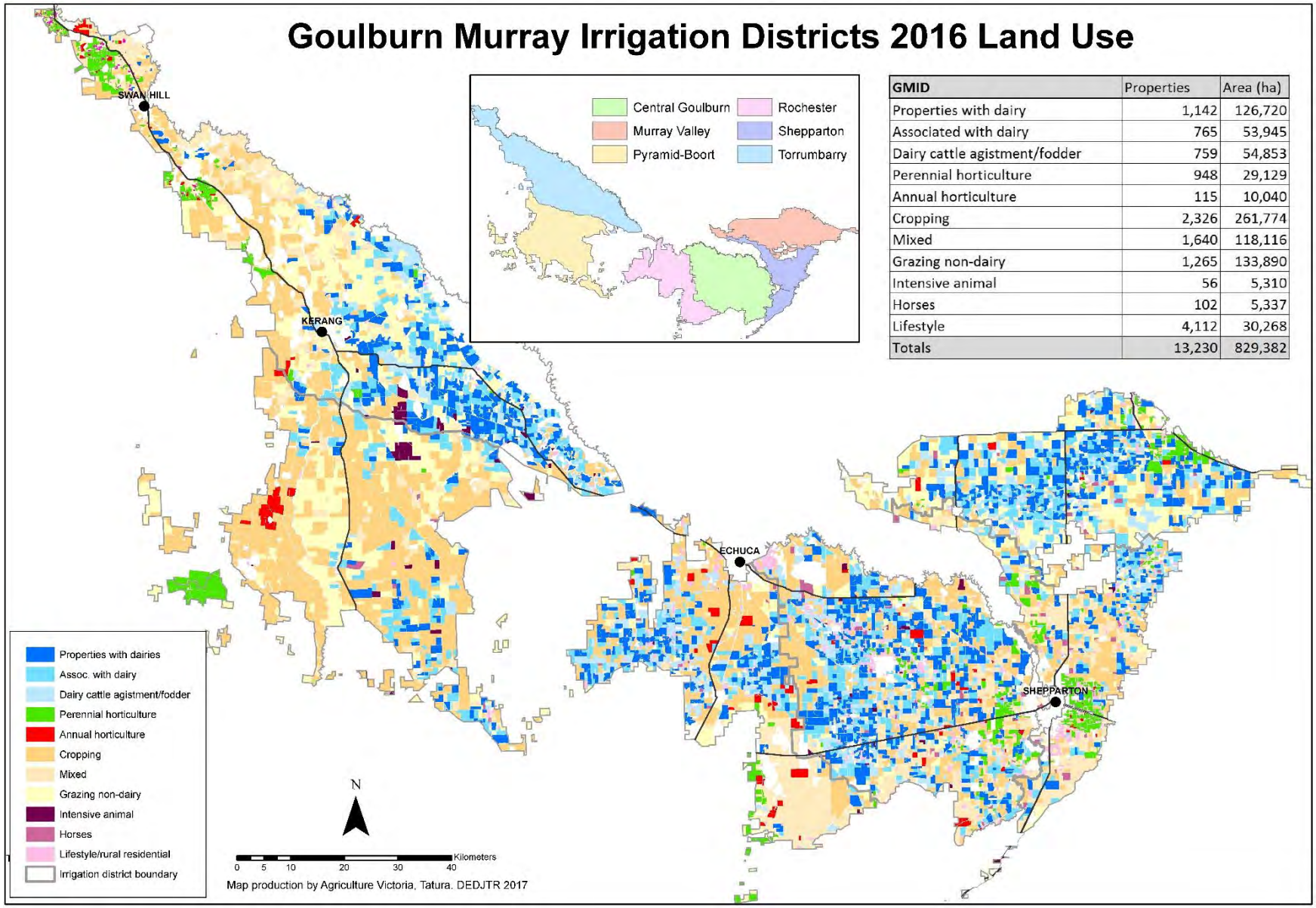


Figure 5: Land use categorisation across the GMID

Table 8: Land use across the water service areas in the GMID

Categories	Murray Valley		Shepparton		Central Goulburn		Rochester		Torrumbarry		Pyramid-Boort		Totals	
	Properties (Number)	Area (ha)	Properties (Number)	Area (ha)	Properties (Number)	Area (ha)	Properties (Number)	Area (ha)	Properties (Number)	Area (ha)	Properties (Number)	Area (ha)	**Properties (Number)**	**Area (ha)**
Properties with dairy	264	26,169	103	8,049	363	37,493	155	19,758	204	26,690	53	8,561	**1,142**	**126,720**
Associated with dairy	152	12,365	81	3,678	220	11,454	97	7,774	152	11,473	63	7,201	**765**	**53,945**
Dairy cattle agistment/fodder	153	11,137	44	3,250	238	14,243	199	13,637	115	11,448	10	1,138	**759**	**54,853**
Perennial horticulture	136	4,672	227	6,482	179	5,460	9	981	389	7,086	8	4,448	**948**	**29,129**
Annual horticulture	8	794	12	283	28	2,203	25	3,501	37	1,139	5	2,120	**115**	**10,040**
Cropping	198	21,607	271	19,792	508	45,845	397	38,118	412	39,154	540	97,258	**2,326**	**261,774**
Mixed	76	4,856	292	21,561	471	35,451	201	20,000	505	23,638	95	12,610	**1,640**	**118,116**
Grazing non-dairy	456	40,540	99	6,901	113	7,578	47	3,955	418	48,197	132	26,719	**1,265**	**133,890**
Intensive animal	2	52	1	74	21	978	6	160	17	2,110	9	1,936	**56**	**5,310**
Horses	14	761	31	1,855	42	1,821	8	245	1	8	6	647	**102**	**5,337**
Lifestyle	379	5,690	645	5,755	1,454	11,014	734	4,198	760	2,835	140	776	**4,112**	**30,268**
Totals	1,838	128,643	1,806	77,680	3,637	173,540	1,878	112,327	3,010	173,778	1,061	163,414	**13,230**	**829,382**

Land use and extent were further refined from a GMID scale to a smaller water services area. Figures 6-11 illustrate the land use categories and extent for the six water service areas across the GMID, including Murray Valley, Shepparton, Central Goulburn, Pyramid-Boort, Rochester and Torrumbarry.

For the ***Murray Valley*** water service area (Figure 5) 'Grazing non-dairy' formed the most extensive land use, with 456 properties totalling 40,540ha. 'Properties with dairy' (e.g. a functioning dairy) and 'Associated with dairy' (relationship with a functioning dairy) combined to form the second most extensive land use with 416 properties covering 38,534ha. 'Dairy cattle agistment/fodder' covered 153 properties, totalling 11,137ha. 'Cropping' was the third highest land area within Murray Valley with 21,607ha and 198 properties. Dairy properties were located through the centre of the area, with grazing non-dairy and cropping properties located primarily around the perimeters of multiple dairy properties. There were a small number of 'Annual horticulture' (e.g. tomatoes) properties (eight), totalling 794ha; and a further 136 'Perennial Horticulture' properties, totalling 4,672ha. 'Lifestyle' properties accounted for 379 properties totalling 5,690ha.

For the ***Central Goulburn*** water service area (Figure 6) 'Properties with dairy' and 'Associated with dairy' when combined; formed the most extensive land use across the area with 583 properties covering 48,947ha. The extent of properties with dairy and associated with dairy was the highest in Central Goulburn compared to the other water service areas. 'Cropping' was the second most extensive land use for Central Goulburn, covering 45,845ha and comprising 508 properties; followed by 'Mixed' farming with 471 properties totalling 35,451ha. The dairy properties and associated with dairy properties were focussed geographically around the towns of Stanhope, Girgarre, Tongala, Wyuna, Undera and south of Tatura. These properties were surrounded by areas of dairy cattle agistment/fodder, cropping and mixed farming. The highest amount of 'Lifestyle' properties were located in Central Goulburn (compared to the other water service areas) with 11,014ha of land (1,454 properties) and were generally associated with townships. 'Perennial horticulture' comprised 179 properties, totalling 5,460ha and were concentrated around Kyabram, Ardmona and Tatura. 'Annual Horticulture' properties were scattered with 28 properties covering 2,203ha.

Figure 7 shows the land use categories and extent for the ***Shepparton*** water service area. It shows a concentration of dairy enterprises in the north eastern section near Katandra, as well as a number of properties near Arcadia and Nathalia, with a total of 184 properties totalling 11,727ha. However, the highest land use extent in the Shepparton water service area was 'Mixed' farming with 292 properties totalling 21,561ha, followed by 'Cropping' with 271 properties totalling 19,792ha. There were 227 'Perennial Horticulture' properties totalling 6,482ha, concentrated particularly near Shepparton East and Bunbartha. The lowest extent of 'Annual horticulture' was found within the Shepparton water service area with 12 properties totalling 283ha. The extent of the land use categorised as 'Horses' in Shepparton was the highest (1,855ha) compared to all of the other water service areas, followed by Central Goulburn (1821ha). This was also the same for 'Lifestyle' properties with Central Goulburn (11,014ha) and Shepparton (5,755ha) having the two highest extents of this land use compared to the other water service areas.

Figure 8 shows the ***Rochester*** water service area; with 'Cropping' (38,118ha) the most extensive land use. Dairy enterprises were the next most extensive land use, with 252 properties totalling 27,532ha. There were a further 199 properties, totalling 13,637ha categorised as 'Dairy cattle agistment/fodder', with dairy related properties located predominantly in large clusters around the towns of Lockington and Rochester. 'Mixed' farming was found predominantly near Corop and Colbinabbin with 201 properties totalling 20,000ha. 'Lifestyle' accounted for 734 properties, with 4,198ha and were located near townships, particularly west of Echuca. There were 25 properties totalling 3,501ha categorised as 'Annual horticulture' (e.g. tomatoes) at the time of survey and were often associated near 'Cropping' and 'Mixed' land use areas. Rochester water service area contained the least amount of 'Perennial horticulture', with nine properties totalling 981ha.

'Cropping' was the most extensive land use in the ***Pyramid-Boort*** water service area (Figure 9) with 97,258ha (540 properties) which is over half the total number of irrigation properties in the area. 'Grazing non-dairy' was the second highest land use for Pyramid-Boort with 26,719ha and 132 properties. There were 116 dairy enterprises totalling 15,762ha, located near Dingee, between Durham Ox and Mitiamo and near Lake Meran. 'Mixed' farming properties accounted for 12,610ha and 95 of the 1,061 total properties in the Pyramid-Boort water service area. 'Perennial horticulture' had eight properties, located near Boort covering 4,448ha of land area. Although part of these properties are located outside of the geographic area of the GMID, they were included in this report because their irrigation water is supplied out of the Pyramid-Boort irrigation system (off the Waranga Western main system). Five properties totalling 2,120ha of 'Annual Horticulture' (e.g. tomatoes) were identified in a large patch north of the township of Boort.

'Grazing non-dairy' is the most extensive land use (48,197ha) across the ***Torrumbarry*** water service area (Figure 10). 'Cropping' was the next highest land use extent with 39,154ha, followed by dairy enterprises totalling 38,163ha. Dairy was found predominantly along the Murray River near the towns of Koondrook, Cohuna, Leitchville and Torrumbarry, and east of Kerang through to Torrumbarry. 'Perennial horticulture covered 7,086ha and was predominantly located in the North-west near Nyah Nyah West, Swan Hill and Lake Boga. These areas also supported most of the 37 properties of 'Annual horticulture' found in this water services area (1,139ha). There were 17 'Intensive animal' categorised properties, covering 2,110ha.

<u>Key findings from Stage 1 land use mapping include:</u>

- The extent of 'Properties with dairy' and 'Associated with dairy' was highest in Central Goulburn (48,947ha) and Murray Valley (38,534ha); and lowest in Shepparton (11,727ha) and Pyramid-Boort (15,762ha).
- The extent of 'Perennial horticulture' was highest in Torrumbarry (7,086ha) and Shepparton (6,482ha); and lowest in Rochester (981ha) and Pyramid-Boort (4,448ha).
- The extent of 'Annual horticulture' was highest in Rochester (3,501ha) and Central Goulburn (2,203ha); and lowest in Shepparton (283ha) and Murray Valley (794ha).
- The extent of 'Cropping' was highest in Pyramid-Boort (97,258ha) and Central Goulburn (45,845ha); and lowest in Shepparton (19,792ha) and Murray Valley (21,607ha).
- The extent of 'Mixed' farming was highest in Central Goulburn (35,451ha) and Torrumbarry (23,638ha); and lowest in Murray Valley (4,856ha) and Pyramid-Boort (12,610ha).
- The extent of 'Grazing non-dairy' was highest in Torrumbarry (48,197ha) and Murray Valley (40,540ha); and lowest in Rochester (3,955ha) and Shepparton (6,901ha).
- The extent of 'Intensive animal' was highest in Torrumbarry (2,110ha) and Pyramid-Boort (1,936ha); and lowest in Murray Valley (52ha) and Shepparton (74ha).
- The extent of 'Horses' was highest in Shepparton (1,855ha) and Central Goulburn (1,821ha) and lowest in Torrumbarry (8ha) and Rochester (245ha).
- The extent of 'Lifestyle' was highest in Central Goulburn (11,014ha) and Shepparton (5,755ha); and lowest in Pyramid-Boort (776ha) and Torrumbarry (2,835ha).

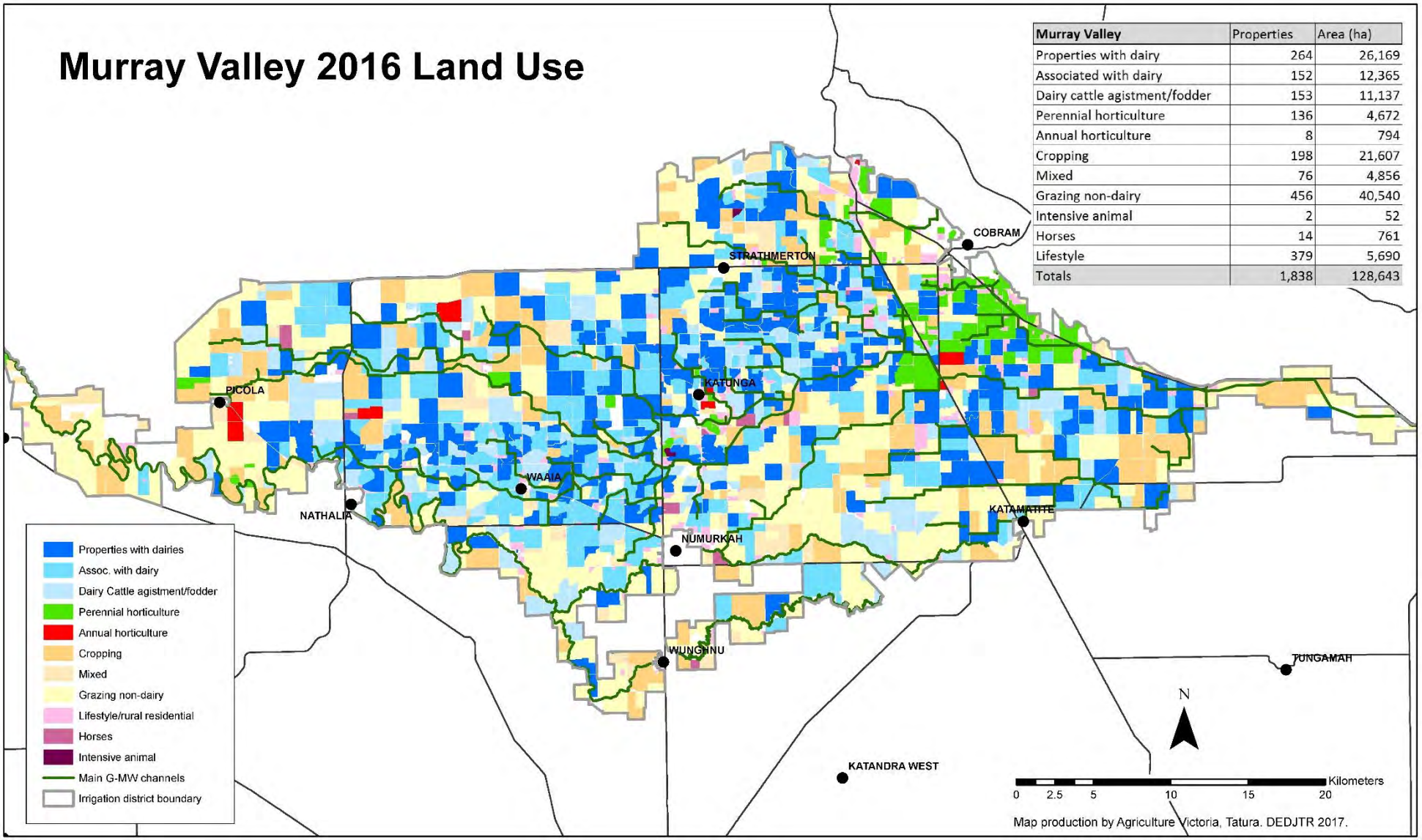
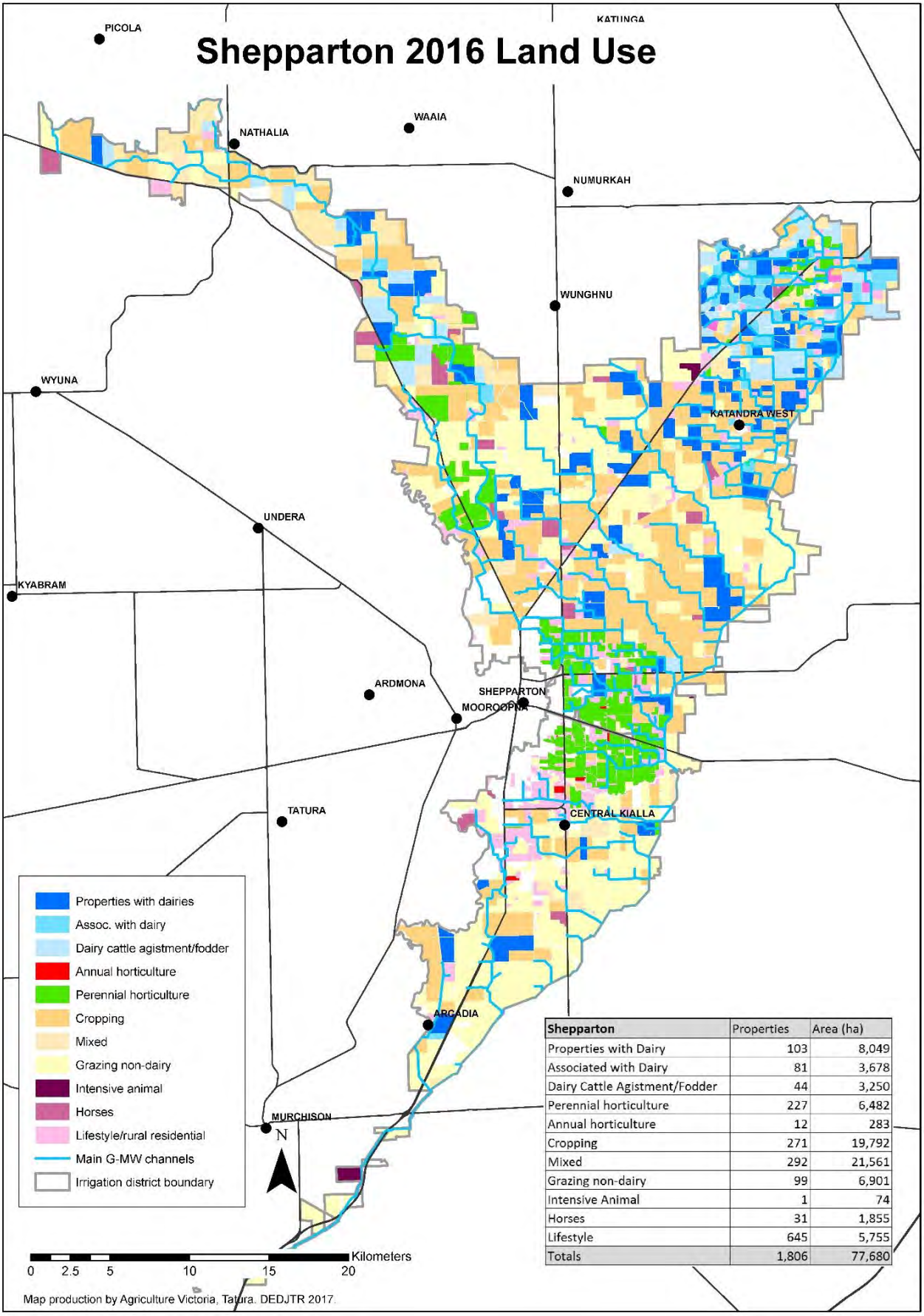


