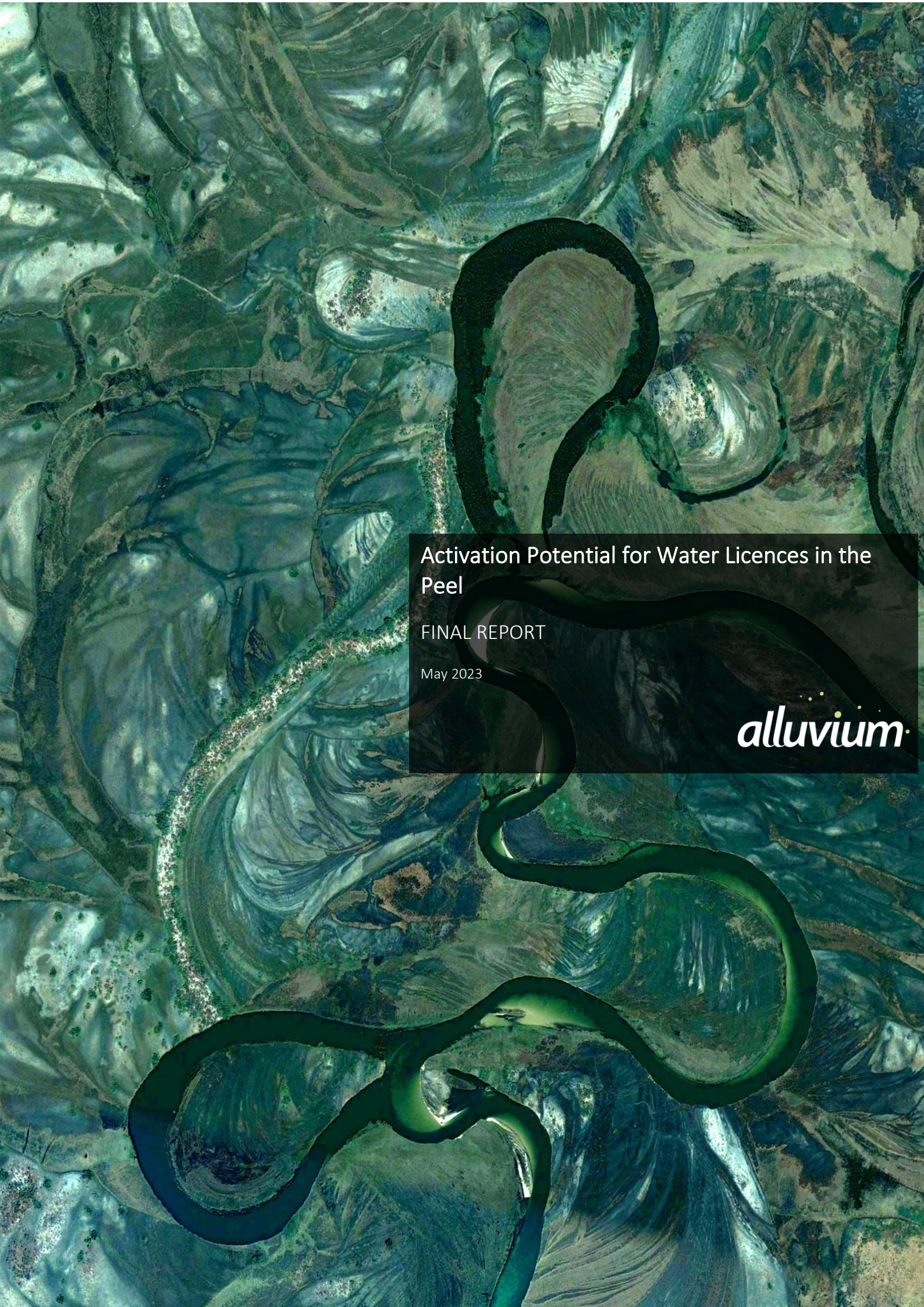

Activation Potential for Water Licences in the Peel

FINAL REPORT

May 2023

alluvium

Alluvium recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country, and Elders past and present.

Artwork by Vicki Golding. This piece was commissioned by Alluvium and has told our story of water across Country, from catchment to coast, with people from all cultures learning, understanding, sharing stories, walking to, and talking at the meeting places as one nation.

This report has been prepared by Alluvium Consulting Australia Pty Ltd for the department of Planning and Environment under the contract titled PROC 1442 'Study into Activation Potential for Water Licences in the Peel'.

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Contents

1 Executive Summary

In the Peel Regulated River system and the Peel Alluvium groundwater source, the number of shares is significantly higher than the megalitres set in the long-term average annual extraction limit – approximately 5 times higher in the Peel Regulated River and approximately 6 times higher in the Peel Alluvium. However, average use remains below the extraction limit. Despite this, active irrigators in the Peel can presently access 1 ML per share in a large proportion of years because there are currently many licences that are underused or not used at all (Figure 1).

If inactive licences are activated to a point where water use increases above the Long-Term Average Annual Extraction Limit (LTAAEL) allocations to general security water licences, licences will need to be reduced to contain usage to a level within the LTAAEL. More generally, growth in utilisation against licenced volumes would have the effect of eroding available water determinations (and hence reliability of supply) across all general security water users.

This report was prepared for the New South Wales Department of Planning and Environment (DPE) to investigate the potential of unused irrigation water licence being activated in the regulated and connected alluvial systems in the Peel. The project entailed:

- An analysis of the economic and market conditions that influence the utilisation of water licences and rates of growth in utilisation over time, and
- An assessment of the current perceptions of water access licences holders, water user groups and Tamworth council.

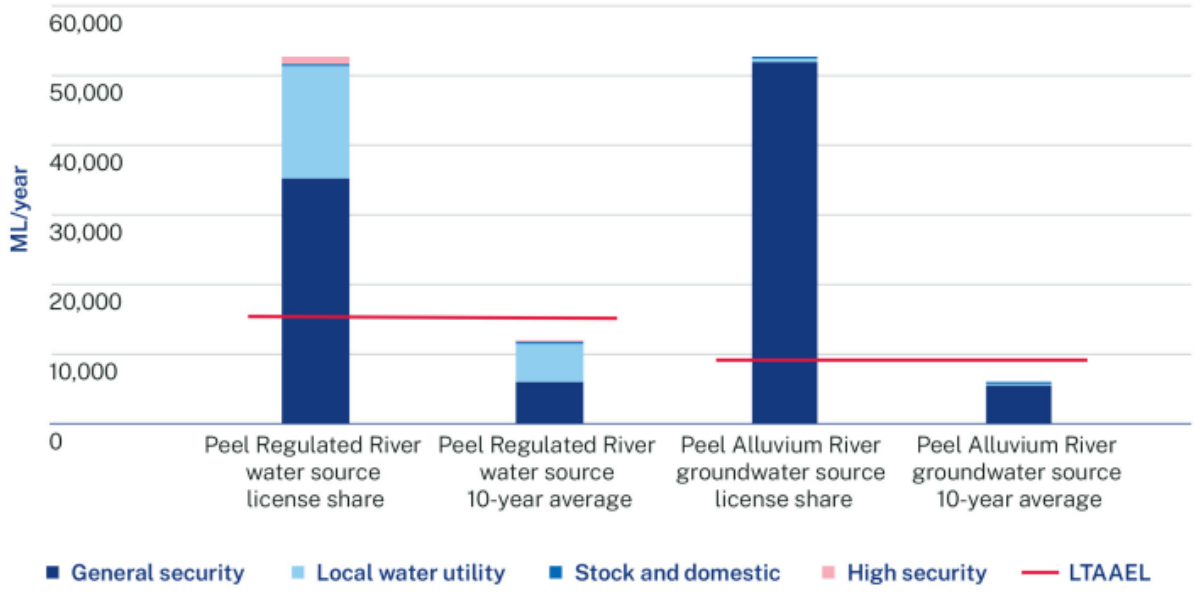

Figure 1. Peel Valley water usage and Long Term Average Annual Extraction (DPE, 2021)

Background

Agriculture is a significant driver of regional economic activity in the Peel Valley, generating up to 40.5% of indirect employment in the region (ABS, 2021). Changes to agricultural land use, water availability and the market will influence the risk of unused licences being activated.

Spatially, agricultural land in the Peel Valley is dominated by dryland livestock production. Irrigated agriculture, which is confined to the valley floor, produces lucerne and sorghum, pasture for dairy cattle, as well as some limited areas under horticulture and cereal crops. Agricultural land use in the Peel Valley is stable, with some slight increases in dryland cereals and irrigated pasture since 2015.

The climate in the Peel Valley is temperate to semi-arid. Climatic conditions influence water licence activation, where a decline in annual rainfall (i.e., dryer conditions) is typically correlated with increased demand for, and use of, available irrigation water, as illustrated in Figure 2.