Figure 6: Area of each land use category for the Murray Valley water service area



Shepparton	Properties	Area (ha)
Properties with Dairy	103	8,049
Associated with Dairy	81	3,678
Dairy Cattle Agistment/Fodder	44	3,250
Perennial horticulture	227	6,482
Annual horticulture	12	283
Cropping	271	19,792
Mixed	292	21,561
Grazing non-dairy	99	6,901
Intensive Animal	1	74
Horses	31	1,855
Lifestyle	645	5,755
Totals	1,806	77,680

Figure 7: Area of each land use category for the Shepparton water service area

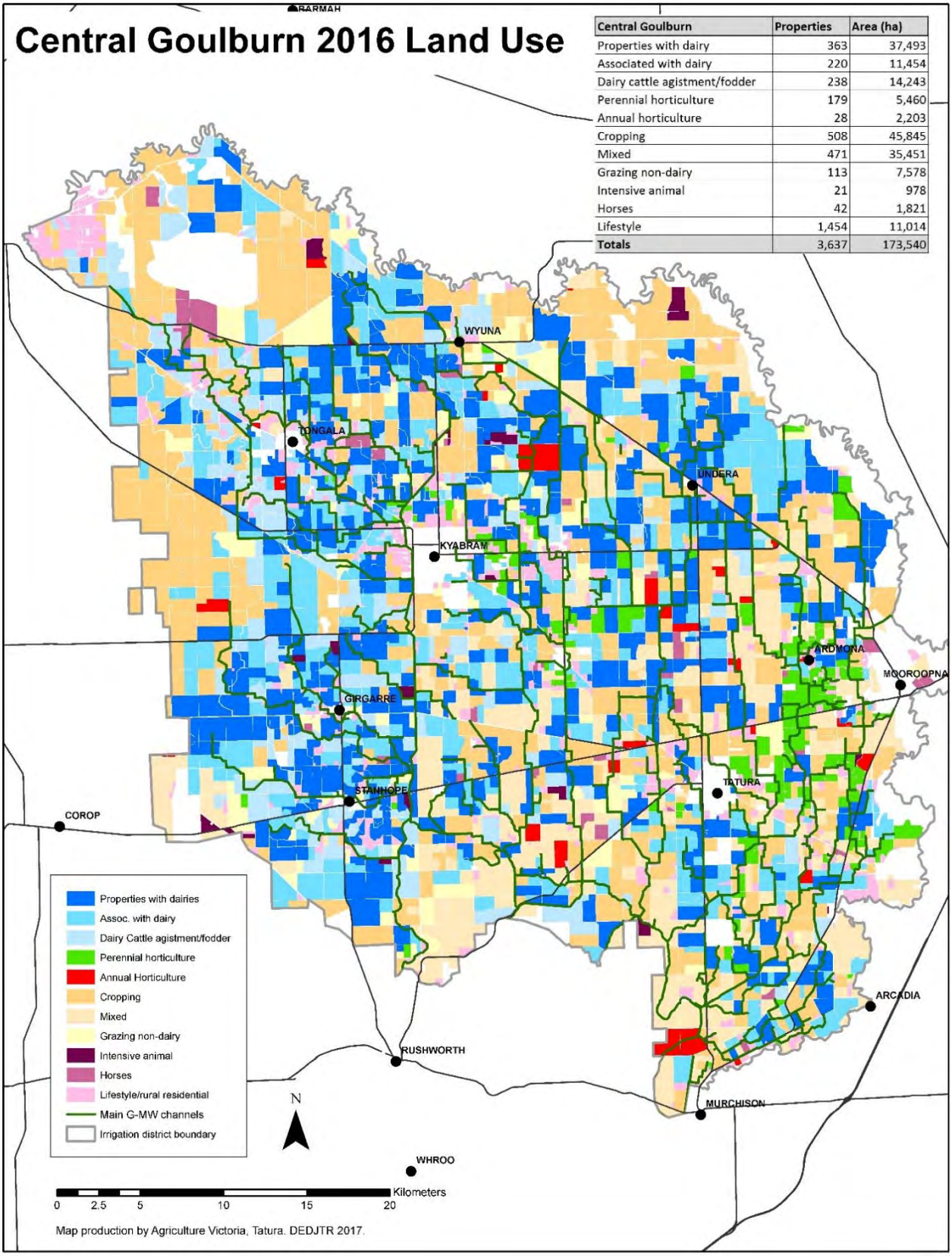


Figure 8: Area of each land use category for the Central Goulburn water service area

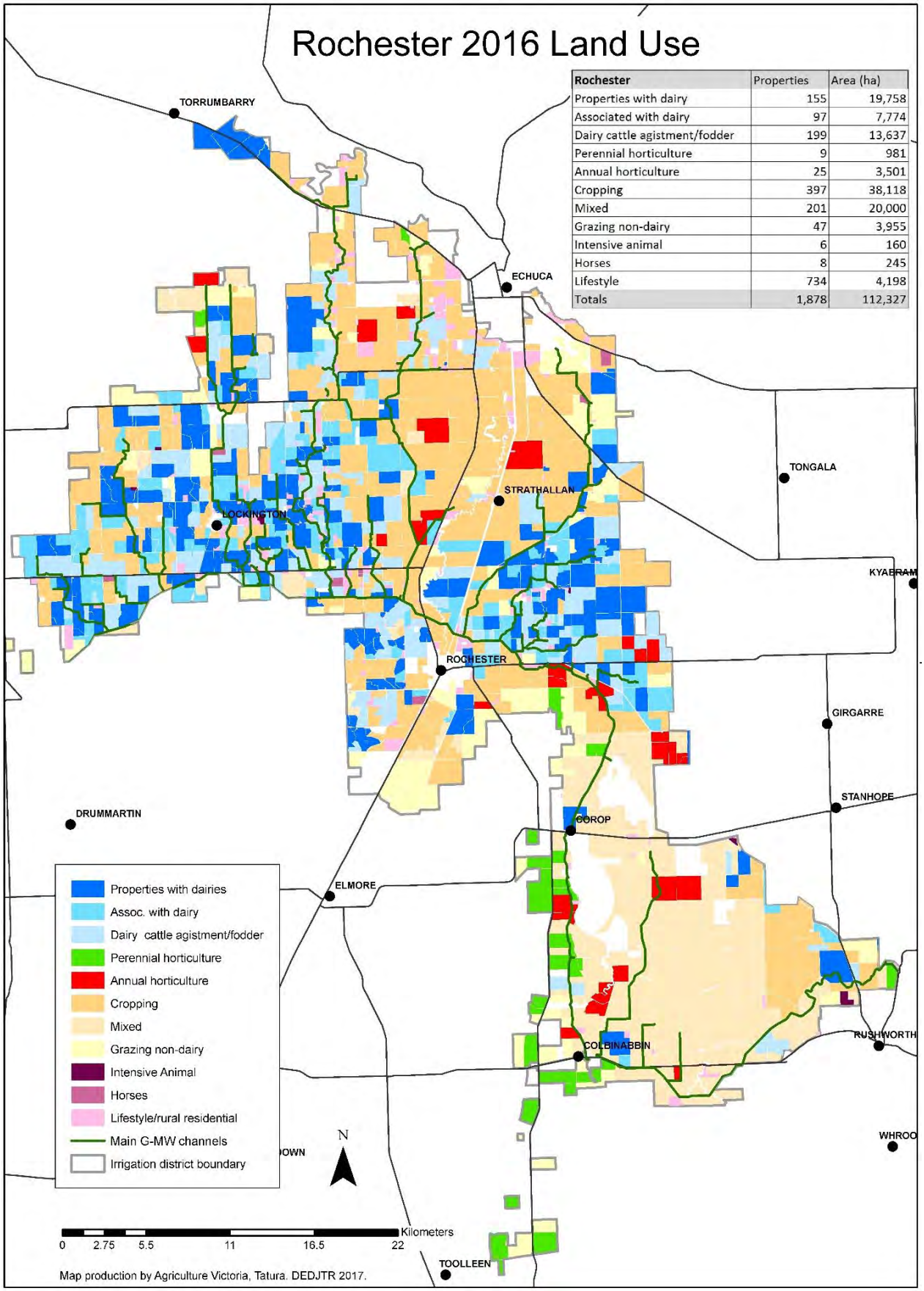


Figure 9: Area of each land use category for the Rochester water service area

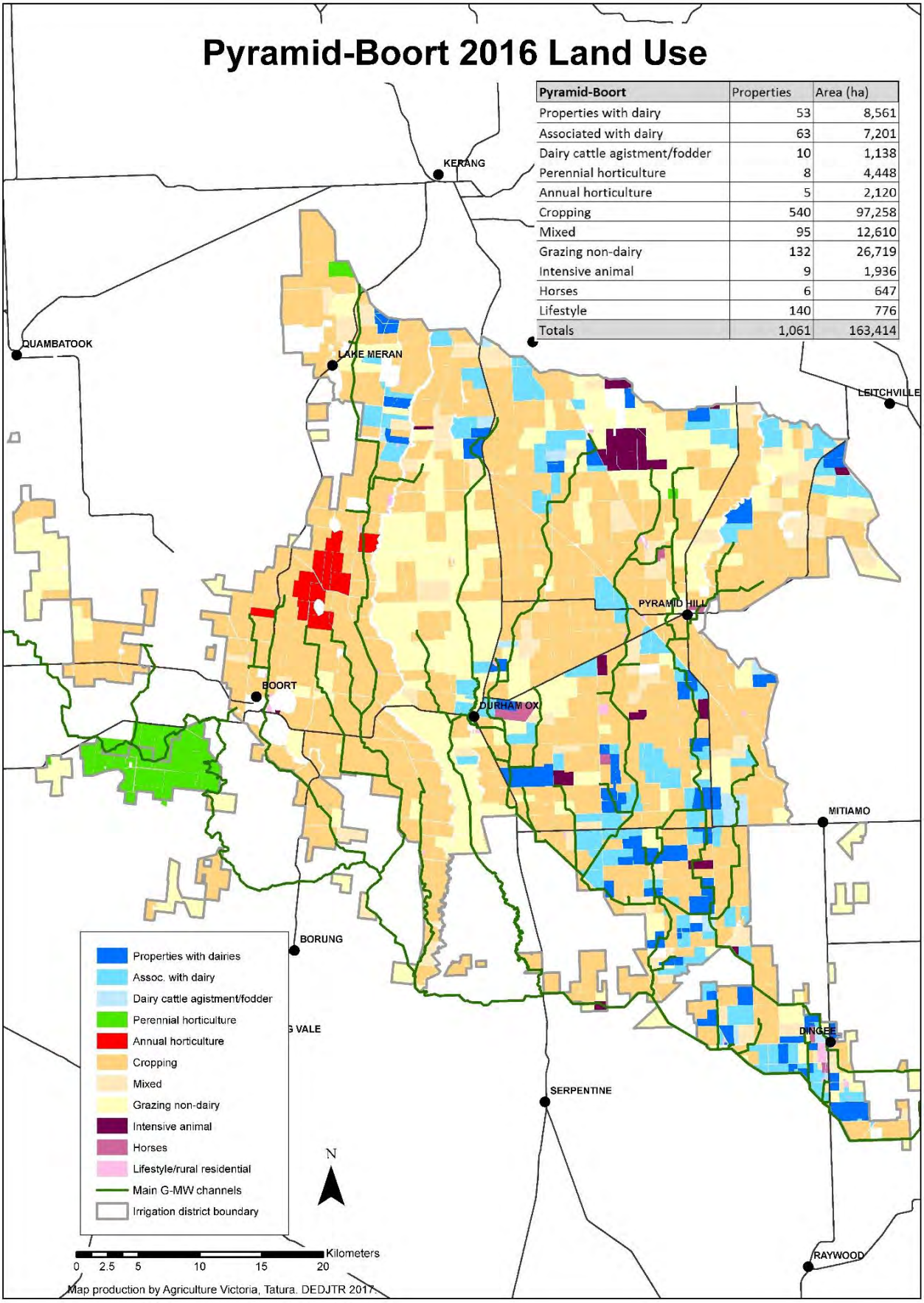


Figure 10: Area of each land use category for the Pyramid-Boort water service area

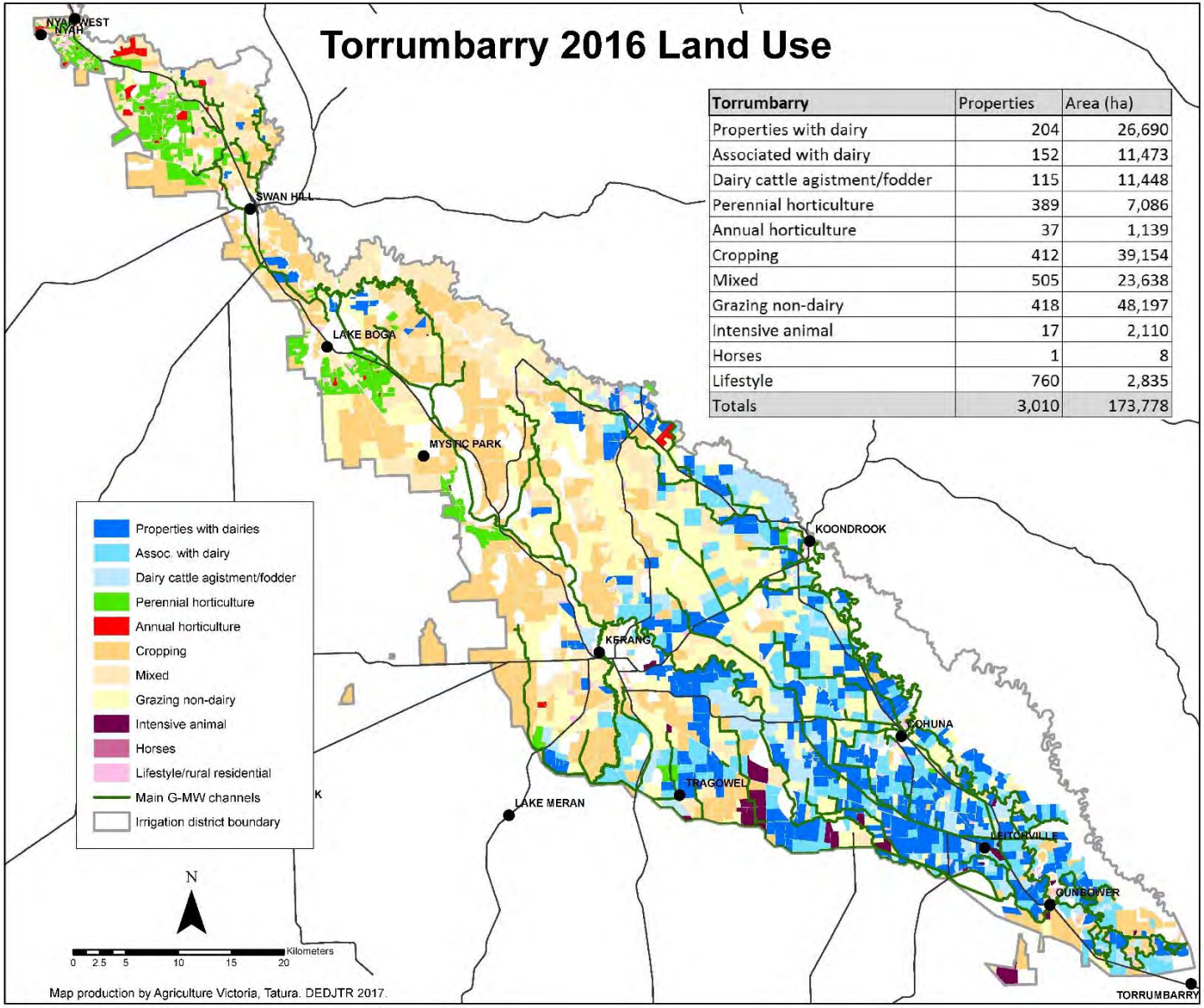


Figure 11: Area of each land use category for the Torrumbarry water service area

3.1.1.2 Land use change

This project compared the 2015/16 land use data across the GMID with data from 2000-2004 and 2009/10 (HMC Property Group 2010) for the 'Dairy', 'Associated with dairy' and 'Dairy cattle agistment/fodder' categories. This occurred specifically in relation to dairy due to resourcing; and is intended to occur for other land uses in the future.

Tables 9 shows a comparative analysis of dairy land use change across each dairy related land use category from 2000 to 2015/16. The 2000-04 period was chosen for comparison to reflect the peak period of production in the GMID for the dairy industry; whilst the 2009/10 data (HMC Property Group 2010) was collated near the end of the Millennium drought (van Dijk 2013).

Data shows that properties with functioning dairy sheds ('Dairy properties') declined significantly between 2000-2004 and 2009/10, with 114,500ha or 1700 properties identified as transitioning out of dairy ('Ex-Dairy'). In 2015/16 'Dairy properties' remained similar to numbers identified at the end of the drought period (2009/10) with 1142 properties totalling 126,720ha. No 'Ex-Dairy' categories were used in 2009/10. In its place, 'Associated with dairy' and 'Dairy cattle agistment/fodder were used to further define the 'Ex-Dairy' category used in 2009/10. 'Associated with dairy' included 765 properties; whilst 'Dairy cattle agistment/fodder' included a further 759 properties, totalling 2666 total properties.

Table 9: Dairy land use change from 2000 to 2015/16

Land Use	2000-2004 [1]	2009/10	2015/16
Dairy properties [2]	235,584ha (2721 properties)	123,571ha (1143 properties)	126,720ha (1142 properties)
Ex-Dairy (in transition)		114,500ha (1700 properties)	
Associated with dairy [3]			53,945ha (765 properties)
Dairy cattle agistment/fodder [4]			54,853ha (759 properties)
Total hectares (ha) [5]		**238,071ha (2843 properties)**	**235,518ha (2666 properties)**

1. This period reflects the peak production in the GMID dairy industry and is sourced from Valuers for that period.
2. Dairy properties are defined as council rated properties that have a functioning dairy shed.
3. Properties associated with dairies that have been linked to dairy properties through customer data and therefore form part of the dairy enterprise.
4. Dairy agistment/fodder represents former dairy properties that either still service the dairy industry or are in transition (but have not been linked to a dairy property or enterprise).
5. Total (ha) do not always match between periods due to exits and entries from new properties that previously weren't dairies.

Table 10 shows the outcome of the 2009/10 'Ex-dairy' category and what those properties transitioned to following refined categorisation in 2015/16. These 2015/16 categories (e.g. 'Associated with dairy' and 'Dairy cattle agistment/fodder') would have existed in 2009/10, but were grouped as 'Ex-Dairy'. Therefore some of the 'Ex-Dairy' category (114,500ha) in 2009/10 would have actually formed part of larger dairy enterprises; as evident in 2015/16.

Table 10: Outcome of dairy land use change from the 2009/10 'Ex-Dairy' category

Land Use	2009/10	2015/16 (ex-dairy transition)
Ex-Dairy [1]	114,500ha (1700 properties)	
Dairy properties [2]		12,000ha (109 properties)
Associated with dairy		30,000ha (410 properties)
Dairy cattle agistment/fodder		37,000ha (559 properties)
Mixed & Grazing		14,000ha (208 properties)
Cropping		20,000ha (298 properties)
Total hectare (ha)	**114,500ha**	**113,000ha** [3]

1. Properties defined as council rated properties with a non-functioning dairy shed.
2. Properties defined as council rated properties with a functioning dairy shed.
3. There are other minor categories of change that account for differences in (ha) between 2009/10 and 2015/16 (i.e. Lifestyle).

The 2015/16 data allows an improved understanding of the transition of farmers from the dairy industry since 2000. For example, of the 114,500ha or 1,700 'Ex-Dairy' properties in 2009/10, the 2015/16 data identified that:

- 42,000ha (519 properties) are still directly linked to a dairy enterprise;
- 37,000ha (559 properties) represent former dairy properties that were not able to be directly linked to a property with a functioning shed, so they either still service the dairy industry (e.g. through agistment or fodder) or are in transition; and,
- 34,000ha (506 properties) have transitioned out of dairy and were classified as mixed/grazing or cropping.

3.1.1.3 Water use change

Water use change across the GMID in total and for the dairy industry specifically was analysed, by connecting land use to water use licence data. This process identified many properties (defined as land parcels or titles) that operate at an enterprise level (i.e. multiple properties) across the GMID, suggesting that some farming businesses are expanding to accommodate changing needs.

Analysis of the dairy industry specifically was able to occur due to data availability and stakeholder funding. Dairy Australia and Murray Dairy (2017) have developed a detailed analysis on the dairy water ownership and use from collated data from this report.

Table 11 identifies the volume of High Reliability Water Shares (HRWS) owned and total volume of water use (in gigalitres - GL) by GMID irrigators and dairy between 2001/02 to 2015/16. The volume of HRWS owned by GMID irrigators remained comparative between 2001/02 and 2007/08, and then continued to decline to 2015/16 where it is 597GL less than 2001/02 volumes. Total water use by GMID irrigators fluctuates slightly from year to year, but is generally close to the volume of HRWS owned until 2006/07. Water use in the GMID fell dramatically in 2006/07 during the Millennium Drought (van Dijk 2013) when allocations dipped as low as 33-35% against HRWS in the GMID. Water use in the GMID increased around 2010/11, and in some seasons (e.g. 2012/13 and 201/15) is as high as before the drought. This has resulted in a gap between HRWS and water use by GMID irrigators (and dairy) since 2011/12.

Table 11: Water use change in the GMID and dairy industry

Year	GMID HRWS (GL)	GMID water use (GL)	Dairy HRWS (GL)	Dairy water use (GL)
2001/02	1597	2053	819	1065
2002/03	1598	1450		
2003/04	1567	1652	709	922
2004/05	1543	1534		
2005/06	1517	1739		
2006/07	1480	945		
2007/08	1585	769		
2008/09	1490	574		
2009/10	1365	774		
2010/11	1273	772		
2011/12	1103	1286		
2012/13	1068	1622	470	746
2013/14	1068	1295		
2014/15	1000	1456	465	740
2015/16	1000	1230	465	600

Data source: GMW & DEDJTR

Figure 12 illustrates the current gap between water ownership and water use, with water use higher than the volume of HRWS ownership in the GMID. This means GMID irrigators have an increased reliance on the allocation (temporary) trade market to meet their production needs.

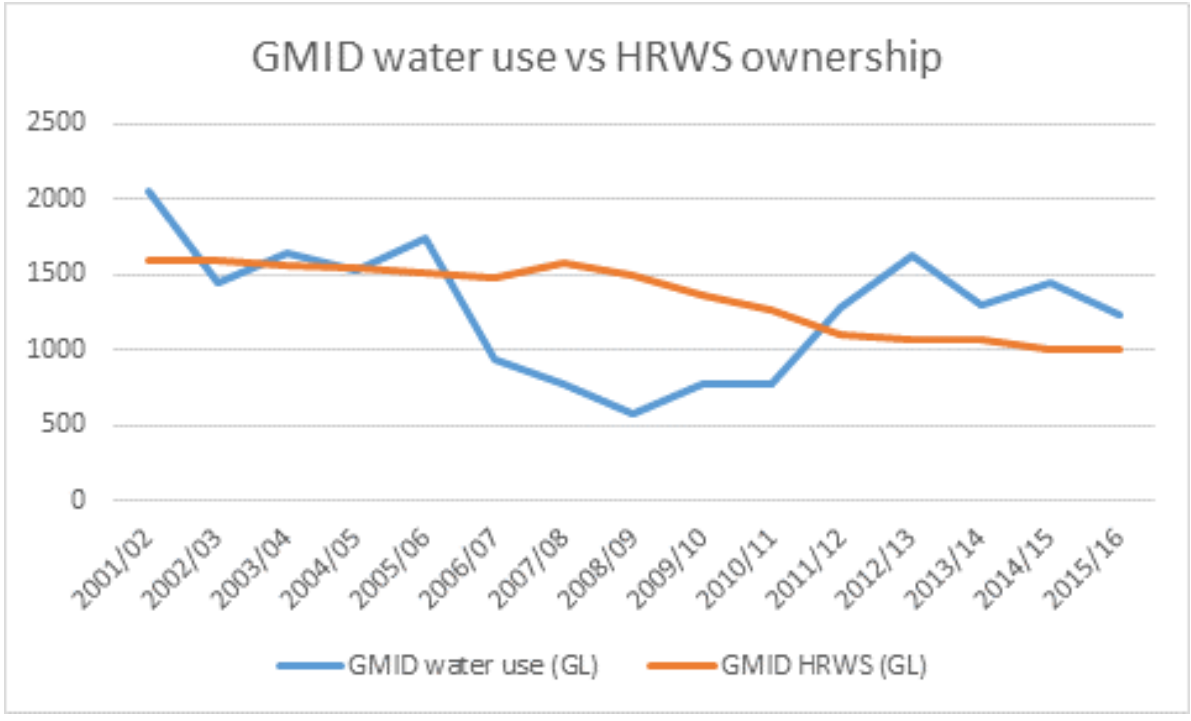


Figure 12: GMID water use versus High Reliability Water Share ownership

Water use for GMID irrigators was also analysed and assessed at a pod (a grouping of irrigation properties in a geographical area) scale. Figure 13 depicts the percentage change of overall total usage for each pod, between the 2014/15 and 2015/16 irrigation seasons to demonstrate the distribution of water use change. Data indicates that most of the pods declined in water use but the extent of decline was varied across the GMID and there are some pods that actually increased their water use. This illustrates the effects of two different allocation seasons and provides data for further interrogation for future projects.

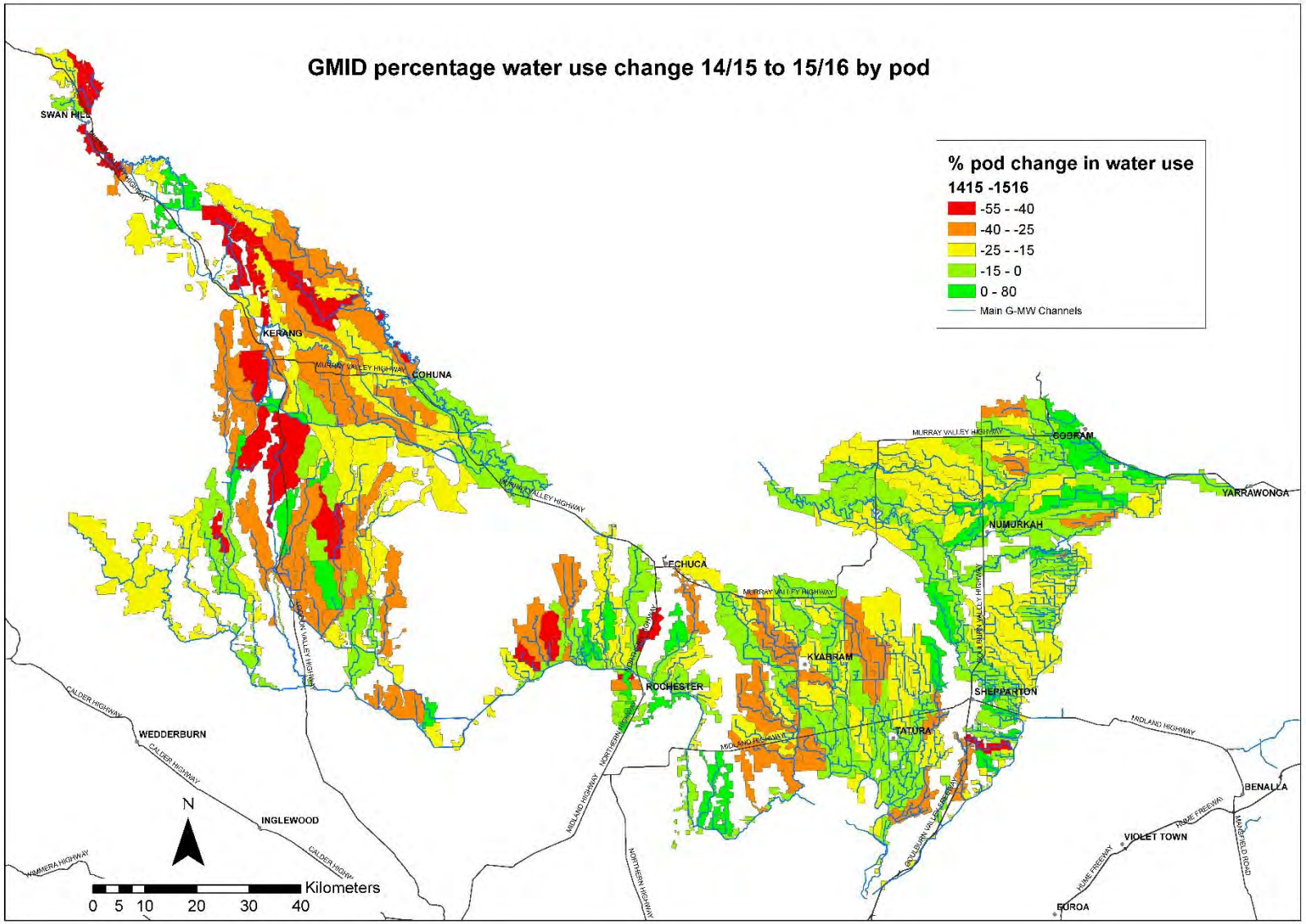


Figure 13: Percentage of water use change across the GMID between 2014/15 to 2015/16 by 'pod'

3.1.1.4 Irrigation methods

Stage 1 data capture identified the irrigation delivery method for each of the 13,230 irrigation properties surveyed across the GMID. Discussions with landholders were held if it was difficult to ascertain the method of delivery. Results indicate that 86% of properties were irrigated by gravity channel, followed by pipe and riser (4.4%), drip or trickle irrigation (4.2%) and travelling irrigators, centre pivots/linear move (3.8%) (Table 12).

Table 12: Types of irrigation methods used across the GMID

Irrigation Method	Area (ha)	%
Gravity channel irrigation	222,268	86
Pipe and riser	11,221	4.4
Drip or trickle irrigation	10,769	4.2
Travelling irrigators, centre pivots/linear move	9,758	3.8
Fixed sprinkler systems with knocker type action	1,798	0.7
Micro and mini-sprinklers	1,244	0.5
Furrow irrigation	772	0.3
Other	287	0.1
Total	**258,117**	**100**

3.1.1.5 Irrigated land cover/usage

Areas of land usage (cover) that were irrigated at the time of survey (January to May 2016) were determined across the 13,230 irrigation classified properties, with a total of 258, 117ha under irrigation. The most extensive irrigated land use/cover was 'winter grain or fodder crops' with over 131,000ha, comprising over 50% (131,00ha) of the total irrigated land use/cover in the GMID at the time of survey. Annual pasture covered 62,497ha, a total of 24.2% of the total irrigated land use/cover (Table 13).

Table 13: Irrigated land cover/usage in the GMID

Irrigated land cover/usage	Total (ha)	Percent%
Winter grain or fodder crop (e.g. wheat, barley, canola, faba beans, oats)	131,029	50.8
Annual pasture (pasture irrigated in spring and/or autumn)	62,497	24.2
Perennial pasture (pasture irrigated through to summer)	20,267	7.9
Summer grain or fodder crop (e.g. maize, millet, sorghum, soybean)	18,717	7.3
Irrigated lucerne	6,108	2.4
Stone fruit (e.g. apricot, peach, nectarine)	4,309	1.7
Pome fruit (e.g. apples, pears)	3,843	1.5
Other permanent orchard species (e.g. kiwi fruit, berries, avocados, nuts)	3,447	1.3
Grapevines	2,380	0.9
Tomatoes	2,239	0.9
Poor block (weeds only)	825	0.3
Other vegetables and annual fruit crops (e.g. melon, lettuce)	742	0.3
Turned and rested paddock or orchard	630	0.2
Other irrigated plantings (please specify)	442	0.2
Any other irrigated crops or irrigated fallow	346	0.1
Citrus fruits of all types	226	0.1
Irrigated wood lots (not shelter belts)	71	0.0
Total	**258,117**	**100.0**

3.1.1.6 Modernisation

Twenty-one percent of the 13,230 properties were identified in Stage 1 surveys as having part of their on-farm irrigation modernised (upgraded using modern technologies) (Table 14). This data identified properties that had undergone modernisation of on-farm irrigation methods regardless of whether these works were part of government-funded on-farm efficiency works or had been carried out independently. Results were determined on the basis of the irrigation infrastructure observable by the valuer as at the date of inspection.

Table 14: Percentage of irrigation properties that have modernised irrigation infrastructure (%)

Modernised Irrigation Infrastructure [1]	%
Yes	21
No	79

1. 'Modernised' is not whether the property is connected to the main delivery channel (commonly referred to as the backbone), but whether the irrigation technology delivering water to the property has been modernised (upgraded).

3.1.2 Stage 2 interview results

Detailed interviews of 384 randomly selected irrigators were undertaken during the 2015/16 irrigation season, to accompany the Stage 1 land use data capture. The interviews were conducted as a means of providing information about farm irrigation enterprises within the Goulburn Murray Irrigation District (GMID) in northern Victoria and improve understanding of irrigator's views of land and water issues.

The following section presents a summary of the technical data analysed following the 384 irrigator interviews. Where possible, a comparison has been made with 2004/05 results (GMW 2006) which was when the last comparative irrigator interview project was undertaken.

The spread of respondents by municipality is shown in Table 15. The properties originally selected are shown and not the attached enterprises. The spread of respondents by land use (e.g. dairy, cropping and horticulture) were provided previously (Table 7) as it is the basis for stratification of the population to determine our sample.

Table 15: Spread of respondents by municipality

Municipality [1]	No. Irrigators	%
Campaspe	126	32.8
Gannawarra	62	16.1
Loddon	47	12.2
Moira	99	25.8
Greater Shepparton	50	13.0
Total Interviews	**384**	**100**

1. Excluding Swan Hill

3.1.2.1 Land use practices

For the 2015/16 irrigation season, the majority of respondents (53.9%) reported growing annual pasture, followed by perennial pasture (34.4%) and winter grain/fodder (32%). Table 16 provides the tabulated data on land use.

Dairy farmers reported growing annual pasture (73.6%), followed by perennial pasture (59.5%) and lucerne (46.3%). Growing annual pasture was more common among dairy farmers, although it was also popular among other industry groups. Almost 28% of all irrigators were growing lucerne, with 46% of dairy respondents growing lucerne. Over 32% of respondents reported growing winter grains and fodders; which was observed as the most extensive land cover across the GMID in the Stage 1 land use surveys.

Table 16: Proportion of irrigators growing major crops/pasture on their property (%)

Industry	Perennial pasture	Annual pasture	Lucerne	Winter grain/fodder	Summer grain/fodder
Dairy	59.5	73.6	46.3	26.4	16.5
Cropping	21.5	46.3	19.8	37.2	7.4
Mixed farming	21.3	44.3	19.7	44.3	6.6
Livestock production	35.6	59.3	25.4	32.2	6.8
All irrigators [1]	**34.4**	**53.9**	**27.9**	**32.0**	**9.6**

1. Some respondents provided multiple responses

3.1.2.2 Irrigation systems

This section provides information on the types of irrigation systems operated by irrigators on their properties in the GMID (Table 17). More than 76% of respondents reported that they operate a gravity channel irrigation system on their properties. Twelve percent of all irrigators are using pipe and riser systems. Nearly three percent reported having pressurised systems, mainly centre pivots and linear move sprinkler systems. Micro-drips and sub-surface irrigation systems are common among orchard properties. Although the methodology for Stage 1 and 2 were different, both found that gravity channel irrigation is the most extensive irrigation method to deliver water in the GMID.

Table 17: Proportion of irrigators using different irrigation methods on their properties (%)

Industry	Gravity channel irrigation	Pipe and riser	Furrow irrigation	Centre pivot and linear move	Fixed sprinkler systems	Micro drip and sub-surface irrigation
Dairy	86.0	24.0	0.0	5.0	0.8	0.0
Cropping	77.7	6.6	0.8	0.8	0.0	2.5
Orchard	18.2	0.0	0.0	0.0	31.8	36.4
Mixed farming	70.5	4.9	0.0	0.0	1.6	4.9
Livestock production	84.7	10.2	0.0	6.8	0.0	1.7
All irrigators [1]	**76.8**	**12.0**	**0.3**	**2.9**	**2.3**	**3.9**

1. Some respondents provided multiple responses

When asked about the sources of water that supported respondent's irrigation properties, the majority (84%) reported channel supply as the major source of water (Table 18). Other respondents reported using groundwater (9.9%), drain and river diversion (3.9%) and some (0.3 %) using treated waste water.

Table 18: Proportion of irrigators using various sources of water on their properties (%)

Industry	Channel supply	Groundwater supply	Drain or river diversion	Treated wastewater
Dairy	89.3	17.4	6.6	0.8
Cropping	85.1	7.4	2.5	0.0
Orchard	86.4	0.0	0.0	0.0
Mixed farming	75.4	6.6	0.0	0.0
Livestock production	83.1	6.8	6.8	0.0
All irrigators [1]	**84.6**	**9.9**	**3.9**	**0.3**

1. Some respondents provided multiple responses

3.1.2.3 Farm context and irrigators views on-farm operations

The survey results showed that the majority of irrigators had been farming for more than 35 years, ranging from 30 to 40 years for different industry groups (Table 19).