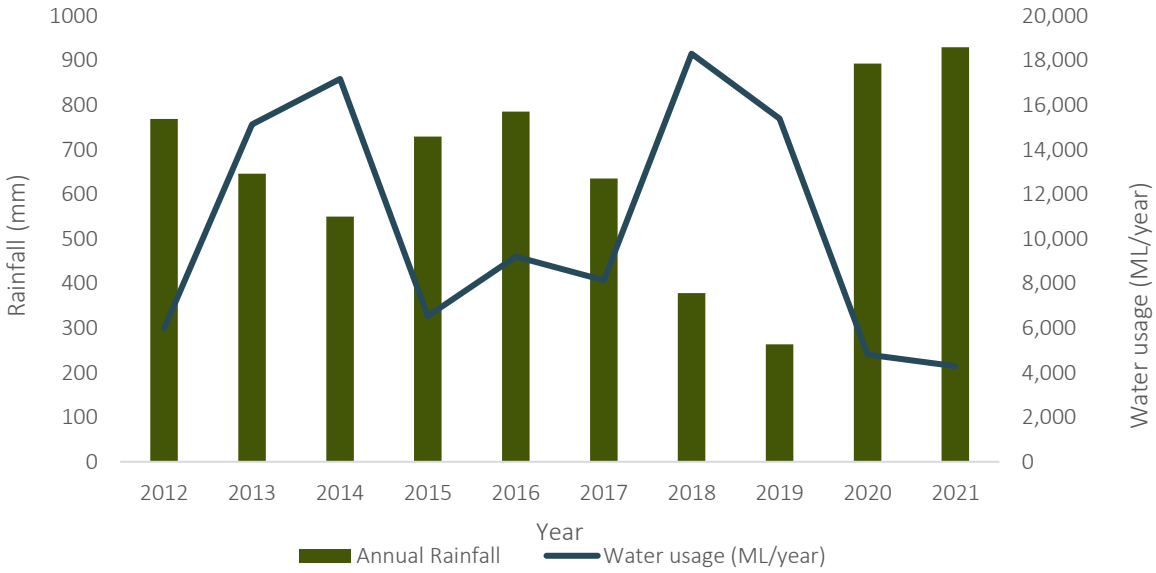

Figure 2. Tamworth airport annual rainfall and annual general security regulated river and aquifer water use (BOM, 2022; WaterNSW, 2022)

Key findings

Licence holders hold large water entitlements to manage risks of variable water availability. Water allocated by DPE to general security regulated river water entitlements varies depending on water availability. During periods of low rainfall, such as in 2014 and 2018, there are often spikes in water demand (illustrated in Figure 2 above) with almost 50% of licenced volumes activated in 2017-18 (shaded in grey in Figure 3) suggesting that periods of rainfall deficit are a significant drivers of licence activation. However, during sustained dry periods (such as the 2017 – 2020 drought), demand is constrained by available seasonal water allocations under both general security regulated river water and aquifer (general security) licences[1].

[1] Note: Allocations under aquifer (general security) licences are partially constrained under a formula tied to general security regulated river water licences allocations. (Water Sharing Plan for the Namoi Alluvial Groundwater Sources Order 2020)

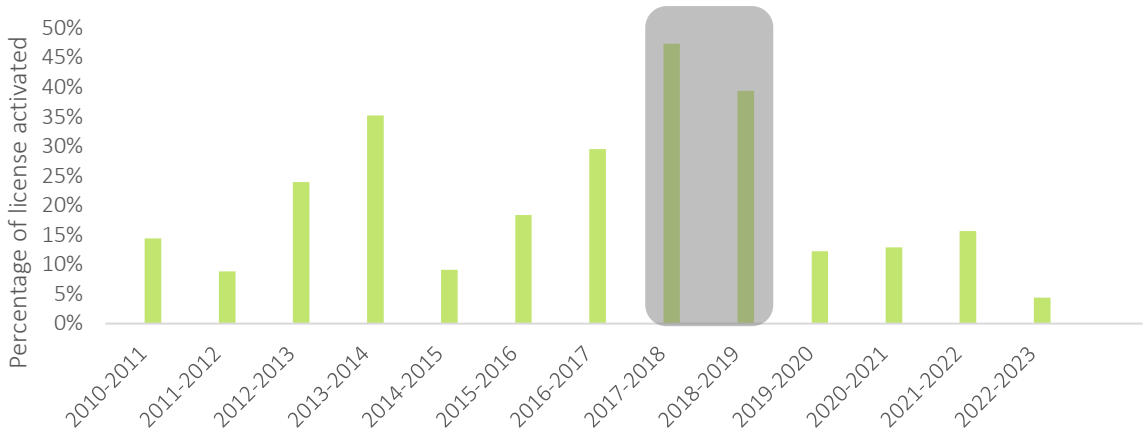

Figure 3. Annual general security (surface and groundwater) licence activation in the Peel Valley (DPE, 2022b)

Water availability and the variability in water allocations are seen as significant barriers to licence activation. Many water users hold large entitlements to manage the risk of low or variable regulated surface water allocations. Seasonal water allocations available under general security regulated river and groundwater licences varied considerably between 2010 – 2022.

During low rainfall periods in 2014 - 2015 and 2018 – 2019 general security regulated river AWD's fell as low as zero per cent. The volume of water allocated to a groundwater licence was consistently higher than regulated river water allocations with exceptions in 2016 and 2021. Groundwater allocations declined to just 1% in late 2018 but were never cut to zero per cent. Through the stakeholder consultation process it was found that irrigators consider groundwater the most reliable water source and relied proportionately more on groundwater during dry periods when surface water availability is low. However, the LTAAEL for the Peel Alluvium has not been exceeded, even during extended dry periods.

Irrigators consider water licences valuable assets and despite holding inactive licences, stakeholders consulted were unwilling to sell or trade licences on the valley-specific seasonal allocation market. A key advantage of holding licences in excess of annual usage requirements is that, in years of low allocations, irrigators have access to more water. Hence this practice provides irrigators with greater water security during dry periods than would otherwise be the case. As indicated in Figures 2 and 3, both annual water usage and availability are quite variable from year to year, and overall trends in water usage and demand over the life of the existing Water Sharing Plan appear relatively stable. Consistent with both allocation rules governing access to groundwater and stakeholder feedback, the data suggests that groundwater is used conjunctively with regulated river water to optimise reliability of supply.

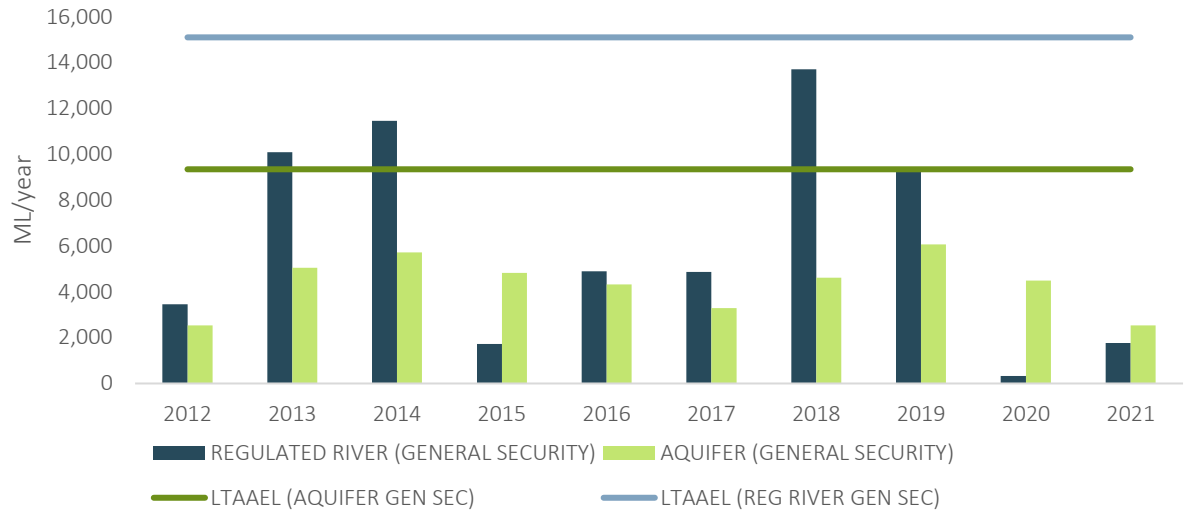

Figure 4. General security licence usage in the Peel Valley (2012 – 2021) (WaterNSW, 2022)

Farmers face significant production risks including climate, market output price volatility, pest, and disease predation, which can all significantly impact the returns from land use. Managing these risks is a critical part of farming, climate and market risks have the largest impact on profit from land use. Annual land use and market output price data from 2012 – 2021 was used together with the capacity to pay to create a risk profile for the average irrigator in the Peel Valley[2].

From stakeholder consultation two thirds of farmers are risk averse to risk neutral, choosing a range of land uses to ensure they are not overly exposed to climate, market, or production risks in any particular land use. Risk neutral to risk averse farmers generated off farm income, reducing the impact of negative returns on their overall income. A third of farmers were risk takers, which can be characterised by solely relying on one land use, with many of these farmers wholly reliant on the income from irrigated land use, therefore significantly exposed to any reduction in water allocations, climate, or price shocks. A weighted risk profile was created combining the two risk profiles to predict land allocation with varied water availability, variation in farmer risk profile, market output and input prices, to determine the most likely land use and water demand in the Peel Valley.

The outcomes of the risk modelling were combined with current urban water usage to predict a base case scenario, where some irrigated livestock and bread wheat production fodder occurs, with fodder production maintained to offset wheat climate production risks.

8 out of the 25 respondents surveyed as part of this study were considering increasing water usage to expand their irrigation area on net water demand. Survey respondents indicated that rather than activating licences they would purchase water from the market. None of the stakeholders surveyed were considering selling water in the temporary market. This suggests that the decision to increase water usage through temporary market trades is likely to result in limited expansion of irrigated land use.

To analyse the impact of increased irrigated land use, an expanded land use scenario was developed (incorporating a threshold on land able to be irrigated to reflect geographical constraints in the Peel valley, with water allocations restricted to the LTAAEL, with all other modelling assumptions used in the base case scenario applied). The most likely outcome is shown in Figure 5**Error! Reference source not found.**, with water demand increasing, but remaining below the LTAAEL.

[2] Land use data was taken from ABARES for the region and market price data was taken from ABS commodity price data

A simple, high-level evaluation of the impact of climate change on water demand was also undertaken, with projected climate change impacts captured through a factor which incorporated rainfall reduction and heat stress and varied the base case scenario water demand (base case + climate change demand scenario). Crop evapotranspiration and climate change impacts on water supply were not considered in this scenario analysis as a detailed analysis of this nature was out of scope.

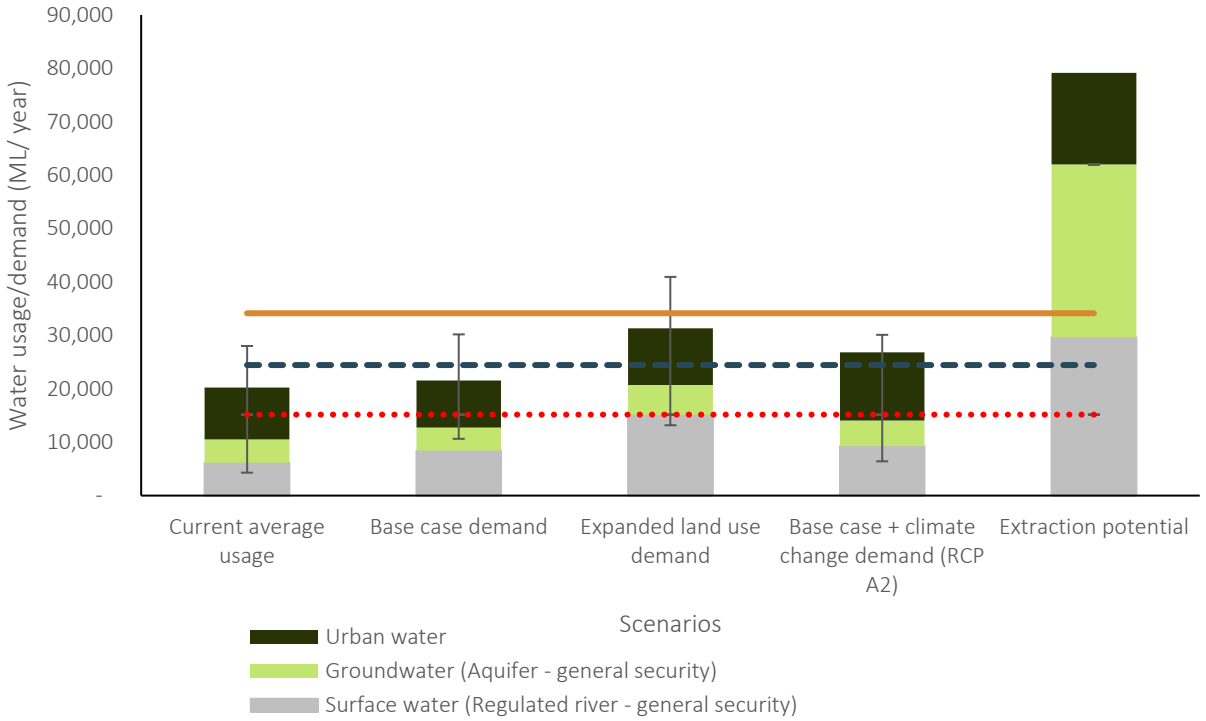

Figure 5. Future Peel Valley regulated river and aquifer estimated annual water demand (to 2035) (Alluvium estimate)

Overall irrigated fodder crops (sorghum, lucerne and hay) return the lowest profits per hectare, but nevertheless represent the dominant irrigated land use across all scenarios investigated, consistent with current land use. Stakeholder consultation revealed that a number of land users had entered into long term contracts to supply fodder to North East New England and coastal regions. The existence of opportunities for long term supply contracts for fodder crops, and the fact that fodder crops are preferred over more profitable but more climate sensitive wheat, or more price volatile legume crops, suggests farmers are unlikely to vary land use or water demand significantly over the next 10 years.

Summary of Key Findings

1. **Irrigated land use**: Fodder production is the dominant irrigated land use, in part driven by the income stability afforded by long term fodder contracts, utilising available water allocations to maintain production and meet contractual obligations. There is no evidence to suggest a trend towards more profitable irrigated crop options (which typically entail greater price volatility). Managing risk by diversifying between irrigated and dryland land uses is expected to continue.
2. **Water licensees**: A key perceived benefit of holding licences greater than annual usage requirements is improved access to water in years of low allocations. Half of survey respondents reported using half or less of their licensed volumes annually. 9 of the 25 survey respondents were concerned that overallocation of water licences presents a risk to their businesses.
3. **Capacity to combine surface and groundwater use:** Consistent with Water Sharing Plan rules, irrigators value the capacity to combine surface water usage with access to more reliable groundwater allocations.
4. **Water trade:** Irrigators surveyed expressed little or no desire to sell licences or seasonal allocations. They consider water licences add value to a landholding, and no-one expressed any desire to trade any of their current water holdings.
5. **Risk appetite**: Generally speaking, Peel Valley irrigator survey respondents do not have a high appetite for risk. However, a limited number of survey respondents did express a desire or intention to invest in growing their areas under irrigation. These stakeholders are more likely to be solely producing fodder crops.
6. **The risk of unused licences getting activated and exceeding the LTAAEL is small**: water use is likely to remain within LTAAEL over the coming 10 year period.
    a. Despite the relatively low profits per hectare, fodder crops are less sensitive to climatic and price variation than other crops produced in the region.
    b. The combination of land suitable for irrigation, farmer risk appetites, water requirements, production costs, market output price volatility and available water allocations restricts irrigation expansion in the region.
    c. It is expected that water demand will expand slightly over the coming decade, if (i) average temperatures increase under climate change; (ii) production costs and/or water charges decline, and (iii) if water allocations experience a sustained increase.
    d. Some limited expansion into irrigated cereals is expected to occur in response to continued global market supply challenges, strong global demand and as a land diversification strategy to manage risks
    e. With the existing constraints it is unlikely that land use or water demand will change substantially in the near future.

2 Background and context

2.1 Regional overview

The Peel Valley covers an area of approximately 4,700km and is located in the New England - North West region of NSW. The Peel River flows in a westerly direction through the Peel Valley, starting in the Great Dividing Range and ending at a confluence with the Namoi River near Tamworth (NSW Office of Water, 2010). The Peel River is regulated by Chaffey Dam, which has a capacity of 100.5 GL and provides town water to Tamworth and water for agriculture (NSW Department of Industry, 2018). A supplementary source of town water for Tamworth is the Dungowan Dam which is fed by the Dungowan Creek and has a capacity of 6.3GL (Water NSW, 2022).

Figure 6. Tamworth town centre (Shutterstock, n.d)

Tamworth, which is the main regional centre for the Peel Valley, is situated at the junction of the Oxley and New England highways and is serviced by air and rail links to Sydney (NRC, 2020). Its industries include meat processing, other food processing, flour milling, manufacturing (including furniture, glass and aluminium products), and fencing. The city hosts an annual country music festival (in January) and has an art gallery (established 1919) that exhibits works of regional and national significance (NRC, 2020).

Overall, livestock is the major agricultural industry in the Peel valley, with other industries including crops for hay, cereal crops, milk, wool, and eggs (DPE Water, 2020). Dryland cropping and livestock production is the dominant aerial agricultural land use on the sloping hills surrounding the valley, with an estimated 66 square kilometres of irrigated agriculture in the valley (NSW Department of Industry, 2018). Irrigated agriculture is concentrated around the Peel Regulated River, with 80% of irrigation used for pasture or fodder production (NRC, 2020).

2.2 Climate:

The Peel Valley has been described as semi-arid to a temperate climate illustrated in Figure 7 (NSW DPI, 2010).

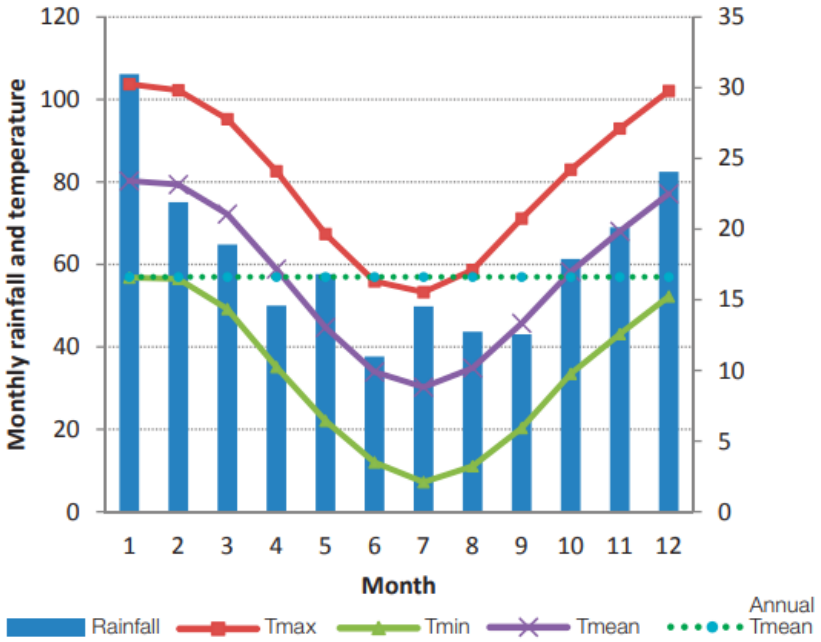

Figure 7. Peel Valley Average Monthly Climate 1960 - 1991 (AdaptNSW, 2022)

2.3 Climate Change:

The climate change projections developed by AdaptNSW used developed two future 20-year time periods (AdaptNSW, 2022):

1. The climate projections for 2020–2039 are categorised as the NEAR FUTURE

2. The climate projections for 2060–2079 are categorised as the FAR FUTURE

Our analysis is focussed on the NEAR FUTURE (to 2035) illustrated in Figure 8, which suggests that there will be a slight increase in temperatures, with decreased winter rainfall and increased autumn rainfall. Future basin catchment and water supply may decrease with the predicted future rainfall and increased evapotranspiration with hotter temperatures.