Table 19: Years of farming

Industry	No.	Median (years)	Mean (years)	Standard Error of Mean
Dairy	n=120	37.0	35.6	1.35
Cropping	n=117	40.0	37.9	1.78
Orchard	n=21	30.0	33.0	4.15
Mixed farming	n=59	30.0	35.7	3.47
Livestock production	n=58	36.5	35.7	2.07
All irrigators [1]	**n=375**	**35.0**	**36.2**	**0.97**

1. Not all respondents answered all questions in the interviews

Responses to 'how many years have you been operating the present property' are provided in Table 20. On average irrigators were operating their present property for 25 years.

Table 20: Operating the present property

Industry	No.	Median (years)	Mean (years)	Standard Error of Mean
Dairy	n=120	24.0	25.7	1.52
Cropping	n=116	22.5	26.3	1.88
Orchard	n=20	27.0	29.6	3.55
Mixed farming	n=59	16.0	20.59	2.08
Livestock production	n=57	25.0	24.39	2.23
All irrigators [1]	**n=372**	**22.0**	**25.07**	**0.92**

1. Not all respondents answered all questions in the interviews

More than 96% of the respondents owned their properties and there were very few who in the 2015/16 irrigation season, reported leasing, managing (for another person) or share-farming properties. All orchardists and livestock production farmers interviewed owned their propert(ies). Ninety-two percent of dairy farmers interviewed owned their propert(ies) (Table 21).

Table 21: Ownership of properties (%)

Industry	No.	Own	Leased	Managed	Share-farm
Dairy	n=107	92.5	2.8	3.7	0.9
Cropping	n=112	97.3	0.9	0.9	0.9
Orchard	n=17	100	-	-	-
Mixed farming	n=52	98.1	1.9	-	-
Livestock production	n=51	100	-	-	-
All irrigators [1]	**n=327**	**96.5**	**1.5**	**1.5**	**0.6**

1. Not all respondents answered all questions in the interviews

When asked about their intention to keep operating the farm, more than 50% of respondents mentioned that they expect to continue operating for more than 10 years (Table 22). There were 8.6% of respondents who were undecided about their intension to remain on-farm. A few respondents mentioned that their properties were on the market and another 6.5% who indicated that they might not be operating their farm within a year. The responses were compared to the 2004/05 responses (GMW 2006) and showed the majority of respondents in 2004/05 also expected to keep operating the property for more than 10 years (or ongoing). There was a significant reduction in those expecting not to be operating in one to five years with 29.6% in 2004/05 and 7.6% in 2015/16. Many respondents qualified their answers with "whilst capable".

Table 22: Expected period of operating the property

Expect to keep operating	No.	All irrigators (%)	2004/05 data (%)
0 years	25	6.5	N/A
1-5 years	29	7.6	29.6
6-10 years	81	21.2	24.6
More than 10 years/on-going	205	53.5	45.8
Don't know/ undecided	33	8.6	N/A
On-market/sold	10	2.6	N/A

Answers to the above question were compared among industry groups to check for differences. There were no differences to the expected period of operating the property among industry groups (Table 23).

Table 23: Chi-square test result showing no association between 'expected period of operating the property' and 'industry group'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is no association between *'expected period of operating the property'* and *'industry group'*	Chi-square test	23.494	20	Not sig. at 0.10 probability level

Table 24 shows irrigators responses when asked to respond to the statement – '*I think this property will be irrigated in 5 years' time'*. More than three-quarters (78.4%) agreed that their properties would still be irrigated in the next five years and seven percent disagreed. Very few irrigators were willing to indicate that their property would not be irrigated in five years' time. The results were compared to the 2004/05 data (GMW 2006) and showed that the majority of respondents agreed with the statement that they would be irrigating in 5 years' time. This contrasts with Table 22 data where the majority of respondents expect to keep operating the property for 10 years or more.

Table 24: Response to a statement – 'I think this property will be irrigated in 5 years' time' (%)

Industry	Disagree	Undecided	Agree
Dairy (n=117)	9.4	11.1	79.5
Cropping (n=110)	8.2	18.2	73.6
Orchard (n=19)	0.0	0.0	100.0
Mixed farming (n=52)	3.8	15.4	80.8
Livestock production (n=58)	5.2	19.0	75.9
All irrigators (n=356)	**7.0**	**14.6**	**78.4**
2004/05 data	**2.2**	**10.3**	**87.5**

When asked about their intention to pass properties to another person in the family, 50% of all respondents said that they would pass on their properties to another person in the family. The responses are similar across all industry groups (Figure 13). The result was similar to the 2004/05 data (GMW 2006) where 51.2% said that they would pass on their properties to another person in the family.

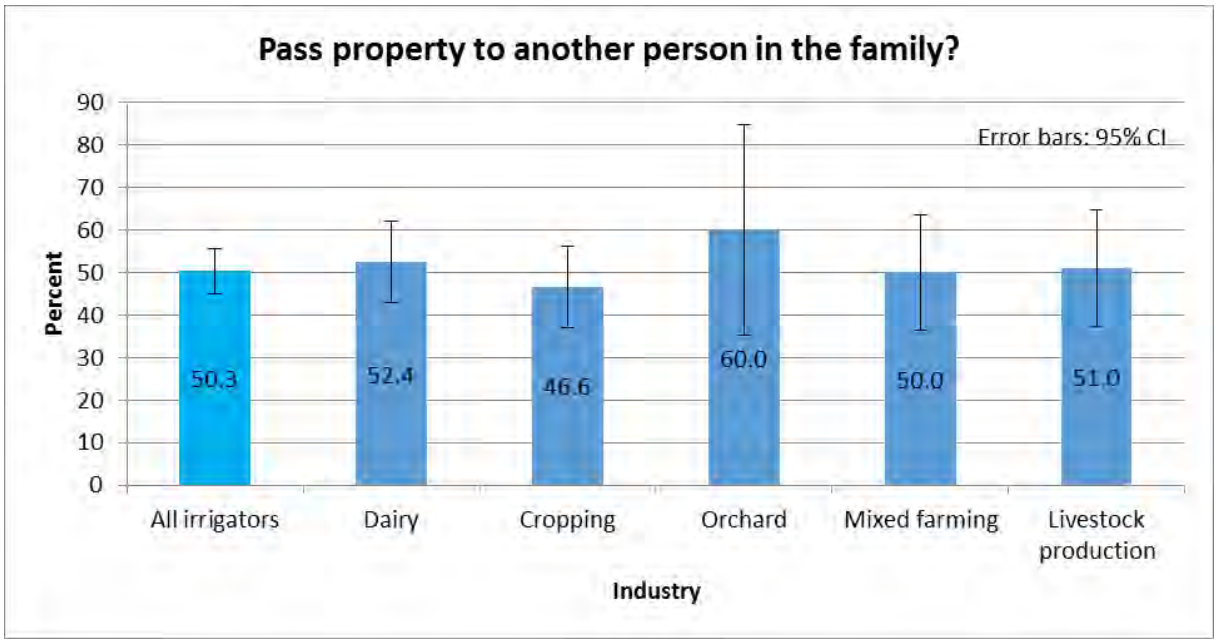


Figure 13: Interviewees response to whether they would pass the property to another family member (%)

An analysis was undertaken to determine if there was an association between expectations for family succession and industry group (e.g. dairy). Analysis found that there is no association between 'expectation for family successions' and 'industry group' (Table 25).

Table 25: Chi-square test result showing no association between 'expectation for family successions' and 'industry group'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is no association between *'expectation for family successions'* and *'industry group'*	Chi-square test	1.321	4	Not sig. at 0.10 probability level

3.1.2.4 Modernisation of irrigation infrastructure and connections

A series of questions on modernisation were asked of respondents. Nearly 68% of respondents reported being connected to the Goulburn-Murray Water main channel (backbone) system. The variation in connections among different industries are shown in Figure 14, with cropping having the highest percent of irrigators connected to the main channel system, followed by dairy and mixed farmers.

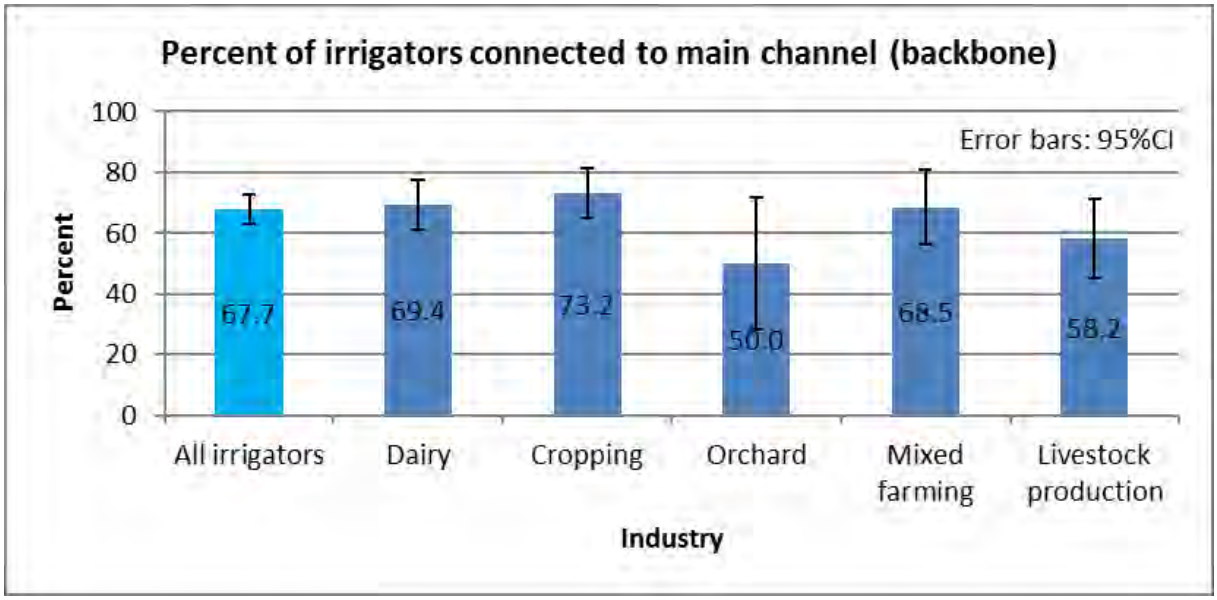


Figure 14: Percent of irrigators connected to main channel (%)

The respondents who reported being connected to the main channel system varied between municipalities, with lower connections to the main channel system in Gannawarra and Moira municipalities at the time of the survey (Table 26).

Table 26: Irrigators connected to main channel by municipality

Municipality	No.	% connected
Campaspe	n= 117	67.5
Gannawarra	n= 61	47.5
Loddon	n= 46	80.4
Shepparton	n= 91	79.1
Moira	n=47	59.6
All irrigators	**n= 362**	**67.7**

The respondents who were connected to the main channel system were also asked whether they had implemented changes to their on-farm irrigation systems following this connection (which can include outlet modernisation). Over 39% of respondents for who this was applicable said that they had improved their on-farm irrigation systems following connection to the main channel system. Dairy had the highest percent of respondents who had improved their on -farm irrigation systems and mixed farming was the lowest with 18.8% (Figure 15).

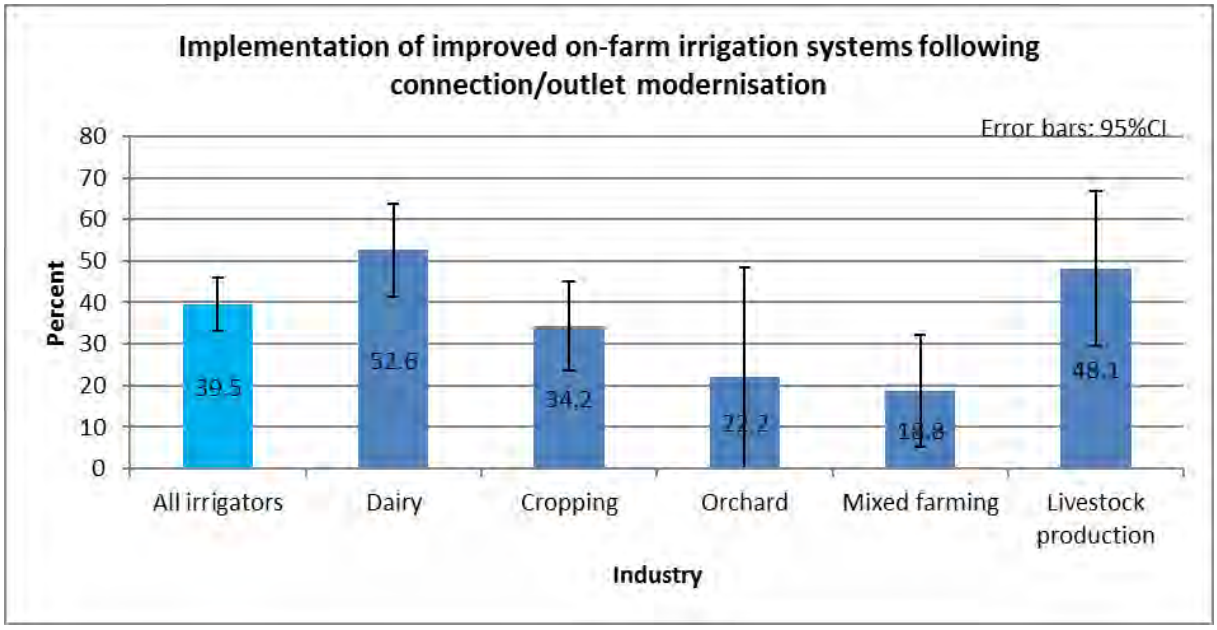


Figure 15: Implementation of improved on-farm irrigation systems by interview respondents following connection/outlet modernisation (%)

Respondents who had modernised their on-farm irrigation systems (Figure 16), were asked if they had increased production following modernisation of their on-farm irrigation infrastructure (not necessarily having to be connected to the main channel) (Table 25). Over 64% of respondents said that they had. Of the 52.6% dairy respondents who had modernised their on-farm irrigation systems (Figure 15) 75% of those increased production as a consequence (Table 27).

Table 27: Increased production after modernisation of on-farm infrastructure

Industry	No.	%
Dairy	n=40	75.0
Cropping	n=24	58.3
Orchard	n=2	50.0
Mixed farming	n=7	57.1
Livestock production	n=12	50.0
All irrigators	**n=85**	**64.7**

3.1.2.5 Changes to irrigation practices

When respondents were asked whether they had upgraded their on-farm irrigation infrastructure in the last five years (regardless of connection to the channel system), more than 50% responded that they had. The responses varied between industries, with more than 65% of dairy respondents saying that they had improved their irrigation systems in the last five years (Figure 16).

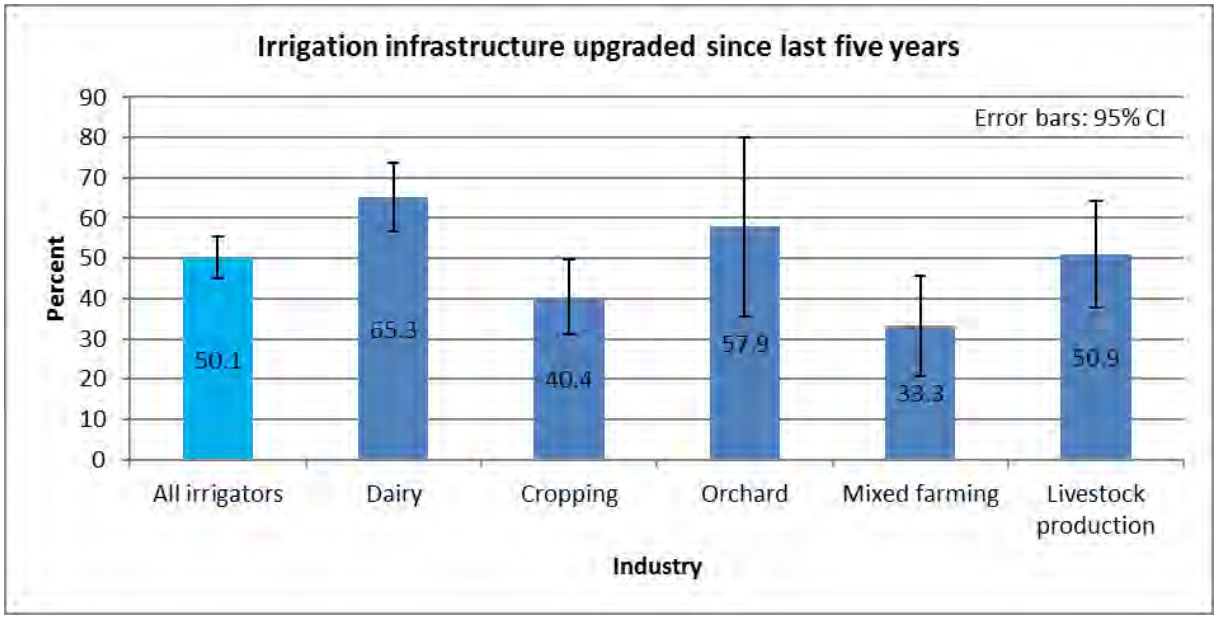


Figure 16: Irrigation infrastructure upgrades in the last 5 years prior to 2015/16 (%)

When all respondents were asked about their intention to change their irrigation infrastructure in the next five years, about half of respondents (47.8%) mentioned that they planned to do so (Table 28).

Table 28: Planning to change irrigation infrastructure in the next five years (%)

Industry	No.	Yes (%)	No (%)	Maybe (%)
Dairy	n=102	52.0	48.0	0.0
Cropping	n=92	43.5	53.3	3.3
Orchard	n=14	42.9	57.1	0.0
Mixed farming	n=44	50.0	47.7	2.3
Livestock production	n=47	46.8	48.9	4.3
All irrigators	**n=299**	**47.8**	**50.2**	**2.0**

Respondents who had upgraded their on-farm irrigation infrastructure were asked whether they had received funding (government or other i.e. private) in the last five years to do so (e.g. through an irrigation efficiency program). Thirty-six percent of all respondents who had upgraded their on-farm irrigation infrastructure (modernised) reported having received government funding to do so, with orchardists (50%) and dairy respondents (46.3%) the highest percentage who had received funding (Figure 17).

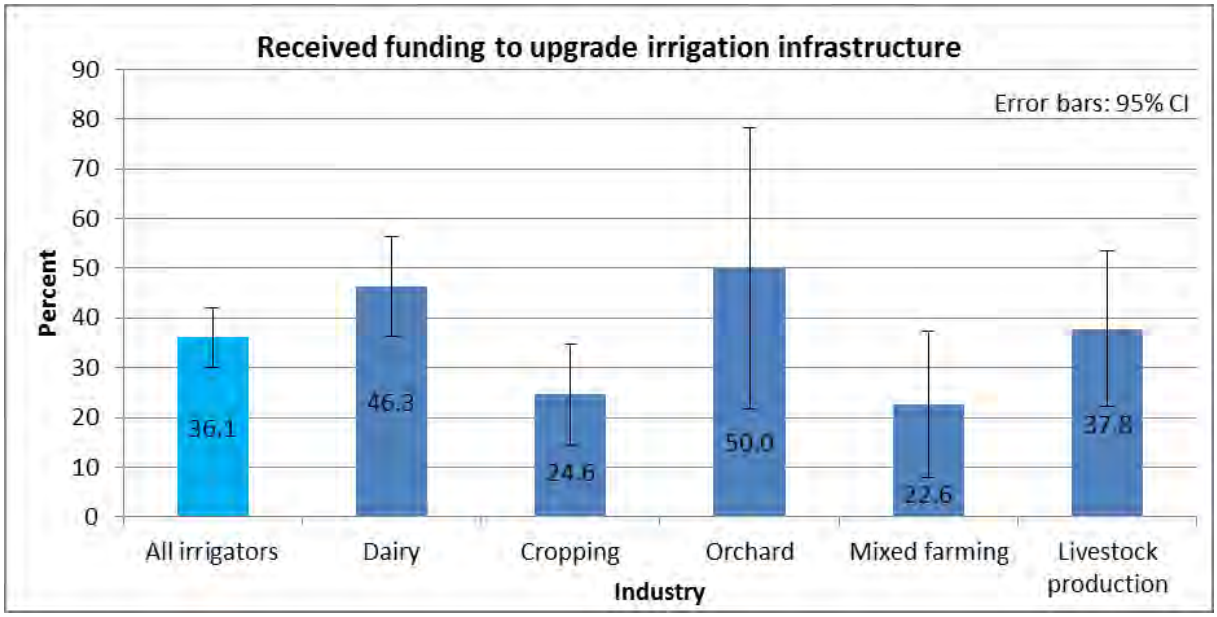


Figure 17: Received funding (government or other) to upgrade their irrigation infrastructure (%)

3.1.2.6 Barriers to changing irrigation management practices

All respondents were asked to identify significant barriers to changing their on-farm irrigation management practices. Table 29 presents the results for 2015/16 interviews along with a comparison with 2004/05 responses.

The top three barriers in 2015/16 included uncertainty of water allocation (53.9%); lack of financial resources (52.6%) and inadequate water availability (46.1%). Inadequate water availability increased substantially (by 26.8%) as a barrier to changing irrigation practices, from 19.3% in 2004/05 to 46.1% in 2015/16. Dairy and horticulture (orchard) respondents found uncertainty of water allocation and lack of financial resources to be the largest barriers to changing their irrigation management practices. Orchardists had the highest response (22.7%) to insufficient or inadequate information being a barrier for to changing their irrigation management practices.

Uncertainty of water allocation and lack of financial resources remained the highest two barriers in 2004/05 and 2015/16, with both increasing as a barrier by 6.8% and 2.4% respectively in 2015/16. Lack of time remained similar (approximately 20%) between both survey years.

Table 29: Barriers to changing irrigation management practices (%)

Barriers [1]	Dairy	Cropping	Orchard	Mixed farming	Livestock production	All irrigators	2004/05 data
Inadequate water quality	12.4	9.1	45.5	18.0	10.2	**13.8**	**2.3**
Uncertainty of water allocation	63.6	51.2	63.6	55.7	33.9	**53.9**	**47.1**
Lack of financial resources	57.0	47.9	63.6	44.3	57.6	**52.6**	**50.2**
Lack of time	21.5	19.0	13.6	21.3	27.1	**21.1**	**20.0**
Insufficient or inadequate information	6.6	6.6	22.7	6.6	6.8	**7.6**	**3.6**
Doubts about likely success	10.7	6.6	9.1	13.1	8.5	**9.4**	**12.1**
Age or poor health	11.6	24.0	22.7	21.3	11.9	**17.7**	**12.9**
Inadequate water availability	52.9	44.6	59.1	50.8	25.4	**46.1**	**19.3**
Connection/ outlet modernisation	20.7	21.5	18.2	23.0	54.2	**26.3**	**N/A**
No barriers	5.8	5.0	4.5	6.6	5.1	**5.5**	**N/A**

1. Multiple responses were provided

3.1.2.7 Allocation trade and their views on water trade

Respondents were asked how much High Reliability Water Share (HRWS) they own (at time of interview). Forty-nine percent of irrigators reported owning less than 200ML of HRWS, including almost eight percent owning no water share. This was mirrored in the positive, with 50.6% owning more than 200ML HRWS, including 7.6% owning more than 1000ML HRWS. There was some variation on the ownership of water entitlements among different industry groups (Table 30).

Table 30: High Reliability Water Share (HRWS) (%)

HRWS [1]	Dairy (n=117)	Cropping (n=113)	Orchard (n=17)	Mixed farming (n=55)	Livestock production (n=54)	All irrigators (n=356)[2]
No water share	4.1	10.6	5.9	12.6	5.6	7.8
1-50ML	11.1	24.8	23.4	25.5	22.2	19.9
51-100ML	5.1	15.9	11.8	10.9	3.7	9.6
101-200ML	10.3	10.6	11.8	18.2	13.0	12.1
201-500ML	36.8	22.1	35.3	16.4	35.2	28.7
501-1000ML	22.2	8.0	5.9	10.9	16.6	14.3
More than 1000ML	10.3	8.0	5.9	5.5	3.7	7.6

1. As respondents found it difficult to respond about how much Low Reliability Water Share they own and how much total water share they owned before unbundling (<1 July 2007), data did not enable analysis.
2. Some respondents did not answer.

In the GMID in 2015/16, nearly 64% of respondents said that they did not own enough water entitlements to meet their irrigation needs. The figures were higher among dairy respondents with 73.5% responding that they do not have the amount of water entitlements they require (Table 31).

Table 31: Response to a statement – 'I have the amount of water entitlements to irrigate my property that I require' (%)

Industry	Disagree	Undecided	Agree
Dairy (n=113)	73.5	5.3	21.2
Cropping (n=110)	60.0	13.6	26.4
Orchard (n=19)	63.2	0.0	36.8
Mixed farming (n=54)	59.3	13.0	27.8
Livestock production (n=58)	55.2	10.3	34.5
All irrigators (n=354)	**63.6**	**9.6**	**26.8**

Nearly 37% of respondents said that they rely heavily on the allocation trade (temporary) market to meet their water needs; 21% said they have some reliance; and 42% said that they had no or little reliance on the temporary market. There were 15% higher number of dairy industry respondents who said they had a large reliance on the temporary market to meet their water needs (49.2%) than any other industry (Table 32).

Table 32: Reliance on allocation trade to manage through the irrigation season (%)

Industry	No or little Reliance	Some Reliance	Large Reliance
Dairy (n=118)	31.4	19.5	49.2
Cropping (n=117)	47.0	18.8	34.2
Orchard (n=19)	42.1	26.3	31.6
Mixed farming (n=57)	45.6	21.1	33.3
Livestock production (n=58)	50.0	29.3	20.7
All irrigators (n=369)	**42.0**	**21.4**	**36.6**

Almost 46% of irrigators said allocation trade forms a large part of their farm water use. This figure was higher for dairy respondents with 54.2% (Figure 18).

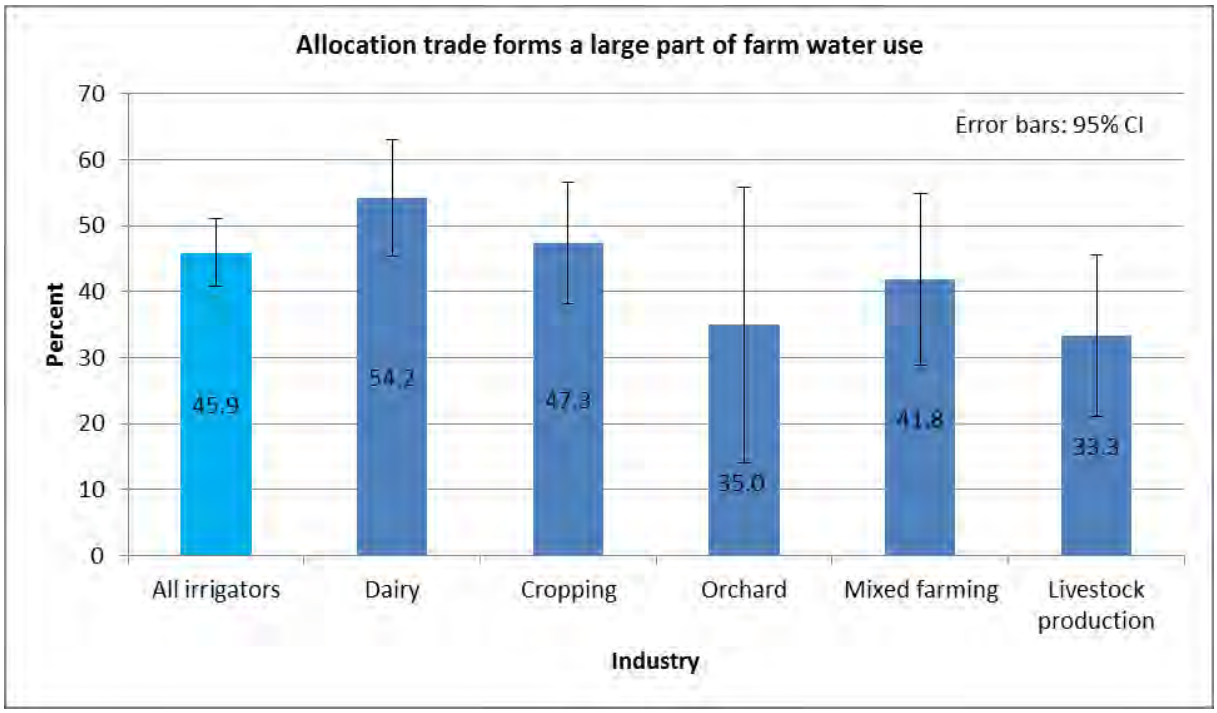


Figure 18: Allocation trade forms a large part of farm water use (%)

Few irrigators were found to trade water within their own businesses (Figure 19), with most going outside their business to trade (e.g. don't trade with entities linked to their farm business such as a superannuation fund).

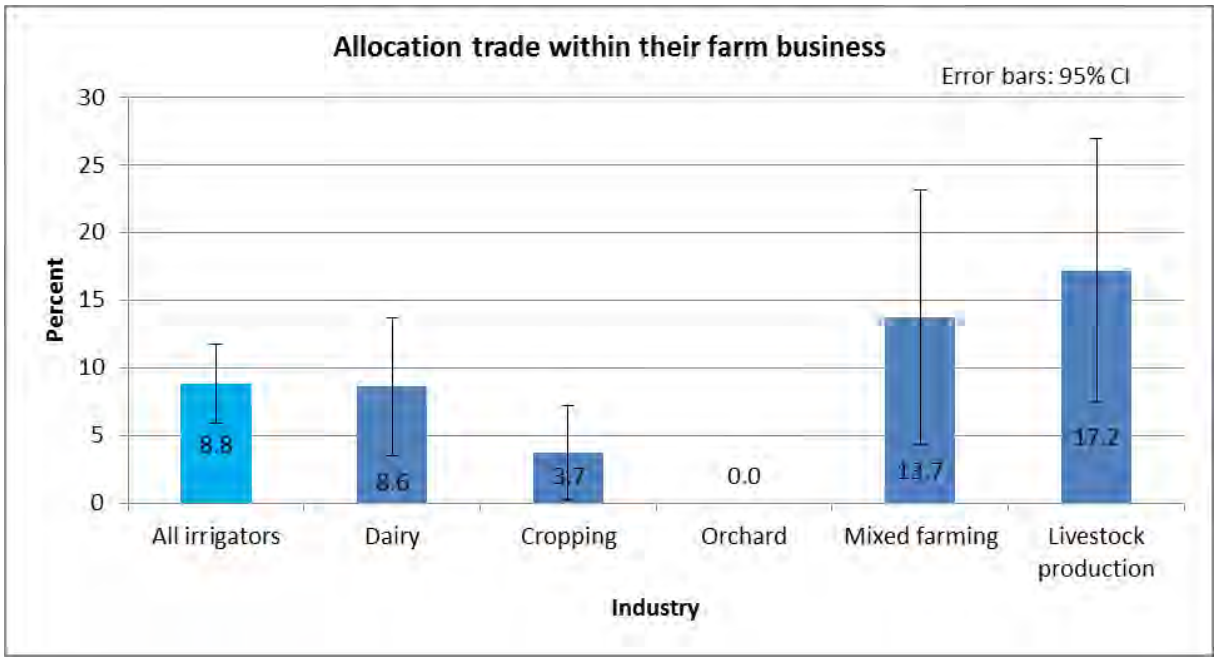


Figure 19: Allocation trade occurs with entities linked to their farm business (%)

More than 50% of respondents said that it was part of their long-term plan for their business to use allocation trade to manage through the irrigation season. The figure was substantially higher for dairy respondents with 61.3% compared to 40% orchard (horticulture) (Figure 20).

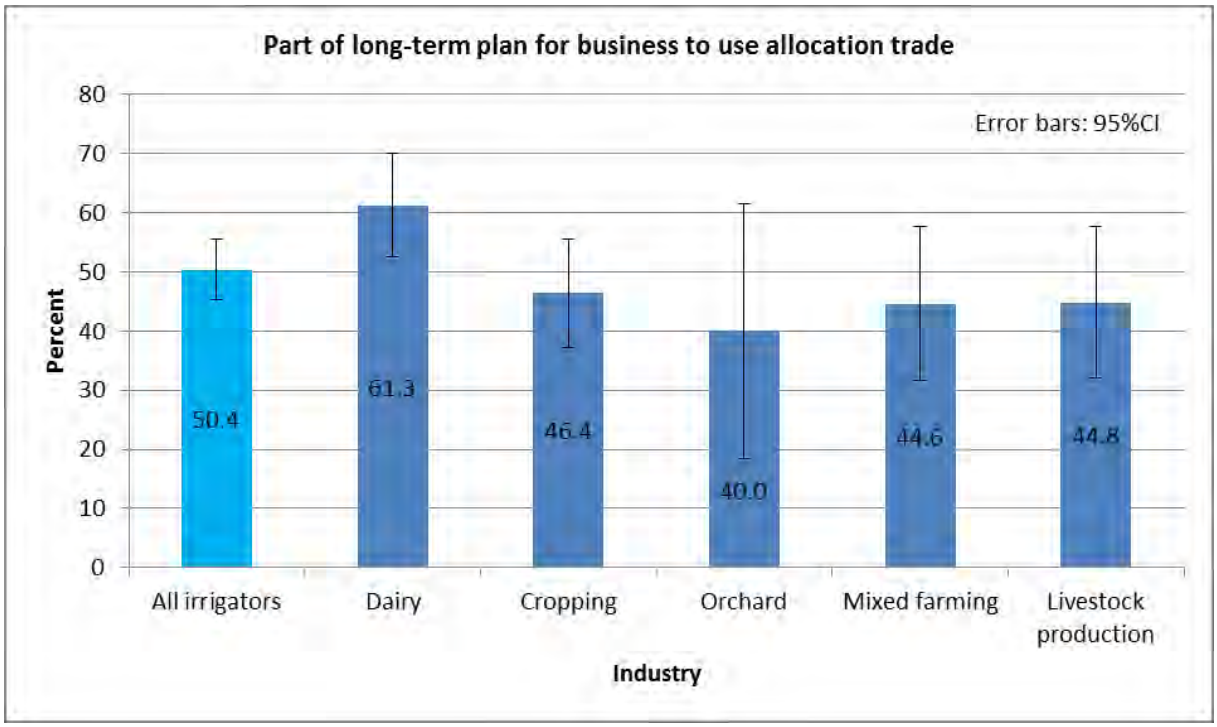


Figure 20: Part of long-term business plan to use allocation trade to manage through the season (%)

3.1.2.8 Statistical analyses between years of farming, water share and allocation trade

Some additional statistical analyses were undertaken to understand the relationship between years of farming versus 'agreeing' or 'disagreeing' with certain statements, including water share and allocation trade.

There was a significant difference between the 'mean years of farming' among irrigators who agreed or disagreed to the statement – '*I have the amount of water entitlements to irrigate my property that I require*'. The 'mean years of farming' is higher for those who agreed with the statement, indicating that older or more established farm businesses have the amount of HRWS they require, compared with younger farmers or new entrants. The result is presented in Table 33.

Table 33: Relationship between 'years of farming' versus the response 'I have the amount of water entitlements to irrigate my property that I require'

Statistical test	Test	Mean years of farming who 'disagree' with the statement	Mean years of farming who 'agreed' with the statement	Test value	Degrees of freedom	Statistical signif-icance
The mean '*years of farming*' differ between those who agree with the statement *'I have the amount of water entitlements to irrigate my property that I require'*	t-test	34 years	41 years	3.247	315	Sig. at 0.00 probability level

Similarly there was a significant difference between the 'mean years of farming' among those who have a long-term plan to use allocation trade to manage through the irrigation season versus those who do not have a long-term plan to use allocation trade (Table 34).

Table 34: Relationship between 'years of farming' versus the response 'I have a long-term plan to use allocation trade to manage through the irrigation season'

Statistical test	Test	Mean years of farming who has 'long-term plan to use allocation trade'	Mean years of farming who do not have 'long-term plan to use allocation trade'	Test value	Degrees of freedom	Statistical signif-icance
The mean *'years of farming'* differ between those who responded to the statement that they have a *'long-term plan to use allocation trade to manage through the irrigation season'*	t-test	32 years	40 years	4.177	359	Sig. at 0.00 probabilit y level

The statistical analysis also showed that there is no correlation between 'years of farming' and 'ownership of High Reliability Water Share' (Table 35).

Table 35: Correlations between 'years of farming' versus 'ownership of High Reliability of Water Share'

Statistical test	Test	Test value	Statistical significance
There is no correlations between *'years of farming'* and 'ownership of High Reliability Water Share'	Correlations	r (n=349) =0.022	Correlation value low

3.1.2.9 Impact of water price

The majority of respondents (71.4%) reported that the price of water during the 2015/16 irrigation season affected their water purchase and selling decisions. The responses were similar across all the industries with ranges from 66.7% (orchards) to dairy (75.3%) (Figure 21).

Note: 2015/16 was a dry, warm year with low irrigation allocations in some water entitlement types in the southern Basin. The seasonal conditions coupled with scarcity put upward pressure on trade allocation prices. For example in 2013/14 volume-weighted average prices were around $70/ML and in 2014/15 about $120/ML, compared to $220/ML in 2015/16 (Aither 2016).