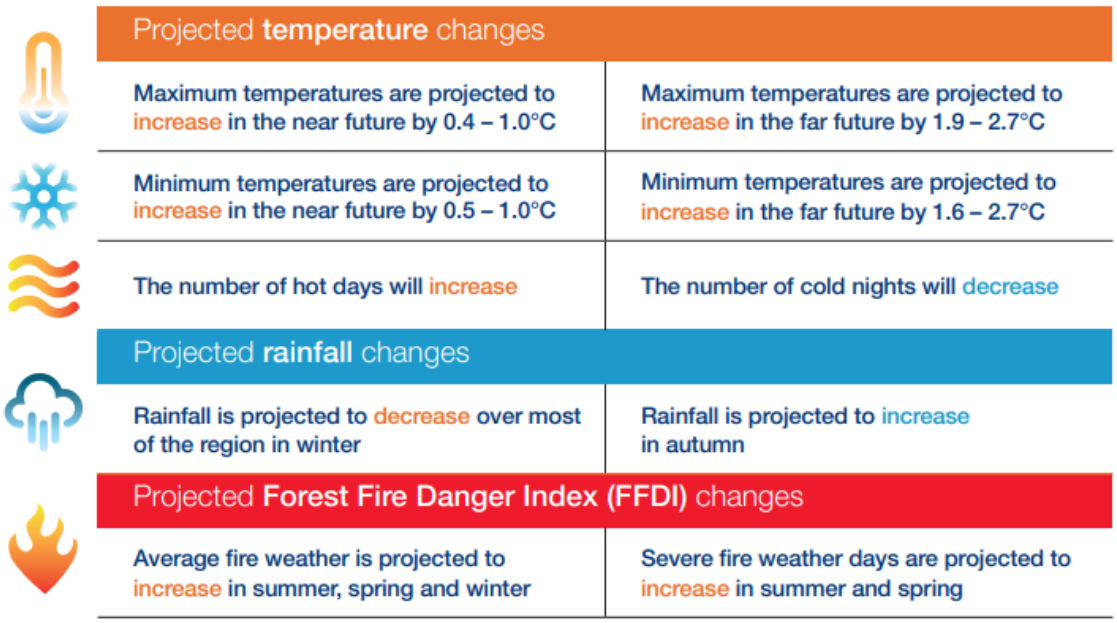

Figure 8. New England & North West NSW Region Predicted Climate Change for the NEAR FUTURE (LHS) and the FAR FUTURE (RHS) (Adapt NSW, 2022)

2.4 Demographics

The Tamworth regional population (which includes the Peel Valley) has grown by 5.6% between 2016 and 2021 and is expected to continue to grow steadily over the next 30 years (ABS 2016, ABS 2021). The Tamworth regional population is forecast to continue growing to between 64,000 – 74,000 by 2041, as illustrated in Figure 9. The forecast population growth will increase urban water use as a proportion of the available water resource; a fact that (all other things being equal), will erode the reliability of irrigation water supplies.

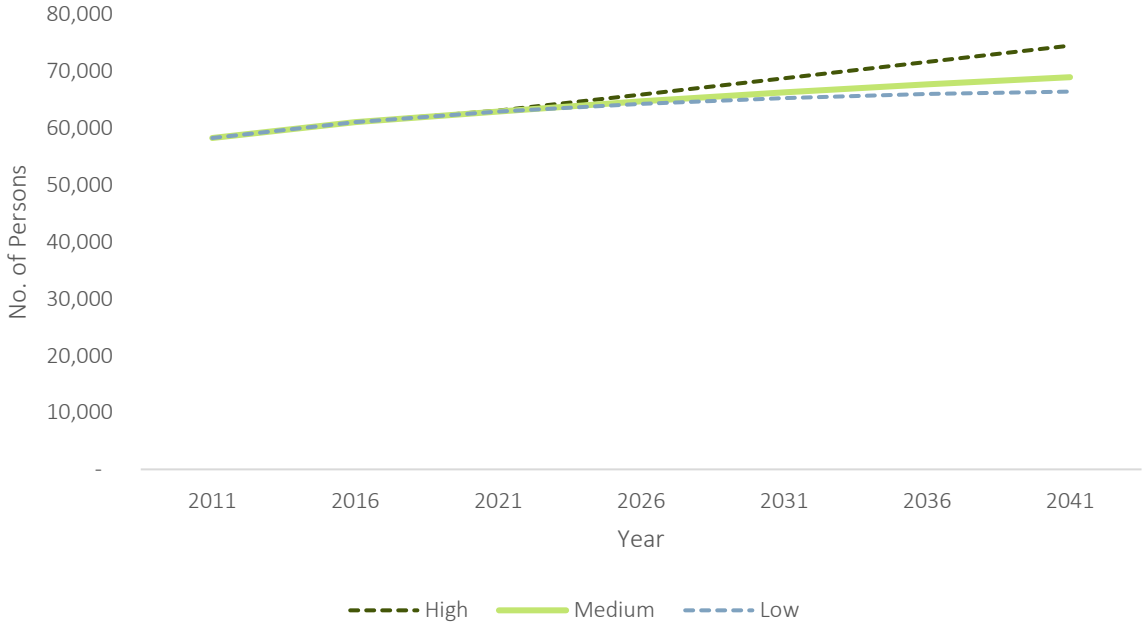

Figure 9. Tamworth forecast population growth (ABS, 2021)

2.5 Employment

The total employment in the Tamworth Regional Local Government Area in 2020-21 was approximately 24,695 shown in Table 1 (ABS, 2021)[3]. The four biggest sectors in the Peel Valley are: Health Care and Social Assistance, Manufacturing, Agriculture, and Education and Training. Together, these sectors make up a total of 45.3% of employment in the area.

Agricultural employment is just under 11% of total employment in the Peel Valley, (Table 1), however the indirect employment benefits from the agricultural sector economic activity, generates approximately 40.5% of the economic activity and subsequently employment in the Peel Valley (Reid, 2022). The resilience of a local economy to withstand shocks is often demonstrated by a diversity of economic activity across multiple sectors, as diversity can diffuse any negative shocks to the local economy. Many businesses in the service sector are geared to support agricultural production, suggesting that the Peel Valley economy is vulnerable to agricultural sector shocks.

Table 1. Largest sources of employment by industry in the Peel Valley (2021) (ABS, 2021)

Sector	Peel Valley	Peel Valley (% of total)	New South Wales (% of total)
Health Care and Social Assistance	3,357	13.60%	12.30%
Manufacturing	2,973	12.00%	7.10%
Agriculture, Forestry and Fishing	2,697	10.90%	2.60%
Education and Training	2,172	8.80%	8.30%
Retail Trade	2,163	8.80%	8.50%
Construction	2,033	8.20%	9.80%
Public Administration and Safety	1,708	6.90%	6.30%
Transport, Postal and Warehousing	1,688	6.80%	5.40%

3 Current agricultural context

3.1 Land use

Current agricultural land use in the Peel Valley is dominated by dryland livestock production, with 76% of gross value of agricultural production (GVAP) generated from livestock (ABS, 2021), as illustrated in Figure 10. The Peel Valley is more heavily reliant on livestock production than the rest of New South Wales, which makes up 30 – 34% of GVAP in 2015 – 2021. Dryland cereal crop production increased by 2% between 2015 – 2021, increasing the land area devoted to wheat, barley, or oats. Broadacre and cropping makes up ~38% of New South Wales agricultural production, however, only contributes 6% in 2015 – 2021 to GVAP in the Peel Valley (ABS, 2021).

Approximately 85 per cent of irrigated agriculture is concentrated around the Peel Regulated River Water Source in the Upper and Lower Peel River Tributaries Water Sources. Many irrigators in the Peel Valley have access to groundwater reserves contained within the alluvium of the river's flats. The greatest development in groundwater use is in the central part of the Valley near Tamworth downstream to Attunga. It is here that flats are at their widest, and fairly extensive irrigation is undertaken.

The main irrigated agricultural land uses are pasture and fodder production. Irrigated fodder production, which included lucerne, hay, silage and irrigated pasture land use increased by 6% between 2015 and 2021. Land used for irrigated pasture and other crops both decreased by 1% over this period, the overall proportions of land area devoted to irrigated agriculture and dryland agriculture has remained relatively stable between 2015 – 2021.

[3] ABS data was sourced from the Tamworth regional local government area (LGA17310).

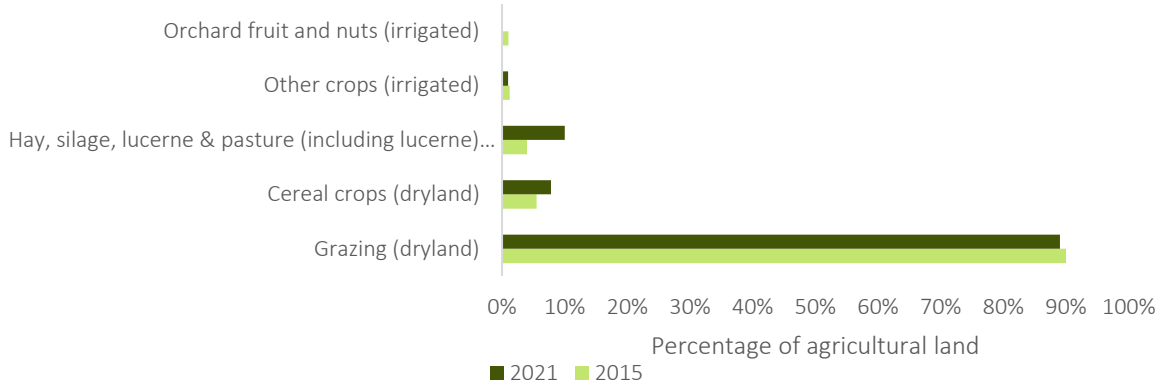

Figure 10. Agricultural land use 215 and 2021 (ABS, 2022)

3.2 Current economic and market conditions

To illustrate the trend in global prices for the agricultural commodities produced in the Peel Valley a chain price index has been used in Figure 11[4]. There has been an upward trend in beef global agricultural commodities between 2011 – 2022 as a result of increased demand for protein globally (ABS, 2022). Similarly, wheat has seen a relatively steady price, with an upwards trend since 2015. In contrast hay and pulses have seen some significant price fluctuations over the 2011 – 2021 period with hay prices declining to 40% of the 2018 price in 2011[5]. Pulses have had similar price fluctuations as hay, suggesting that both crops are relatively more volatile than livestock or wheat. The strong global demand and less volatile prices for dryland livestock commodities may shift irrigated land use to livestock production, irrigated or dryland wheat in the future if water supply is constrained or existing fodder contracts are not renewed.

[4] Price indices generally select a base year and make that index value equal to 100. Every other year is expressed as a percentage of that base year. In Figure 11 2018-19 is the base year: 2018-19: original index value was $2.50; $2.50/$2.50 = 100%, so new index value is 100. A price index is a specific method of measuring changes in prices over time without using actual prices to facilitate comparison between different commodities.

[5] The spike in hay prices from 2017-18 and 2018-19 may have been linked to high demand for fodder due to drought conditions.

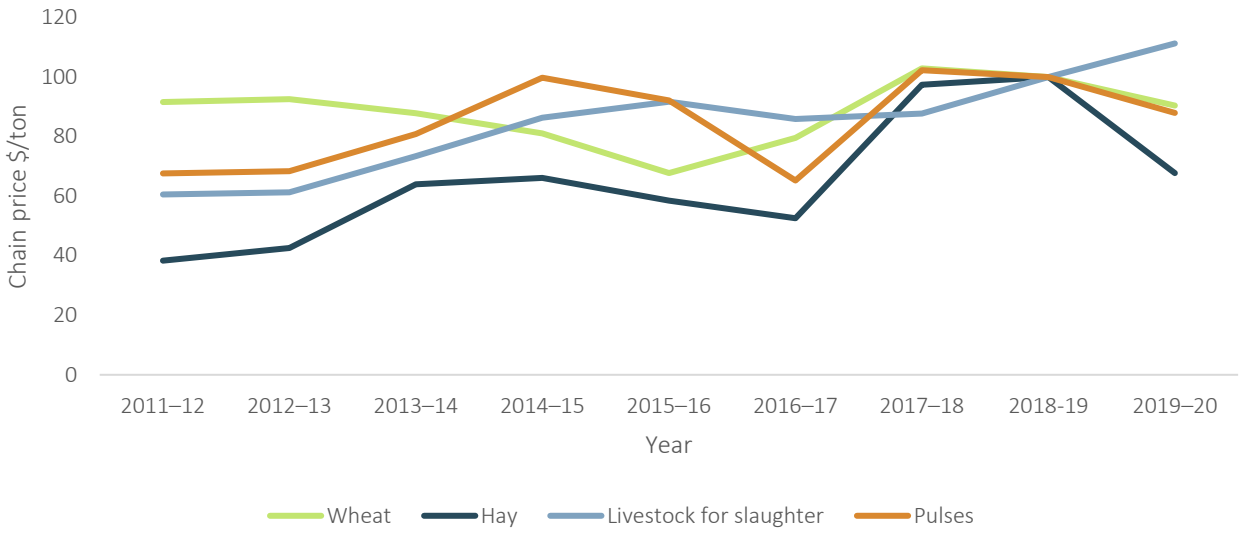

Figure 11. Key agricultural commodity price index (2011 - 2021) (ABS, 2022)

3.3 Barriers and impediments to realising growth opportunities

Irrigated land covers approximately 6,640 ha of the 307,000 ha of agricultural land in the Peel Valley[6]. Irrigation is concentrated on the Valley floor, with the surrounding sloping hillsides unsuited to irrigated agriculture. Further constraints are the cost of pumping water from the river or from alluvial sources to the sloping hills and the land is not suited to the less costly pivot or channel irrigation. The soils on the hillsides are less suited to irrigated agriculture, with lower nutrient content, creating a further barrier for irrigation expansion. Expansion of irrigation is constricted by the geography of the region, pumping and irrigation infrastructure costs.

General security water allocations are variable in the Peel Valley for both surface and groundwater, with low allocations in drier conditions, (discussed further in Section 4), noting that allocations for regulated surface water are less reliable than for groundwater. As further expansion of irrigation areas is most likely to utilise general security surface water, the resultant decline in the reliability of surface water will serve as a constraint irrigation expansion in the Peel Valley.

Based on the ABS projected 30% growth in Tamworth's population by 2041 (ABS, 2021) and the 13% of average available Peel Valley water resources currently dedicated to urban and industrial uses. Future urban population growth illustrated in Figure 9 is likely to increase urban water demand and may negatively impact agricultural water supplies.

4 Water usage

The Peel River flows from its eastern source in the Great Dividing Range, through the Peel Valley in a westerly direction to its confluence with the Namoi River, approximately 40 kilometres downstream of Tamworth. The Peel Valley is regulated through:

- *Water Sharing Plan for the Namoi Alluvial Groundwater Sources Order 2020*
- *Water Sharing Plan for the Peel Regulated River Water Source Order 2022*
- *Water Sharing Plan: NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020*
- *Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012*

[6] Taken from the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources Order 2020*

The Peel Valley covers an area of approximately 4,700km^2 in the New England and North West region of NSW. The Peel River, which forms part of the Namoi River system, is regulated by Chaffey Dam, which has a capacity of 100.5 GL and provides town water to Tamworth and for agriculture (NSW Department of Industry, 2018).

Inflows to Chaffey Dam and the Peel River downstream from the dam fluctuate significantly over time as shown in Figure 12 (WaterNSW, 2020). As inflows are impacted by both inter-annual and seasonal rainfall variation, Chaffey Dam (and to a lesser extent Dungowan Dam) is used to reduce river flow variability and optimise the availability of water for irrigated agriculture and other water uses.

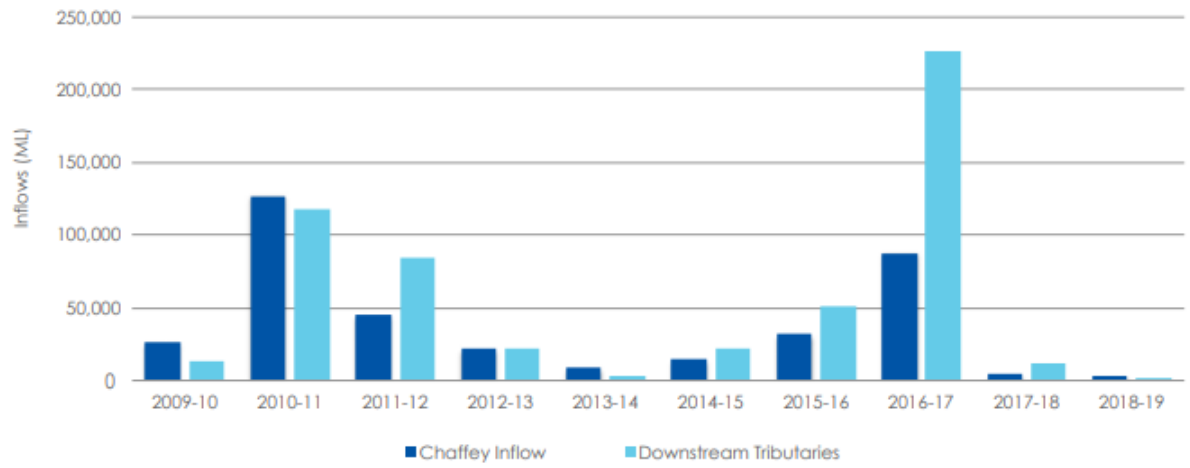

Figure 12. Peel Valley inflows (WaterNSW, 2020)

4.1 Water licences

In the Peel Regulated River system and the Peel Alluvium groundwater source, the number of shares is significantly higher than the megalitres set in the long-term average annual extraction limit – approximately 5 times higher in the Peel Regulated River and approximately 6 times higher in the Peel Alluvium. However, average use remains below the extraction limit. Despite this, active irrigators in the Peel can presently access 1 ML per share in a large proportion of years because there are currently many licences that are underused or not used at all (Figure 13).