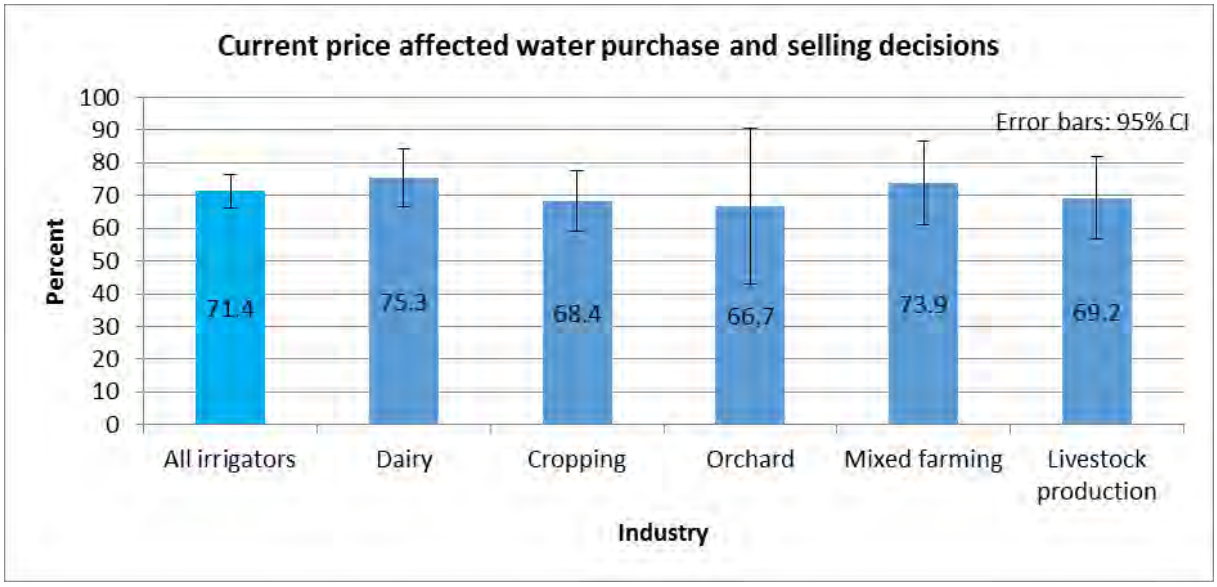


Figure 21: Whether current price affected water purchase and selling decisions (%)

Respondents were highly sensitive to allocation trade (temporary) water price, with 76.5% of all irrigators indicating that water prices greater than $200/ML were not viable for their business (Table 36). Victorian water trade data (2016) identified that the annual weighted average price of temporary water in the southern Basis was $220/ML and peaked at $250/ML in May 2016.

Table 36: Price above which temporary water becomes unviable (%)

Industry	No.	Less than $150/ML	$150-$200/ML	$201-$250/ML	More than $250/ML
Dairy	n= 73	26.0	56.2	12.3	5.5
Cropping	n= 67	41.8	31.3	23.9	3.0
Orchard	n= 12	8.3	16.7	41.7	33.3
Mixed farming	n= 38	52.6	36.8	7.9	2.6
Livestock production	n= 32	21.9	53.1	25.0	0.0
All irrigators	**n= 222**	**33.7**	**42.8**	**18.5**	**5.0**

The median price above which allocation trade (temporary) water become unviable was $150/ML with some variation among different industry groups (Table 37).

Table 37: Price above which temporary water becomes unviable ($/ML)

Industry	No.	Median ($)	Mean ($)	Standard Error of Mean	Minimum	Maximum
Dairy	n=73	150.0	174.0	6.91	60	400
Cropping	n=67	150.0	162.0	8.18	40	300
Orchard	n=12	250.0	305.0	52.75	100	700
Mixed farming	n=38	135.0	150.0	9.20	50	300
Livestock production	n=32	180.0	173.0	10.17	50	250
All irrigators	**n= 222**	**150.0**	**173.0**	**5.28**	**40**	**700**

3.1.2.10 Impacts of allocation trade

Respondents were asked whether allocation trade had a negative effect on their ability to make a profit in 2015/16. The negative impact figures were higher for both dairy (67%) and orchard (72.2%) respondents. The 2004/05 data (GMW 2006) showed a higher positive response (69.3%) to the impact of allocation trade affecting the ability of respondents to make a profit compared to 2015/16 at 19.5% (Table 38).

Table 38: Allocation trade affecting the ability to make a profit (%)

Industry	Negative impact	No impact	Positive impact
Dairy (n=109)	67.0	23.9	9.2
Cropping (n=104)	36.5	33.7	29.8
Orchard (n=18)	72.2	22.2	5.6
Mixed farming (n=52)	40.4	42.3	17.3
Livestock production (n=56)	26.8	46.4	26.8
All irrigators 2015/16 (n=339)	**47.2**	**33.3**	**19.5**
2004/05 data	**15.1**	**15.6**	**69.3**

The analysis found that allocation trade was having an impact on farm businesses, making up a significant proportion of water use and affecting water purchase and selling decisions. Over 46% of respondents said that allocation trade negatively affects their ability to plan and implement a water budget (Table 39). The figures were even higher for dairy (65.1%) and orchard (72.2%) industries. In response to the same question in the 2004/05 irrigation season, only 14% reported that the allocation trade had a negative impact on their ability to plan and implement a water budget. Similar responses could be seen for allocation trade affecting ease of operation (Table 40).

Table 39: Allocation trade affecting the ability to plan and implement a water budget (%)

Industry	Negative impact	No impact	Positive impact
Dairy (n=109)	65.1	25.7	9.2
Cropping (n=103)	36.9	36.9	26.2
Orchard (n=18)	72.2	22.2	5.6
Mixed farming (n=51)	43.1	43.1	13.7
Livestock production (n=56)	23.2	51.8	35.9
All irrigators (n=337)	**46.6**	**35.9**	**17.5**
2004/05 data	**14.4**	**32.9**	**52.7**

Table 40: Allocation trade affecting ease of operation (%)

Industry	Negative impact	No impact	Positive impact
Dairy (n=109)	64.2	28.4	7.3
Cropping (n=104)	36.5	37.5	26.0
Orchard (n=18)	66.7	27.8	5.6
Mixed farming (n=51)	43.1	43.1	13.7
Livestock production (n=56)	26.8	50.0	23.2
All irrigators (n=338)	**46.4**	**37.0**	**16.6**
2004/05 data	**11.2**	**24.7**	**64.0**

Sixty-four percent of the respondents mentioned that they expected "some" to "large" influence to their business plan by water policy. Almost 36% of respondents mentioned that water policy will have only little or no influence to their business plan (Table 41).

Table 41: Response to the statement – 'my business plan will be affected by water policy' (%)

Industry	Little or no influence	Some influence	Large influence
Dairy (n=117)	27.4	18.8	53.8
Cropping (n=112)	40.2	21.4	38.4
Orchard (n=18)	38.9	16.7	44.4
Mixed farming (n=57)	38.6	21.1	40.4
Livestock production (n=58)	41.4	32.8	25.9
All irrigators (n=362)	**35.9**	**22.1**	**42.0**

3.1.2.11 Statistical analysis of relationships between allocation trade and other variables

To understand the relationships between allocation trade and other variables, statistical analyses were conducted, the results of which are presented below.

- There is an association between 'those who have implemented on-farm irrigation upgrades' and 'those who have a long-term plan to use allocation trade' which is statistically significant (Table 42).
- There is an association between 'those who have implemented on-farm irrigation upgrades' and 'those who are reliant on allocation trade' for their water use (Table 43).
- There is a weak correlation between 'size of irrigated land owned' and 'the amount of High Reliability Water Share ownership' (Table 44).
- Those who responded that the allocation of water trade forms large part of water use on farm tend to pay higher prices for water (Table 45).
- Those who responded that they have a long-term plan to use allocation trade tend to pay higher prices for water (Table 46).
- There is no association between 'reliance on allocation trade' and 'expected period of operating the property' (Table 47).
- There is no association between 'long-term plan to use allocation trade' and 'expected period of operating the property' (Table 48).

Table 42: Chi-square test result showing association between 'those who have implemented on-farm irrigation upgrades' and 'those who have a long-term plan to use allocation trade'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is an association between *'those who have implemented on-farm irrigation upgrades'* and *'those who have a long-term plan to use allocation trade'*	Chi-square test	8.204	1	Sig. at 0.00 probability level

Table 43: Chi-square test result showing association between 'those who have implemented on-farm irrigation upgrades' and 'those who are reliant on allocation trade'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is an association between *'those who have implemented on-farm irrigation upgrades'* and *'those who are reliant on allocation trade'*	Chi-square test	6.597	2	Sig. at 0.05 probability level

Table 44: Correlation result between 'size of irrigated land owned' and 'amount of High Reliability Water Share'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is no correlation between *'size of irrigated land* owned' and 'amount of High Reliability Water Share*'*	Correlations	r (n=340) =0.226	3	Correlation value low

Table 45: Chi-square test result showing association between 'those for who trade forms a large part of water use' and 'those who pay a higher amount for water'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is an association between *'those who trade water as a large part of water use'* and '*those who pay a higher amount for water'*	Chi-square test	18.396	3	Sig. at 0.00 probability level

Table 46: Chi-square test result showing association between 'irrigators who have a long-term plan to use allocation trade' and the 'price paid for water'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is an association between *'those who have a long-term plan to use allocation trade' and the 'price paid for water'*	Chi-square test	20.873	3	Sig. at 0.00 probability level

Table 47: Chi-square test result showing no association between 'reliance on allocation trade' and 'expected period of operating the property'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is an association between *'reliance on allocation trade'* and *'expected period of operating the property'*	Chi-square test	2.501	3	Not sig. at 0.10 probability level

Table 48: Chi-square test result showing no association between a 'long-term plan to use allocation trade' and 'expected period of operating the property'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
There is an association between *a 'long-term plan to use allocation trade'* and *'expected period of operating the property'*	Chi-square test	2.213	3	Not sig. at 0.10 probability level

The investigation of relationships is an important step in the explanation of how two variables relate to each other, which contributes to the building of theories about the nature of their interaction. It does not tell cause and effect of a relationship (e.g. variable A causes variable B) but it can show whether variable A and variable B are related.

3.1.2.12 Farm management practices (environment)

Irrigators were asked whether they had a professionally prepared whole farm plan for the property, with 73.9% of all irrigators indicating that they have. Large numbers of dairy respondents (89%) responded that they had a professionally prepared whole farm plan (Figure 22). The overall figures for professionally prepared whole farm plans were higher in 2015/16 compared to 2004/05 data, which showed that 51.3% had a professionally prepared whole farm plan.

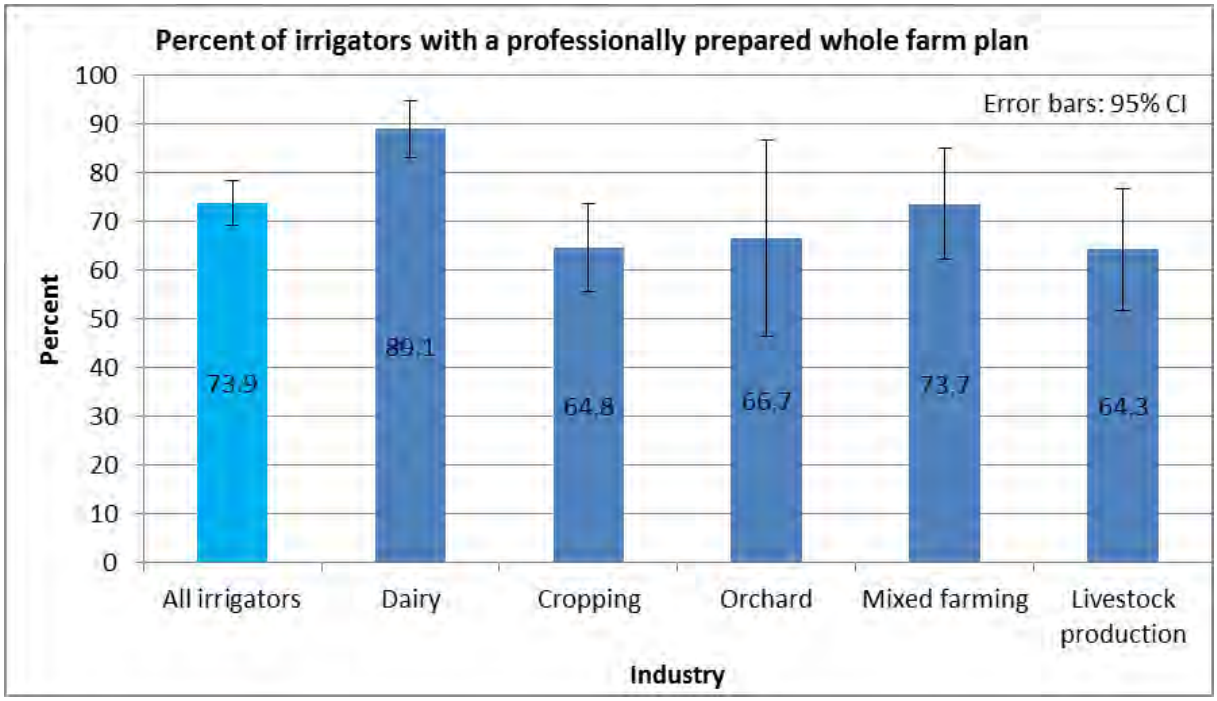


Figure 22: Percent of irrigators with a professionally prepared Whole Farm Plan (WFP) (%)

Irrigators were asked when their whole farm plan was completed. Twenty-five percent had completed their whole farm plan in the last five years, with another 24% completed six to ten years ago and another 24.7% had one for more than ten years (Table 49).

Table 49: When was your Whole Farm Plan (WFP) completed? (%)

Industry	No.	0-5 years	6-10 years	More than 10 years	No WFP
Dairy	n= 110	28.2	29.1	31.8	10.9
Cropping	n= 108	22.2	19.4	23.1	35.2
Orchard	n=21	14.3	47.6	4.8	33.3
Mixed farming	n= 57	24.6	24.6	24.6	26.3
Livestock production	n= 56	28.6	14.3	21.4	35.7
All irrigators	**n= 352**	**25.0**	**24.1**	**24.7**	**26.1**

When asked what portion of the whole farm plan that had been implemented on farm, the majority (70.3%) indicated that they had implemented 75% or above of the plan (Table 50). Dairy had the highest percentage (80.6%) of whole farm plans that had been implemented, followed by livestock production (70.6%) and orchards (63.6%).

Table 50: Portion of the Whole Farm Plan (WFP) implemented on-farm (%)

Industry	No.	0-24%	25-49%	50-74%	75% and above
Dairy	n= 93	3.2	2.2	14.0	80.6
Cropping	n= 62	9.7	1.6	25.8	62.9
Orchard	n=11	0.0	0.0	36.4	63.6
Mixed farming	n= 29	10.3	6.9	27.6	55.2
Livestock production	n= 34	5.9	8.8	14.7	70.6
All irrigators	**n= 229**	**6.1**	**3.5**	**20.1**	**70.3**

When asked about different technologies adopted on-farm, 73.9% of respondents had a professionally prepared whole farm plan, 73.2% had reuse systems, 18.4% had automatic irrigation and 12.1 had irrigation scheduling equipment. All the figures for technologies adopted were higher in 2015/16 compared to 2004/05 Irrigation Farm Survey results (Table 51).

Table 51: Technologies adopted on-farm by irrigators (%)

Technologies adopted	Dairy	Cropping	Orchard	Mixed farming	Livestock production	All irrigators	2004/05 data
Whole farm plan	89.1	64.8	66.7	73.7	64.3	**73.9**	**51.3**
Re-use system	91.1	71.3	16.7	66.0	65.4	**73.2**	**69.1**
Automatic irrigation systems	23.3	14.3	45.0	13.5	11.1	**18.4**	**8.9**
Irrigation scheduling equipment	18.1	6.2	46.7	12.8	0.0	**12.1**	**4.3**

With regards to respondents' willingness to manage salinity issues and protect environmental features, the majority (87.2%) indicated that they have a high level of willingness to manage salinity issues (Table 50) and to manage and protect environmental features on their farm (71.8%) (Table 52).

Table 52: Willingness to manage salinity issues on-farm (%)

Industry	No.	Low willingness (0,1)	Medium willingness (2,3)	High willingness (4,5)
Dairy	n=116	4.3	8.6	87.1
Cropping	n=116	2.6	12.1	85.3
Orchard	n=20	0.0	10.0	90.0
Mixed farming	n=59	1.7	8.5	89.8
Livestock production	n=56	0.0	12.5	87.5
All irrigators	**n=367**	**2.5**	**10.4**	**87.2**

Table 53: Willingness to manage and protect environmental features on-farm (%)

Industry	No.	Low willingness (0,1)	Medium willingness (2,3)	High willingness (4,5)
Dairy	n=116	0.9	31.6	67.5
Cropping	n=116	2.6	21.6	75.9
Orchard	n=20	4.8	23.8	71.4
Mixed farming	n=59	1.7	37.3	61.0
Livestock production	n=56	1.8	14.3	83.9
All irrigators	**n=367**	**1.9**	**26.3**	**71.8**

3.1.2.13 Dairy industry analysis

The irrigation survey conducted during 2015/16 had additional questions on the dairy industry. The results are summarised below. Dairy Australia and Murray Dairy (2017) have developed a detailed analysis on the dairy data collated as part of this report.

3.1.2.13.1 Herd size

The median herd size among surveyed farmers was 300 cows (Table 54) with more than 50% indicating having 300 or less cows on their properties (Table 55). The median is consistent with Dairy Australia data.

Table 54: Mean and median dairy herd size

Dairy herd size	Mean	Median	SE of Mean
Herd size for the enterprise (n=86)	458	300	73

Table 55: Percent of irrigated dairy farmers with cow numbers per enterprise (%)

Cow numbers	%
Less than 100	9.3
100-200	20.9
201-300	23.3
301-400	15.1
401-500	10.5
501-600	3.5
More than 600	17.4

3.1.2.13.2 Calving pattern

Most of the dairy respondents reported having a split calving pattern with very few with autumn calving only and spring calving only (Table 56).

Table 56: Calving pattern (%)

Calving pattern (n=103)	%
Autumn calving	3.9
Spring calving	11.7
Split calving	83.5
None	1.0

3.1.2.13.3 Dairy shed set up

More than 50% of respondents have a swing over dairy shed, with 25% having a rotary system and 21% with double-up system (Table 57).

Table 57: Set-up of dairy shed (%)

Dairy shed set-up (n=100)	%
Rotary	25.0
Double-up	21.0
Swing over	54.0

Respondents with a rotary dairy system had a larger herd size compared to those with a double-up or swing-over system (Table 58).

Table 58: Herd size by types of dairy shed

Set-up of dairy shed	Mean herd size	Std. Error	95% confidence interval for mean	
			Lower bound	Upper bound
Rotary	980	197	577	1384
Double-up	242	25	189	294
Swing-over	284	22	240	328

The statistical analysis indicated that the average herd size was significantly higher for a rotary set up compared to the other two dairy set ups (Table 59).

Table 59: Analysis of Variance to test the mean herd size difference for type of dairy set-up

Statistical test	Test	Test value	Statistical significance
For dairy, an analysis of variance showed that the '*herd size'* for different types of '*dairy sheds'* was significant. Analyses using Scheffe test indicated that the average number of herd size was significantly higher for Rotary set-up (M=980, SE=197) than the other two dairy set-up.	ANOVA	F(2,105) = 16.76	0.001

Additional statistical analyses were conducted for the dairy component of the data, to understand the relationships between various variables. These results are presented below.

- There is an association between those farmers 'growing perennial pasture' and those who have 'sufficient amount of High Reliability Water Share entitlement' (Table 60).
- There is a correlation between 'herd size' and 'the size of the property' (Table 61).
- There is a correlation between 'ownership of High Reliability Water Share' and 'herd size' (Table 62).
- There is a correlation between 'size of the property' and 'ownership of High Reliability Water Share' (Table 63).
- Those who responded that the allocation of water trade forms large part of water use on farm tend to pay higher price for water (Table 64).
- Those who responded that they have a long-term plan to use allocation trade tend to pay a higher price for water (Table 65).