If inactive licences are activated to a point where water use increases above the Long-Term Average Annual Extraction Limit (LTAAEL) allocations to general security water licences will need to be reduced to contain usage to a level within the LTAAEL. More generally, growth in utilisation against licenced volumes would have the effect of eroding available water determinations (and hence reliability of supply) across all general security water users.

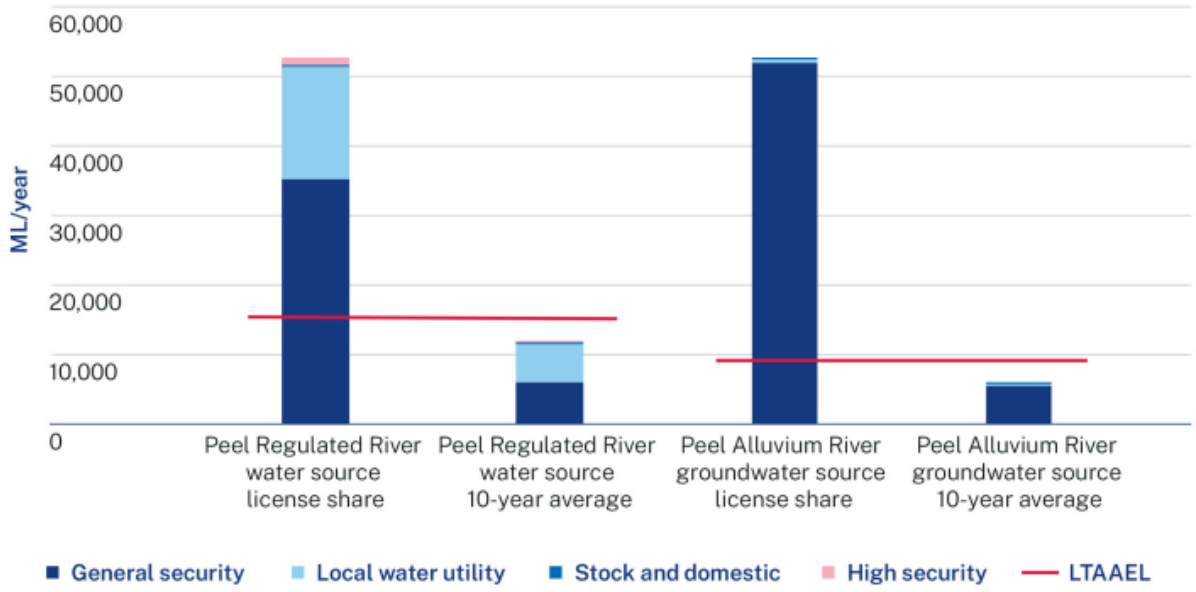

Figure 13. Peel Valley water usage and Long Term Average Annual Extraction (DPE, 2021)

In addition to water issued under licence, Tamworth Regional Council is able to access up to 16.4 gigalitres at Chaffey Dam, and 5.6 gigalitres at Dungowan Dam, to supply Tamworth (Tamworth Regional Council, 2022) with water for urban and industrial purposes.

Water use under general security licences for aquifer and surface water is generally below the annual extraction limits set out in Figure 13 above. The average regulated river water usage for the period 2012 – 2021 was 6,161 ML/ (Figure 14), which included the droughts in 2013 - 2014 and 2016 -2019 where consumption increased by at least 64% compared to the average regulated river usage for the period. Aquifer water usage had less consumption variation with an average annual water use fluctuating around the 2012 -2021 average of 4,342 ML/year.

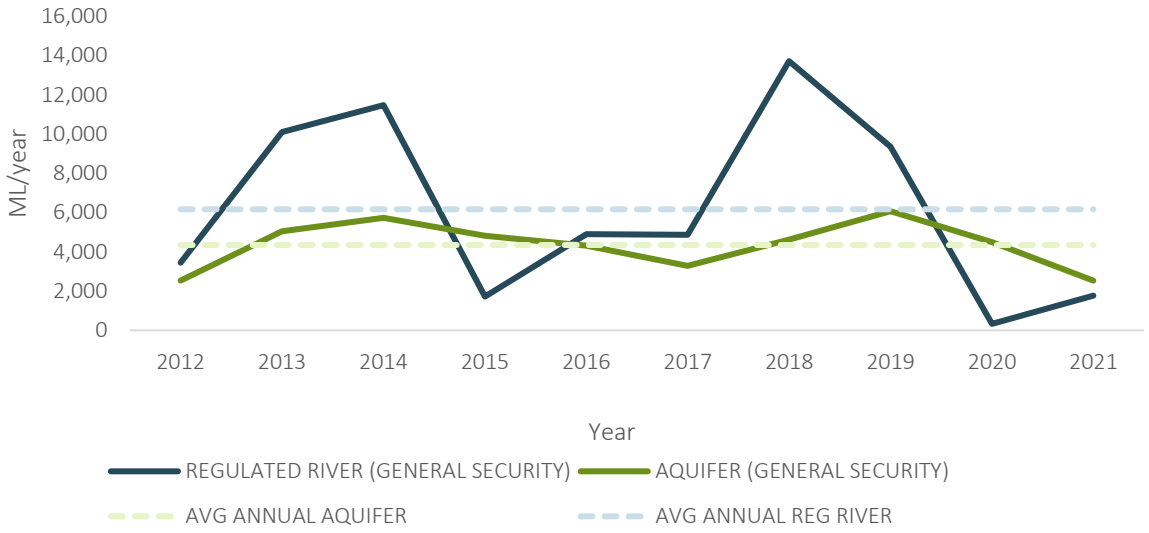

Figure 14. Water usage 2012 – 2021 (ML/year) (DPE WATER, 2021)

Regulated general security river water

Regulated river (general security) water usage in the Peel Valley is highly variable as illustrated in Figure 14 with usage peaking in 2018 and the lowest in 2020, consistent with climatic conditions with a drought between 2016 – 2019. Significant rainfall in the January of 2020 broke the drought and resulted in low water usage in 2020 and 2021. General security regulated river usage has remained below the LTAAEL in the period 2012 – 2021.

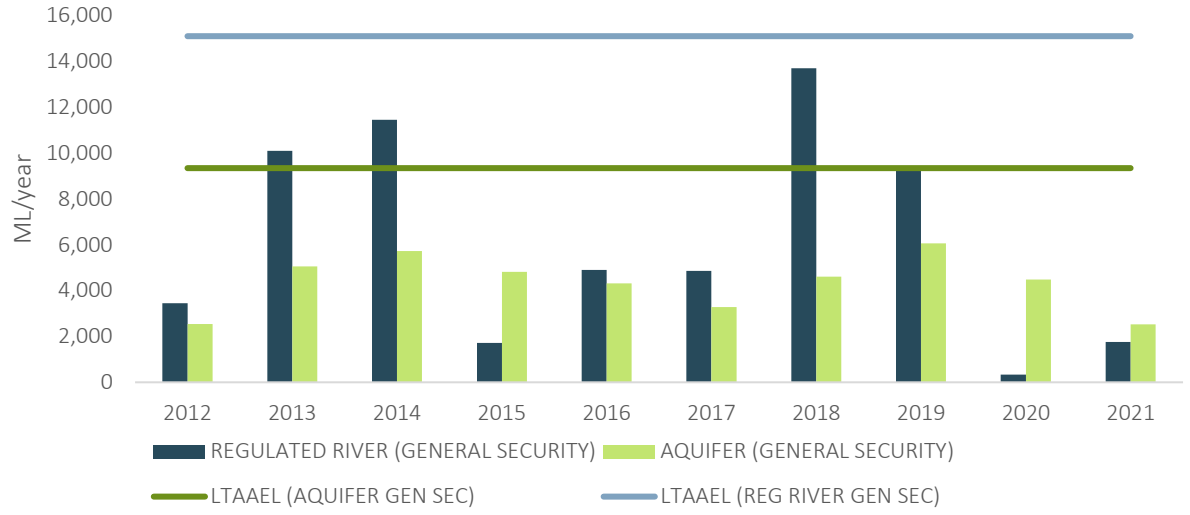

Figure 15. General security licence usage in the Peel Valley (WaterNSW, 2022)

Aquifer (general security) water

Aquifer usage was consistent with regulated river usage, with demand increasing during drier periods. Aquifer water usage over the period 2012 – 2021 remained relatively consistent with increased usage in the dry periods of 2013 – 2014 and 2018 – 2019. Consumption of aquifer water remained below the LTAAEL, as illustrated in Figure 14.

4.2 Water Allocations

There are a range of factors that influence how water is allocated in aquifer and regulated river systems in NSW. These include the physical amounts of water available and predicted to be available through further inflows, and the statutory limitations under the *Water Sharing Plan for the Peel Regulated River Water Source 2022* and *Water Sharing Plan for the Namoi Alluvial Groundwater Sources Order 2020*. At times, restrictions may need to be placed on water in users' accounts if conditions worse than planned for eventuate, particularly at times when there is a risk to Tamworth's urban water security. Consistent with Water Sharing Plan requirements, if the five-year average usage in the Peel Alluvium goes above the extraction limit trigger, then the DPE Water will reduce allocations.

Seasonal allocations available under general security regulated river and groundwater licences varied considerably between 2010 – 2022. During the low rainfall periods in 2014 - 2015 and 2018 – 2019 general security regulated river available water determinations (AWD's) fell as low as zero per cent (shown in Figure 16). The volume of water allocated to a groundwater licence was consistently higher than regulated river water allocations with exceptions in 2016 and 2021. Groundwater allocations declined to just 1% in late 2018 but were never cut to zero per cent. Through the stakeholder consultation process it was found that irrigators consider groundwater the most reliable water source and relied proportionately more on groundwater during the 2017-2020 period when regulated river AWD's declined as the drought progressed (Figure 16).

Figure 16. General security available water determinations (surface water and groundwater) 2011 – 2019 (DPE WATER, 2022)[7]

Water allocations in the Peel Regulated River system vary as illustrated at Figure 16, based both on the available resource and the requirement to make sufficient provision of water to meet current and future urban and industrial water requirements. The percentage of water allocated to each licence varies considerably over the period 2011 – 2021. Comparing regulated general security water allocations (Figure 16) to licence activation rates (Figure 17) there is a relationship between general security water allocations and the number of licences activated. Licence activation is dependent on the climatic conditions and water allocations with a decrease in the available water determination allocation for each licence class generally corresponding with an increase in the activation rate in Figure 17. Seasons with the lowest rainfall for the period 2010 – 2023 in Figure 17 have been shaded in grey, which correspond to the years with the highest licence activation rate.

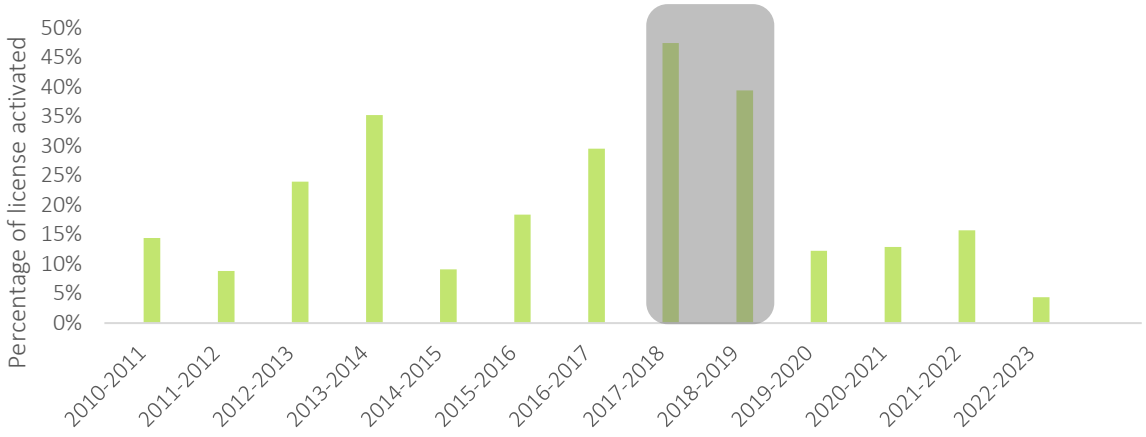

Figure 17. Annual general security (surface and groundwater) licence activation in the Peel Valley (DPE, 2022b)

[7] Note AWD refers to Available Water Determinations which sets the amount of water credited to the water allocation accounts associated with access licences. An available water determination applies to a category of water access licence, and there are various categories of water access licences in each groundwater source.

4.3 Water Licence Trade

Trade in water licences can be economically beneficial by allowing unused water licences to be transferred to where it is needed and by moving water from a low value use to a higher value use. However, trade can also be impacted by water availability (Simpson, 2021). The Peel and Namoi Valleys are two directly hydrologically connected systems, but do not allow either permanent or temporary intra- valley trades.

4.4 Estimated current agricultural water demand

The recent demand for general water licences in the Peel Valley has fluctuated depending on seasonal rainfall. Figure 18 illustrates how demand has fluctuated over the period 2012-2021, with demand closely related to deficits in annual rainfall[8]. Declining rainfall increases annual demand for water. The peak demand for water licences in Figure 18 occurred in 2018, when the region was in a drought and 18,315 general security regulated river and aquifer licences were activated (BOM, 2022, DPE WATER, 2022b). Figure 18 illustrates the relationship between annual rainfall in Tamworth and licence activation in the Peel Regulated River and Alluvium River Systems. There is a strong inverse relationship between annual rainfall and licence activation, suggesting that farmers utilise water licences as a risk mitigation measure when rainfall is insufficient to sustain their agricultural production processes.

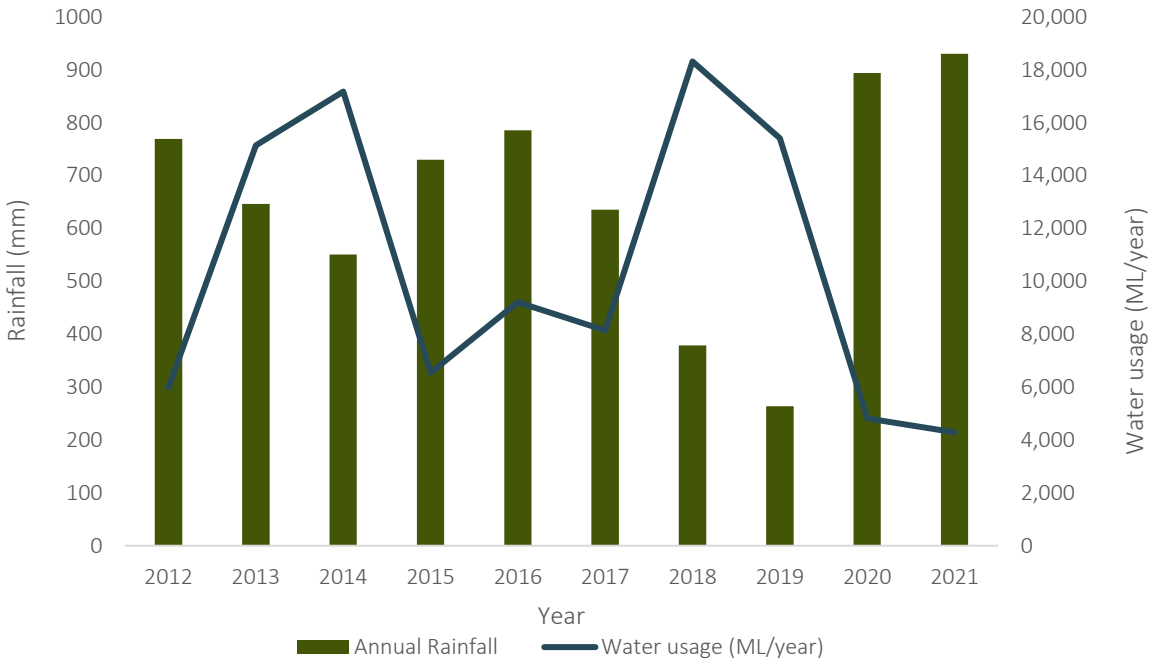

Figure 18. Tamworth airport annual rainfall & annual licences activated (BOM, 2022, WaterNSW, 2022)

[8] High security water licences are a very small proportion of the market and are not utilised for agricultural production in the Peel Valley so have not been included in this analysis.

5 Water demand modelling

5.1 Process

This section describes the process used to assess current and future consumptive demand for water in the Peel Valley. The key aspects include:

- Assessment of current water demand (usage) in the region
- Assessment of future demand to identify the operating environment and potential future expansion of water licence demand and irrigation land use in the Peel Valley incorporating market conditions and establishment costs
- Identification of key factors impacting agricultural water demand including climate change, input and output market price volatility, and farmer individual risk preferences
- Improved understanding of the underlying causes of licence underutilisation
- Stakeholder analysis to confirm the purposes of water use and impacts of changes in water availability

The demand assessment is the centrepiece of this project as it considers the likelihood, volumes, and attributes of future water demand, while testing key preconditions to development (e.g., drivers of demand, commercial viability, the impact of climate change). This data is then assessed in conjunction with potential sources of supply (alluvium and regulated river water supply) to inform effective and efficient development and delivery of water services over the long term.

A number of interrelated methods were used for this long-term demand assessment as shown in Figure 19. Multiple inputs were used (e.g., data and statistical analysis, consultation, climate data, market analysis, and a survey to establish the data inputs, parameters, and assumptions) for developing a detailed probabilistic demand model. A range of prices was used for each input, with Monte Carlo simulations undertaken to determine the most likely price inputs[9]. Using multiple methods underpins the triangulation of findings to develop a more credible demand scenario.