Table 60: Chi-square test result showing association between those farmers 'growing perennial pasture' and respondents who have a 'sufficient amount of water entitlement (HRWS)'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
For dairy, there is an association between *'growing perennial pasture'* and *'having a sufficient amount of water entitlement'*	Chi-square test	5.914	2	Sig. at 0.05 probability level

Table 61: Correlation result between 'herd size' and 'the size of the property'

Statistical test	Test	Test value	Statistical significance
For dairy, there is a correlation between '*herd size'* and *'size of the property'*	Correlations	r (n=86) =0.800	Sig. at 0.01 probability level

Table 62: Correlation result between 'herd size' and 'ownership of High Reliability Water Share'

Statistical test	Test	Test value	Statistical significance
For dairy, there is a correlation between '*herd size'* and *'ownership of High Reliability Water Share'*	Correlations	r (n=80) =0.674	Sig. at 0.01 probability level

Table 63: Correlation result between 'size of the property' and 'ownership of High Reliability Water Share'

Statistical test	Test	Test value	Statistical significance
For dairy, there is a correlation between 'size of the property' and *'ownership of High Reliability Water Share'*	Correlations	r (n=114) =0.621	Sig. at 0.01 probability level

Table 64: Chi-square test result showing association between 'those who trade water as a large part of water use' and 'those who pay a higher amount for allocation water'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
For dairy farms, there is an association *between 'those who trade water as a large part of water use'* and '*those who pay a higher amount for allocation water'*	Chi-square test	14.267	3	Sig. at 0.00 probability level

Table 65: Chi-square test result showing association between 'those who have a long-term plan to use allocation trade' and 'those who pay a higher amount for water'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance
For dairy farms, there is an association *between 'those who have a long-term plan to use allocation trade'* and '*those who pay a higher amount for water'*	Chi-square test	17.192	3	Sig. at 0.00 probability level

4 Discussion

4.1 Land Use

This project has identified diverse land use across 829,000ha of the GMID, ranging from dairy, cropping, horticulture (annual and perennial), mixed farming, grazing, intensive animals, horses and lifestylers.

Cropping was the most extensive land use accounting for more than a quarter (261,774ha) of the total land area in the GMID. Cropping properties were scattered throughout the GMID but concentrated in the west, with over half the Pyramid-Boort water service area identified as cropping. Irrigated cropping accounted for approximately 75% of the total cropping at the time of survey.

Case Study: Decisions about land use

Bob* has owned his 250ha irrigated cropping farm near Undera for almost 40 years. He grows a wide range of fodder and grain crops and has a small area of orchard on the property, one of three he farms. The property is connected to the main channel system but due to the uncertainty around water availability and pricing, he has decided against further irrigation upgrades. Each year Bob makes decisions about what to grow depending on water and commodity prices. Depending on those decisions, Bob then uses a mixture of groundwater, HRWS and internal and trade allocations, to ensure he has the water he needs to meet his farm production needs.

**names have been changed*

Dairy maintains a strong profile, particularly in Central Goulburn, Murray Valley and Torrumbarry water service areas. Properties associated with functioning dairy sheds totalled 180,665ha and are supported by other land uses such as dairy cattle agistment/fodder, mixed farming and cropping. This project has enabled an improved understanding of the number of dairy properties in transition since a 2009/10 study (HMC Property Group 2010) that reported 114,500ha (1700 properties) were no longer dairying. In 2015/16 less than one-third (34,000ha) of the 114,500ha were found to have transitioned to other land uses such as mixed, grazing or cropping. In addition, the 2015/16 survey has shown some of this shift away from dairy occurring close to major regional centres, such as Shepparton and Tatura, where properties that were traditionally able to carry smaller dairies became less profitable, but the small title sizes have lent themselves to lifestyle purchasers, and in some areas, horticultural development.

Grazing non-dairy and **mixed** farming accounted for over one-quarter (250,000 ha) of land used in the GMID, often around the fringes of dairy-based properties. This was particularly evident in Murray Valley and Torrumbarry which had the highest extent of dairy and grazing non-dairy.

Perennial horticulture (e.g. orchards) accounted for 3.5% of the total land area and was concentrated in areas of the GMID such as Shepparton, Bunbartha and Swan Hill, which are traditionally known to be horticultural areas. **Annual horticulture** (1.2% of the total land use) (e.g. tomatoes) was randomly spread across the GMID, indicating that it is an opportunistic, transient land use. The eastern areas of Shepparton and Murray Valley had the lowest extent of annual horticulture (e.g. tomatoes), potentially due to a number of socio-economic factors that influence land use such as land size, land value and land availability (Merlo 2003).

The extent of the **intensive animal** land use was considerably higher in the western half of the GMID (4046ha) compared to the eastern half of the GMID (126ha), likely due to factors such as proximity to towns, property sizes and less lifestyle properties. In comparison the eastern half of the GMID contained 74% of the **lifestyle** properties; and 83% of the horse properties, with proximity to regional centres such as Shepparton/Mooroopna, Echuca, Kyabram and Tatura.

4.2 Land cover

Over 258,000ha of irrigated land cover was identified across the GMID during the survey period (January to May 2016). The most extensive (131,000ha; 50.7%) irrigated land cover identified in Stage 1 (drive by assessments) was winter grain or fodder crop such as wheat, barley, canola, faba beans and oats. Winter grain or fodder crop is popular in Northern Victoria due to climatic conditions and the existence of a domestic and export market for the commodities such as grain, hay and livestock production (primarily as feed for the dairy industry) (Agriculture Victoria 2017a). Annual pasture was also extensive, accounting for 24.2% of the remaining irrigated land cover, which also supports the dairy industry (Agriculture Victoria 2017b).

Over 50% of respondents in Stage 2 identified annual pasture as the (or one of the) land cover(s) on their propert(ies) for the 2015/16 irrigation season, particularly dairy respondents with nearly three-quarters (73.6%) growing annual pasture (for feed). Thirty-two percent of respondents were growing winter grain or fodder which was primarily grown by mixed farmers (44.3%).

Variabilities in data within this survey (Stage 1 and 2) is driven by seasonal and water availability variations, effecting interpretation (e.g. significant rainfall events; and what was irrigated annual cropping after the period of January to June and what constituted perennial pasture during January to June).

4.3 Farm Context

In the GMID, irrigators were on average farming for more than 35 years and on average most (96.5%) own their properties. In 2015/16, 74.6% of respondents indicated that they expect to operate the property for more than five years, an increase of 4.3% since the 2004/05 survey (GMW 2006). Over half of these expected to continue operating for more than 10 years/ongoing, an increase of 7.7% since 2004/05. There were no differences to the expected period of operating the property among land uses.

This project identified many properties (defined as land parcels or titles) that were operating at an enterprise level (involving multiple properties) across the GMID, suggesting that some farming businesses are expanding to accommodate changing needs.

Case Study: Farming longevity

Sam and Ruth* have been farming their 310ha part-irrigated and part-dryland property near Echuca for almost 50 years. Their property is connected to the main channel system and they grow a mixture of pasture and fodder crops. A couple of years ago they sold 20ML of HRWS to enable them to complete some on-farm efficiency upgrades, but they have no plans to do any further upgrades. Their water needs are covered by their remaining HRWS, which fits with their desire to never be reliant on allocation trade to manage through the irrigation season. They plan to keep farming indefinitely.

**names have been changed*

In 2015/16 more than three-quarters (78.4%) of respondents agreed that their properties would still be irrigated in the next five years, which is significantly lower than in 2004/05 where 87.5% of respondents agreed. There were more respondents who were undecided; or disagreed that their properties would be irrigated in the next five years in 2015/16 compared to 2004/05.

More than half of respondents indicated that they expect to pass the property on to a family member, which was a similar response across all industry groups (no statistical association).

These results suggest that in 2015/16 many respondents had a long-term vision to continue operating their properties and to pass the properties to family, despite increasing uncertainty about whether they would continue to irrigate their properties.

4.4 Irrigation infrastructure

4.4.1 Irrigation methods

The most common irrigation delivery method across the GMID is gravity irrigation channel. Gravity irrigation channel was identified as the irrigation method used on 86% of properties in Stage 1 assessments; supported by 76.8% of respondents in Stage 2.

Dairy (86%) and livestock production (84.7%) were most commonly using gravity channel to irrigate their properties. However, this was not the case for orchards, where micro-drips (31.8%) and sub-surface irrigation systems (36.4%) were more commonly used to irrigate properties.

When asked about the sources of water that supported irrigation delivery, the majority of respondents (84%) noted channel supply as the major source of water, significantly higher than groundwater (9.9%), drain and river diversion (3.9%) and treated waste water (0.3%). Dairy properties were the only respondents who reported using treated waste water for irrigation due to access to the resource; and also had the highest percentage of respondents using groundwater (17.4%). Orchard respondents were relying solely on channel supply to irrigate their properties.

Case Study: Installing drip irrigation

Adam* owns a 20ha horticultural property near Shepparton and grows a mixture of apples, plums and pears for the fresh market. In recent years, Adam has sold some high reliability water shares to allow him to upgrade his irrigation infrastructure and currently has drip irrigation throughout his orchard. Given the increasing number of hot years Adam is also considering installing over-head sprinklers to reduce sunburn of his fruit by reducing the skin temperature. Adam now has 50% of his water in HRWS and can pay up to $300/ML if needed on the allocation (temporary) market. Adam believes that he will be farming for a while although he feels that he will need to do something about securing more water.

**names have been changed*

4.4.2 Connected to the main channel system

The majority (67.7%) of irrigators reported being connected to the Goulburn-Murray Water main channel system (backbone). Cropping were most likely to be connected to the main channel system (73.2%) followed by dairy (69.4%) and mixed farming (68.5%). Orchardists were least likely to be connected to the main channel system (50%) for which they reported to be their only source of irrigation water (Section 4.4.1). Of the respondents who were connected to the main channel system, connections varied among municipalities, with connections lower in Gannawarra (47.5%) and Moira (59.6%) municipalities and highest in Loddon (80.4%) and Shepparton (79.1%) at the time of survey.

Case Study: Connected to the main channel

Peter* has owned his 90ha irrigation farm in Northern Victoria for over 25 years. The property is connected to the main channel system, where he sources the majority of his irrigation water. He used to run a dairy herd but that became unviable for his business, so now he is focused on pasture and fodder crops to feed agistment dairy cattle. He sold about a quarter of his water entitlements, but still owns almost 50% of the water he uses in HRWS. Peter is unsure about his future in farming and although he upgraded his irrigation system about 10 years ago on 50% of his farm, he has put any further development on hold.

**names have been changed*

4.4.3 Modernisation of on-farm irrigation infrastructure

Of the respondents who were connected to the main channel system, less than a half (39.5%) had modernised (upgraded) their on-farm irrigation infrastructure. Dairy respondents were more likely (52.6%) to have modernised their on-farm irrigation infrastructure, while mixed farmers (18.8%) and orchardists (22.2%) were least likely to have modernised following connection. This may be due to various factors such as the existing suitability of on-farm irrigation infrastructure to meet the properties' irrigation needs and resourcing.

Half of all respondents indicated that they were intending to modernise their irrigation infrastructure in the next five years, including 52% of dairy respondents and half of the mixed farmers. These results suggest opportunity for assisting irrigators to prepare 'modernised' whole farm plans to adapt to the changing business environment and invest in on-farm water-use efficiency infrastructure.

Case Study: Modernising on-farm irrigation infrastructure

Jack and Rachel* have owned their 500ha dairy farm for over 20 years. A few years ago part of the farm was connected to the main channel system and this created the opportunity to get a whole farm plan and modernise their on-farm irrigation system. They have now lasered over 100ha and improved their drainage, so that 370ha now drains to re-use systems. As part of the works, 120ha has been automated and all the works combined has meant that Jack and Rachel have also been able to improve their irrigation methods. Jack and Rachel believe that with the clear productivity improvements that have come from the upgrades (non-specified) they would be keen to modernise the rest of the farm if it was also connected to the main channel system.

**names have been changed*

Approximately one third (36.1%) of all irrigators who had modernised their on-farm irrigation infrastructure (irrespective of connection to the main channel system) had received funding (government or private) to do so in the last five years, with orchardists (50%) and dairy farmers (46.3%) more likely to have received funding.

Of those who had modernised their on-farm irrigation infrastructure (irrespective of connection to the main channel system), the majority (64.7%) said that they had consequently increased on-farm production. Whether they were using the same amount of water to increase production was not captured. Dairy were more likely to have reported increased production (75%). A respondent who reported productivity increases commented "yes, due to water efficiency gains". Detailed evaluation of productivity gains for irrigators following on-farm irrigation modernisation in the region (GB CMA 2017), identified productivity benefits such as irrigation efficiency and effectiveness, and improved pasture growth, labour efficiencies and equipment savings.

4.5 Barriers to Changing Irrigation Practices

The top three barriers in 2015/16 for irrigators for changing irrigation practices included the uncertainty of water allocation, lack of financial resources and inadequate water availability. Concerns from respondents regarding uncertainty of water allocation and inadequate water availability were a theme throughout the 2015/16 interviews, with many negative comments on both issues such as “a nightmare”, “squeezing viability”, “a total concern” and that “water is the biggest item facing primary industries”. These themes have been evident since the 2004/05 surveys (GMW 2006) however the significant difference is in the increase in the number of irrigators with water availability (+26.8%) and uncertainty of water allocation (+6.8%) as a concern in 2015/16. Data suggests irrigators may be reluctant to invest further in farm upgrades and improved practices due to uncertainty about accessing enough water, at a price they can afford to operate the modernised systems and have a return on investment.

Case Study: Barriers to upgrading infrastructure

In the late 1990s when Allan* first purchased his farm he developed a whole farm plan that he has now fully implemented. Allan and his family were keen to do what they could to manage the threat of salinity to their farm and the region. Their works include installing high flow irrigation structures, lasering the irrigated land and matching that with the installation of re-use systems, to ensure all the runoff is captured and does not flow into the regional drainage system. Recently, the farm has been connected to the main channel but given the previous work they have already done and the uncertainty around water allocations and availability, Allan doesn’t see the value in investing in further irrigation system improvements.

**names have been changed*

4.6 Water Use

The percentage change of overall total water usage for each pod, between the 2014/15 and 2015/16 irrigation seasons, demonstrates the distribution of water use change largely driven by water availability and the high price of allocation (temporary) trade water. Data indicates that most of the pods declined in water use but the extent of decline was varied across the GMID and there are some pods that actually increased their water use. This illustrates the effects of two different allocation seasons including variable seasonal conditions, with 2015/16 being a dry, warm season with low allocations in some entitlement categories, affecting water availability and prices.

Data shows a greater reliance on allocation trade across the GMID now than pre 2010/11, with a reduced amount of High Reliability Water Share (HRWS) held within the region. For example, pre-drought, dairy farmers as a group used about 30% more water each year than they owned in HRWS. Post-drought (e.g. since 2011/12) dairy farmers use about 60% more water than the volume they own in HRWS. The data shows that dairy farmers are highly sensitive to water prices, with water use dropping almost 20% from 740GL in 2014/16 to 600GL in 2015/16. This reflects impacts such as dry conditions and high allocation trade water prices at time of survey.

Reduced HRWS owned across the GMID results in an increased reliance on allocation trade and greater exposure for irrigators to the water allocation market (e.g. to water price). Almost half (47.2%) of all respondents said that allocation trade was having a negative impact on their farm business, with one respondent commenting that “year to year, water is the largest component of our expenses”. However, half of all GMID irrigators have not made allocation trade part of a long-term business plan. Further detail on allocation trade is provided in Section 4.7.

4.7 Impact of Allocation Trade

Nearly 64% of respondents disagreed that they have the amount of water entitlement (High Reliability Water Share) (HRWS) required to irrigate their properties. Only 26.8% agreed; and 9.6% were undecided. Statistically, older or more established farm businesses were more likely to agree that they have the amount of HRWS (but not necessarily a higher amount) they need, compared to younger farmers or new entrants.

HRWS of (more than or less than) 201ML divided the respondents; with half having more than 201ML and half less than 201ML. Given this, and that nearly eight percent own no water share, it is not surprising that almost 46% of irrigators (54.2% of dairy) reported that allocation trade forms a large part of their farm water use; with 37% having a large reliance on allocation trade to manage through the irrigation season.

Case Study: Allocation Trade

Les* has been farming all his life and has owned his 2500ha mixed cropping farm in Northern Victoria for over 20 years. Les irrigates approximately 170ha each year with 20ha of tomatoes and the rest in winter grains and fodder crops, which he supplies to the dairy industry. Les sold all of his HRWS to reduce farm debt and as long as the price is below $230/ML, he buys between 1000-1500ML on the allocation trade market each year. Although Les acknowledges that he doesn't have adequate water entitlements, he is not in a financial position to buy back HRWS.

**names have been changed*

Fifty percent of respondents have planned for allocation trade to be part of their long-term business plan; and it forms a large part of their water use. Statistical analysis showed an association between those who have implemented on-farm irrigation upgrades and those who have a longer term plan to use allocation trade; and those who have a long-term plan to use allocation trade and the price paid for water (higher). However, there was no association between the long-term plan to use allocation trade and expected period of operating the property.

A theme of negativity toward allocation trade was evident in 2015/16 amongst irrigators. This included over two-thirds (70%) indicating that allocation trade was affecting their ability to make a profit (up from 15.1% in 2004/05). Allocation trade was reported to negatively affect respondent's ease of operation (46.4%) (up from 11.2% in 2004/05); ability to plan and implement a water budget (46.6%) (up from 14.4% in 2004/05) and had a large influence on their business plan (42%).

A highly competitive water trade market in the GMID impacts on the price of water; which was found to affect more than 70% of respondents water buying and selling decisions. Of these respondents, only 8.8% traded water within their own businesses with most going outside their business to trade. Therefore irrigators reported being highly sensitive to the price of allocation trade, with 33.7% saying that in 2015/16 water price over $150/ML was not viable for their business. The study showed that once the water market price reached $201/ML, and at $250/ML it became unviable for five percent of irrigators.

Allocation trade water price was significantly higher than $201/ML as with the annual weighted average price in the southern Basin $220/ML and peaked at $250/ML in May 2016 (Victorian Water Trade data 2016); and the volume weighted average price for the 2015/16 season was $220/ML (Aither 2016). This would have priced irrigators out of the water market or increased the stress on farm businesses to purchase water beyond their means.

4.8 Farm Management Practices (Environment)

Over 73% of all irrigators have a professionally prepared Whole Farm Plan. Whole farm plans were popular with dairy farmers with 89% having one for their property. This correlates with the intensive irrigation requirements and lay-outs required to sustain efficient and effective dairy practices. There has been a 37.7% increase in the number of properties with professionally prepared whole farm plans since the 2004/05 interviews (51.3%) (GMW 2006). The majority of respondents have implemented more than 75% of the plan. Dairy properties were most likely to have implemented a reuse system on their farm, compared to 16.7% of orchardists'. However orchardists' were more likely to have implemented automatic irrigation systems and irrigation scheduling equipment compared to the other land uses.

Case Study: Valuing Natural Resource Management

Matthew* has been farming his 120ha irrigated (70ha) and dryland (50ha) property near Mooroopna for over 10 years. He has a mixture of perennial pasture, annual pasture, irrigated lucerne and winter grains with 90ML of HRWS. Matthew has almost no reliance on allocation trade to manage through the irrigation season. He has a whole farm plan that is 6-10 years old; which has been fully implemented, including installation of a reuse system. Matthew has a high willingness to manage his property for environmental and salinity values. Over the last five years this has included planting of 2500 indigenous plants, fencing of 3ha of remnant vegetation and fencing of additional low lying areas.

**names have been changed*

A majority of respondents (87.2%) indicated a 'high' willingness to manage salinity issues on their farm, with no correlation with land use. More respondents were willing to manage salinity issues compared to managing and protecting environmental features on their properties, however the majority (71.8%) still noted a 'high' willingness to do the latter. Livestock production respondents were most willing to protect environmental features on their properties, while orchardists had a low willingness to do so.

4.9 Dairy Analysis

Dairy remains an extensive land use across the GMID, and is supported by dairy agistment/fodder and other industries such as cropping and mixed farming. This report found barriers for dairy farmers in investing in their on-farm assets such as irrigation infrastructure including; uncertainty of water allocation (63.6%), inadequate water availability (52.9%) and lack of financial resources (57%).

Over 30% of dairy farmer respondents owned less than 200ML of High Reliability Water Shares (HRWS), and 4.2% owned no water share. Statistical analysis showed an association between those farmers 'growing perennial pasture' and those who have 'sufficient amount of HRWS entitlement'. There is also a correlation between 'ownership of HRWS' and 'herd size' indicating that the amount of water owned is a limiting factor on the size of the dairy herd, but also that the size of the herd impacts on the amount of water required by the business to meet its production needs.

Case Study: Dairy Land and Water Use

Ryan and Sarah* amalgamated 10 separate dairy and beef properties to form their 1000ha dairy farm, near Shepparton. They have 160ha of perennial pasture, with the remainder a mix of annual pasture and fodder crops. They run 750 dairy cows that they milk using an 80-stand rotary dairy. They are connected to the main irrigation channel, have reduced their outlets from 40 to 10 and accessed government funding to upgrade their irrigation system. This included 180ha of travelling and pivot irrigation infrastructure, re-use systems, 270ha of automation and large-scale earthworks. During the Millennium Drought they sold 1,600ML of HRWS and although they have access to over 500ML of groundwater, they are very exposed to changes in water availability and price. They feel that as it has turned out, their current water trading situation has had a large negative impact on their ease of operating their business and their ability to plan and implement a water budget.

**names have been changed*

4.10 Further Opportunities

The dataset collected as part of this project was extensive. This project provides initial analysis and interpretation of the dataset and (where possible) draws comparisons with data previously collected in irrigator interviews (GMW 2006) and land use mapping (HMC Property Group 2010).

However, beyond this initial analysis and interpretation, the extensiveness and complexity of the dataset will enable opportunity for further testing, including additional comparisons and analysis of land and water use change in the GMID. For example, further immediate opportunities include an evaluation of land use change for each land use since 2000-04; industry water use change since 2000/01; social changes to understand the role of water in communities; and resilience and persistence of farming systems. Its ability to inform planning and policy is extensive.

5 Conclusion

The overarching picture is that the land and water use profile in the GMID is changing in response to many factors such as seasonal fluctuations, climate change, commodity prices and changes in water and planning policy (i.e. implementation of the Murray-Darling Basin Plan).

In 2015/16 less water was being used by irrigators across the GMID. Irrigators were more reliant on the allocation trade market to meet their production needs and therefore were more exposed to higher water prices than in 2004/05. Irrigators were highly sensitive to allocation trade water price which they said impacted their ability to make a profit. More than 76% of irrigators said it was unviable for their business to participate in the water market once the price reaches $201/ML and almost half of all respondents (47.2%) said that allocation trade was having a negative impact on their farm business. Different industries were willing to pay higher prices (e.g. orchards) compared to other land uses.

There was evidence of irrigators upgrading their irrigation infrastructure to increase productivity and use water more efficiently. Some have undertaken works with government funding, others have financed works privately. The majority of irrigators had developed and were implementing a professionally prepared whole farm plan, which shows willingness to improve their water use efficiency. Allocation trade now forms a large part of farm water use for many irrigators. More than 50% of irrigators' long-term business plan is to use allocation trade to manage through the irrigation season.

There is an association between respondents who have implemented on-farm irrigation upgrades and respondents who have a long-term plan to use allocation trade. Respondents who have a long-term plan to use allocation trade for their business, also tend to be willing to pay a higher price for water on the water market.

Significant barriers remain for irrigators in upgrading their irrigation infrastructure including uncertainty of water allocation, lack of financial resources and inadequate water availability. These barriers were evident in 2004/05 but have increased significantly.

At the time of survey, allocation trade was having a negative impact on irrigators in the GMID, including on their ability to plan and implement water budgets, make a profit and ease of operation. The impact of allocation trade was significantly higher in 2015/16 than 2004/05.

Irrigators interviewed had been on average farming for more than 35 years and most owned their own properties. More than 70% of irrigators interviewed believed that they would be farming their property in the next 5-10 years, and half expected to pass their property to a family member. The ageing demographic highlights the importance of understanding the barriers and encouraging transition of younger generations in to agriculture.

This project identified many properties (defined as land parcels or titles) that were operating at an enterprise level (involving multiple properties) across the GMID, suggesting that some farming businesses are expanding to accommodate changing needs.

Irrigation systems remain predominantly gravity channel fed, with some modernisation to pipe and riser and pressurised systems. This shows evidence of different industries attempting to increase their flexibility to cope with seasonal water market volatility. The challenge for industries is to adopt integrated and flexible production systems able to adjust from one year to the next to make best use of the water available, and still remain profitable – that is, turn short-term survival strategies in to profitable business management strategies.

The challenge for the GMID is how to help productive industries to remain resilient and adaptable to withstand the increasing pressures of more frequent weather extremes as a result of climate change, as well as changing water policy, market volatility and competition in the water market, which over the last decade, have led to reduced water use in the GMID. For example, opportunities exist to assist irrigators and industry groups to prepare for and adapt to change, through regional and on-farm infrastructure investments and business planning to enhance decision making.

This project is considered a first phase in the ongoing assessment and reporting on land and water use in the GMID, to inform regional, national and state water policy. Analysis and interpretation of the data collated will continue, providing a valuable and extensive resource to inform future planning and policy across a range of industries in the GMID.

6 Appendices

Appendix 1 - Steering Committee

A steering committee representing each of the participating organisations has overseen the conduct of the study (Table 65).

The steering committee was formed in 2015 and first officially met in December 2015. Its membership is shown below. The Steering Committee provided a coordinated focus to the project. Each stakeholder played a valuable role in progressing the project from inception through to data analysis, report development and communicating the results with our stakeholders and community.

Eight Steering Committee meetings were held throughout a 12 month period. An operational group was also established to support the project and comprised of members of the Steering Committee as noted in the following table.

Organisation	Representatives
Agriculture Victoria - Department of Economic Development, Jobs, Transport and Resources (DEDJTR)	Andy McAllister & Rabi Maskey
Department of Environment, Land, Water and Resources (DELWP)	Lisa Hocking, Charles Harman Brown, Michael Mozina
Goulburn Broken Catchment Management Authority (GB CMA)	Carl Walters (chair), Bek Caldwell
North Central Catchment Management Authority (NCCMA)	Tim Shanahan, James Burkitt
Dairy Australia	Claire Miller
Murray Dairy	Jenny Wilson
Goulburn-Murray Water (GMW)	Graeme Hannan, John Weber
Goulburn-Murray Water (Connections)	Mark Nayar, Shannon Lancaster, Jacki Madgwick
HMC Property Group (Consultants)	David McKenzie, Marcus Hann, Rob Gunn

Table 65: Steering Committee representatives

Appendix 2 - Stage 2 Interview Questionnaire

Interviewer name _____from LG Valuation Services, Kyabram.

LG Valuation Services have been engaged as an independent consultant by a number of agencies (as listed in media release provided), to undertake land use mapping across the Goulburn Murray Irrigation District (GMID) and to complete a random selection of one-to-one surveys with irrigators about their farming enterprise.

Purpose of the Survey

This project seeks to renew both the land and water use data for our region and provide enhanced information for on-farm infrastructure investment, property values and management practices. This information will help inform areas such as modernisation, regional development and water policy objectives.

Random selection and confidentiality

You have been randomly selected for survey. If you are happy to participate in this survey, there are up to 60 questions based on key land and water management themes. To get through the full set of questions typically takes us about 30-35 minutes, but less if not all questions apply to you. All information collected will remain **confidential** with no identifiers provided external to the collecting authorities. Details gained from the survey will be made available as aggregated information.

Opportunity to opt out

Your involvement in the land use mapping survey will be much appreciated, but is entirely voluntary. If this is not a suitable time for you we would like to come back at a more suitable time. Of course you can decline the interview and opt out now or at any time if you are not happy or are too busy to proceed.

Preamble for the Surveyor to introduce the survey format– 2015/16 irrigator surveys

For this interview, all questions asked are for the 2015/16 irrigation season (covering the period of 15th August to 15th May 2016 inclusive). Some of the information is known to authorities such as water use, however we would like to ask some of these questions to ensure accuracy of the survey. Please let me know if you do not wish to answer any of the questions or wish to pause and return to a question later.

Definition - When we use the term **"property" it can be 1 or multiple land titles, but operates as the one farm business.**
There are up to 60 questions and the number of questions will be based on the type of enterprise that you have and will be guided by how you respond to some of the questions. For example, there is a section on dairy, so this will be relevant/or not relevant for you.

Property ID _____ Municipality _____ Address _____

FOR THIS INTERVIEW, ALL QUESTIONS ASKED ARE FOR THE 2015/2016 IRRIGATION SEASON COVERING THE PERIOD BETWEEN 15TH AUGUST 2015 TO 15TH MAY 2016

Q1-3 Introduction – In this section we ask questions about your properties land use and irrigation area, so we can get an understanding of your property and what you use it for.

1. What is the total area of the property be irrigated? _____ ha

2. For this period, what area of the property was irrigated? _____ha

3. For this period, please classify the area of the property by the following land use categories.
   a. Perennial pasture (pasture irrigated through to summer) _____ ha
   b. Annual pasture (pasture irrigated in spring and/ or autumn) _____ ha
   c. Irrigated Lucerne _____ ha
   d. Winter grain or fodder crop (e.g. Wheat, barley, canola, faba beans, oats) _____ ha
   e. Summer grain or fodder crop (e.g. Maize, millet, sorghum, soybean) _____ ha
   f. Any other irrigated crops or irrigated fallow _____ ha
   g. Other irrigated plantings (please specify_____) _____ ha
   h. Laneways, sheds, dairy and areas of the property not irrigated for the survey period _____ ha
   i. How much of the property has been double cropped? _____ ha
   j. Other non-irrigated areas _____ha

Q4-5 – Irrigation Systems - These questions relate to your irrigation systems so that we can understand your water use and infrastructure.

Questions 1-5 can refer to the main part of the property (i.e. home block) but certainly not the council property that was selected. If it doesn't represent the main part of the property please note this on the survey.

Irrigation Systems

4. What irrigation methods were used on the property during this period? (Tick all that apply) and answer in hectares covered for each applicable type.
   a. Gravity channel irrigation _____ _____ ha
   b. Pipes and Riser _____ _____ ha
   c. Furrow Irrigation _____ _____ ha
   d. Travelling irrigators, centre pivots/linear move _____ _____ ha
   e. Fixed sprinkler systems with knocker type action _____ _____ ha
   f. Others (Please specify) _____ _____ ha

5. What are the sources of water that support irrigation on this property?(Tick all that apply)
   Include hectare or % Irrigated by each source
   a. Channel supply _____
   b. Groundwater supply _____
   c. Drain or river diversion _____
   d. Treated wastewater (e.g. Treated effluent) _____

Q6-12 – Farm Context – These questions relate to farm context so we can understand some of the social issues around farming in the Region.

6. How many years have you been farming? _____ years

7. How many years have you been operating this property _____ years

8. Do you own, lease, manage or share-farm this property? _____

9. How long do you expect to keep operating this property? _____years

10. Is this property part of a larger entity/enterprise? Yes [GO TO Q.11] No [GO TO Q.12]

11. How many other properties make up the entity/enterprise? ____ number; Total ha_____

12. When you cease operating the property (include enterprise if applicable), do you expect to pass this property (include enterprise if applicable) on to another person in the family?
    Yes_____ No_____

Q13-20 - Modernisation – These questions relate to the modernisation of irrigation systems. This will help to inform the current modernisation project and water policy objectives.

13. At this current point, is your property connected to the main channel system (backbone)?
    Yes_____ [GO TO Q.14] No_____ [GO TO Q.19]

14. How many irrigation outlets and how many Stock and Domestic outlets were serving your property before you were connected/outlets were modernised?

    _____number of outlets of both irrigation and D&S

15. How many irrigation outlets and Stock and Domestic outlets are currently serving your property? (following connection/outlet modernisation)

    _____number of outlets of both irrigation and D&S

16. Have you implemented changes to your on-farm irrigation systems following your connection/outlet modernisation?
    Yes_____ [GO TO Q.17] No_____ [GO TO Q.19]

17. If yes, please list/describe

    _____

    _____

18. Have you increased production following modernisation of on-farm infrastructure?
    Yes_____ No_____

19. What is the maximum flow your infrastructure enables you to take on farm? _____ML/d

19b. Is this likely to change? Why/Why not? _____

_____

20. (FOR IRRIGATORS NOT CONNECTED/MODENISED) Do you have any plans to change the way you irrigate on farm, which would require a change in your connections?
    Yes_____ No_____
    If Yes please describe? _____
    _____

Q21-25 – Changes to Irrigation Practices – These questions relate to the changes you have made to your properties irrigation practices and will help inform knowledge about on-farm investment.

21. Have you upgraded your irrigation methods in the last 5 years?
    Yes_____ [GO TO Q.22] No_____ [GO TO Q.24]

22. Did you receive government (or other) funding to improve your irrigation system in the last 5 years? (i.e. an irrigation efficiency program)
    Yes_____ No_____

23. What irrigation infrastructure upgrades have you undertaken on your property in the last 5 years?
    a. New irrigation system (specify) e.g. Pipe and riser _____ha
    b. New re-use system
       _____ha
    c. Converted to automation _____ha
    d. Lasered property _____ha

24. Do you intend to change your irrigation infrastructure in the next 5 years?
    Yes _____ (please list the changes below) No_____
    _____

25. What are the significant barriers to changing your irrigation management practices?
    a. Inadequate water quality [ ]
    b. Uncertainty of water allocation [ ]
    c. Lack of financial resources [ ]
    d. Lack of time [ ]
    e. Insufficient or inadequate information [ ]
    f. Doubts about likely success [ ]
    g. Age or poor health [ ]
    h. Inadequate water availability [ ]
    i. Connection/Outlet Modernisation [ ]
    j. Other barriers (please specify)_____ [ ]
    k. No barriers [ ]

Q26-34 – Allocation Trades – These questions relate to trading of water allocations and will help us to renew water use data and understand water use changes.

Pre 26. How much water share do you currently own?
a. High Reliability _____ML
b. Low Reliability _____ML

How much did you own before water unbundling (<1 July 2007)
a. _____ML

b. If any difference WHY? _____

_____

26. How reliant are you on allocation trade to manage through the irrigation season? (e.g. is the entitlement you have enough to cover your production needs?

    0 (No reliance) 1 2 3 4 5(large reliance)

    If not, how much on average do you need to buy on the temporary market?

    _____

    _____

27. Was it part of the long-term plan for your business to use allocation trade to manage through the irrigation season?

    Yes_____ No_____

28. Does allocation trade form a large part of your farm water use?

    Yes_____ No_____

29. Do you trade with entities linked to your farm business, for example a separate company or superannuation fund which holds water shares not linked to your WUL, or from companies held by other family members?

    Yes_____ No_____

30. Has current price (and at what price does irrigation become uneconomic in your enterprise?) of allocation affected your water purchase and/or selling decisions? If so, has it caused you to change your plans and how?

    Yes_____ No_____

    _____

    _____

    30.a At what price does irrigation become unviable for you?_____

31. Do you feel that selling and buying allocation trade water has:

	Large negative impact	Slight negative impact	No impact	Slightly positive impact	Large positive impact
A. Affected your ability to make a profit					
B Affected your ability to plan and implement a water budget					
C Affected your ease of operation					

32. *"My farm business plan will be influenced by water trading?"*

    0 *(no influence)* 1 2 3 4 5 *(large influence)*

33. Please respond to this statement *"I think this property will be irrigated in 5 years' time"*

    a. Strongly disagree _____
    b. Slightly disagree _____
    c. Undecided _____
    d. Slightly agree _____
    e. Strongly agree _____

34. Please respond to this statement *"I have the amount of water entitlements to irrigate my property that I require"*
    a. Strongly disagree _____
    b. Slightly disagree _____
    c. Undecided _____
    d. Slightly agree _____
    e. Strongly agree _____

Q35-44 – Dairy – These questions relate to dairy farming properties and will provide data on dairy numbers and management systems for dairy farms.

35. Is dairy an industry use for the property? Yes_____ No_____

36. For the period outlined, what was the average size of the herd on the property?
    _____cows

37. For the period outlined, if the property is part of an entity/enterprise what was the total herd size for the entity/enterprise?
    _____cows

38. What is the properties calving pattern?
    a. Autumn
    b. Spring split
    c. _____

39. What is the size and setup of the Dairy shed?
    Set up (e.g., rotary)_____ _____number head

40. What is the current utilisation of that shed?
    a. In use _____
    b. Not in use _____
    c. % in use _____

41. Does your property supply agistment to the dairy industry?
    Yes_____ No_____

42. Does your property supply fodder to the dairy industry?
    Yes_____ No_____

43. If the dairy shed is no longer operational, why?
    (yes, no, N/A (e.g. May have been absorbed by entity)
    _____

    _____

    _____

44. If applicable (have left milking), do you intend to return to milking?
    Yes_____ No_____

    Why? _____

Q45-56 - Management Practices - These questions relate the management of your property in terms of whole farm planning, on-farm infrastructure and natural resource management issues.

45. Do you have a professionally prepared Whole Farm Plan for the property and if so, when was it completed?
    Yes_____ [0-5 years]_____ [6-10 years]_____ [>10 years]_____

    No_____

46. What % of whole farm plan has been implemented? _____%

47. Does the property have a re-use system and if so, what area of the property does the re-use system(s) collect water from?
    Yes_____ _____ha drains No_____

48. Where does the reuse system spill to? (e.g. drain) spills to_____

49. Does the property have automatic irrigation controls? And if so, what area of the property is served by automatic irrigation controls?
    Yes_____ No_____

    _____ha served by automation

50. Does the property have irrigation scheduling equipment? If so, what type does it have? And what area (ha) of the property is service by irrigation scheduling equipment?
    Yes_____ No_____

    Types _____ _____ha served by scheduling equipment

51. How many native plants have been planted on the property in the last 5 years?
    _____ number

52. Approximately what area of remnant vegetation has been fenced off? _____ ha

53. Approximately what area of saline areas (soil) has been fenced off? _____ ha

54. Have you completed any other works on the property to protect environmentally sensitive areas?
    Yes_____ No_____

    If Yes, Explain
    _____

55. How would you rate your willingness to manage salinity issues on your property?

    0 (low) 1 2 3 4 5 (high)

56. How would you rate your willingness to manage and protect environmental features on your property?
    0 (low) 1 2 3 4 5 (high)

Thank you for your participation

All information collected will remain **confidential** with no identifiers provided external to the collecting authorities. Details gained from the survey will be made available as aggregated information. If you think of anything else that you would like to add to our discussion today, please contact me on (provide card) the following number.

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