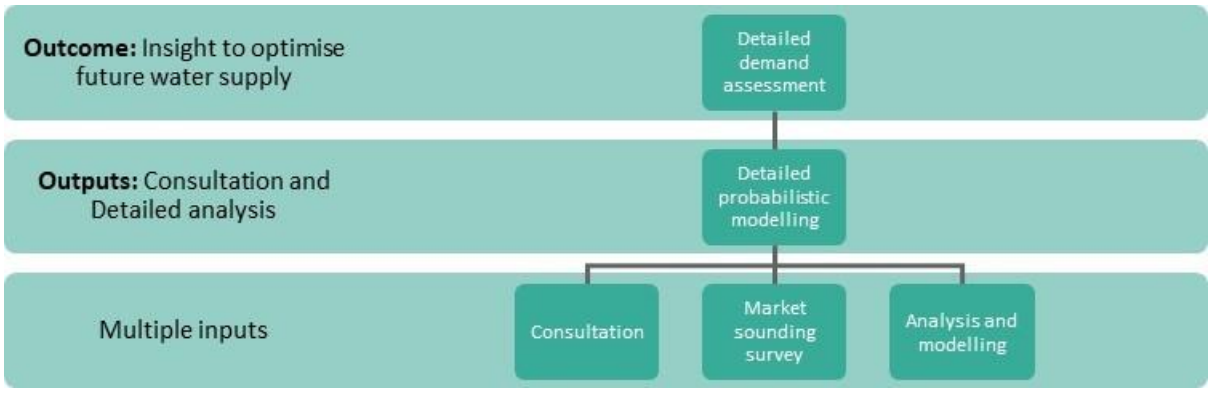

Figure 19. Method for detailed demand assessment

5.2 Drivers of demand

Assessment of water demand entails consideration of factors such as current agricultural conditions and the context of market conditions in which farmers operate.

[9] A Monte Carlo simulation is a model used to predict the probability of a variety of outcomes when the potential for random variables is present. Monte Carlo simulations help to explain the impact of risk and uncertainty in prediction and forecasting models.

Farmers face significant production risks including climate, market output price risk, pest, and disease impacts, which can all significantly impact the returns from land use. Managing these risks is a critical part of farming, climate and market price risks have the largest impact on land use returns. Climate change and the climatic conditions in the Peel Valley are discussed in Section 2. Market price variation can significantly impact the returns from land use. Farmers use commodity markets as a tool to support decision making to reduce market risk exposure and variability in returns.

Irrigated and dryland agricultural production are both exposed to market price risks, with water availability increasing the risks irrigators are exposed to compared to dryland producers. Water is used to produce crop yields that would be otherwise unfeasible. Combining climate risks with market output price volatility increases the risks irrigated producers are exposed to. One method to evaluate land use is by allocating land according to farmer risk preferences, crop water usage, crop profitability, and price volatility. Understanding current land use, farmer risk profiles and commodity market price volatility is central to estimating likely future water demand to 2035.

5.3 Consistency with guidelines and leading practice

Guidelines and reports relating to approaches and leading practice for demand assessment were reviewed, and the key elements were identified.[10] The methodology used in this study is designed to meet the requirements of these guidelines. Table 2 shows the key elements of leading practice, and where inputs to the demand assessment approach meet these elements.

Table 2. Consistency with guidelines and leading practice

Leading practice element	Meeting leading practice		
	Data and statistical analysis	Consultation	Market sounding survey
Internal consultation		• Discussions with DPE WATER stakeholders	
Customer consultation		• Discussions through existing consultation • Series of one-on-one semi-structured interviews with industry representatives • Issue-specific meetings	
Consumer demand	• Modelled reliability and likely price as product attributes (by water product)	• Information sharing	• Web-based survey • Indication of future land use and water demand
Timeframes	• 10-year period used	• Timeframes for consultation	• Timeframes incorporated into market sounding
Prices	• Ability to pay assessed through margins analysis and modelling	• Transparent use of tariff estimates in consultation. • Discussion of how price impacts water demand • Impact of water meter upgrades on willingness to pay	

[10] See, for example, NSW Department of Industry (2018).

Leading practice element	Meeting leading practice		
	Data and statistical analysis	Consultation	Market sounding survey
Optimism bias	• Multiple lines of evidence used • Ranges of all input variables will be used, and probabilistic modelling undertaken	• Multiple lines of evidence used	• Multiple lines of evidence used • Incorporation of early customer commitment in survey
Current supply and demand	• Econometric analysis of current situation and trends, trade, and carryovers • Analysis of groundwater use	• Informed by consultation	• Incorporation of current and future customer demand in survey
Land use change	• GIS analysis of land use	• Informed by consultation	• Informed by survey
Economics of crop demand (including economic environment)	• Research and statistical analysis	• Information sharing	• Informed by survey
Crop requirements	• Research and statistical analysis	• Informed by consultation	• Informed by survey
Financial viability and margins	• Crop economic modelling	• Informed by consultation	• Revealed via survey
Climate change	• Research and statistical analysis	• Insight from consultation	• Informed by survey
Urban use	• Specific modelled demand category	• Focus of consultation	
Industrial use	• Specific modelled demand category	• Focus of consultation	• Specific component of survey
Risk assessment	• Optimisation of land portfolio with returns variance	• Identifies parameters for risk assessment	• Identifies parameters for risk assessment

5.4 Agricultural land use capacity to pay for water

A range of production costs, irrigation costs and market prices for crops was identified, as illustrated in Figure 20. The capacity to pay uses the revenue less production costs for a land use for the region, with data taken from the ABS (2016, 2021) and DPE crop production cost budgets (2013)[11]. The price data was used with Monte Carlo simulations to test the validity of the capacity to pay estimates. For each land use cost item, a number was randomly selected from within the range provided by the data source and used in the simulation to determine if this would impact the land allocations. 1,000 Monte Carlo simulations were run with the most likely results presented in Figure 20.

[11] Cost data was converted into 2022 prices using the Reserve Bank of Australia inflation rates

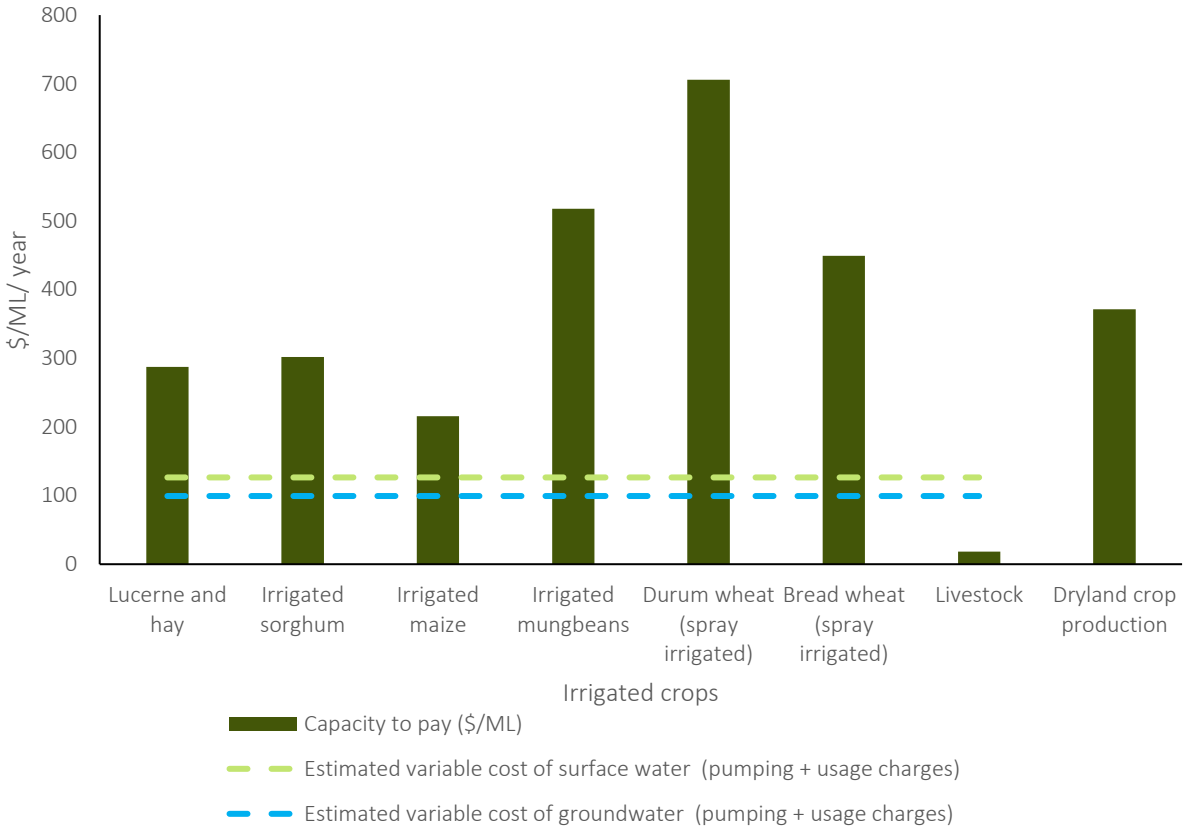

Figure 20. Land use average annual capacity to pay (Alluvium estimate)

As illustrated in Figure 20 lucerne, hay, sorghum and maize are all associated with a relatively low capacity to pay for water. By comparison, irrigated durum wheat, mung beans and bread wheat all have higher capacity to pay for water, noting that in Section 3 it was identified that they also experience more price volatility (Figure 11). A trade-off exists between returns per hectare (or capacity to pay) and variability in market prices. Livestock production has low profits per hectare, but also low price volatility and is suited to the soils and topography of the sloping hills surrounding the valley floor.

5.5 Farmer risk profile

Farmers face significant production risks including climate, market output price risk, pest, and disease impacts, which can all significantly impact the returns from land use, managing these risks is a critical part of farming. Climate and market price risks have the largest impact on profit from land use. Annual land use and market output price volatility data from 2012 – 2021 was used together with the capacity to pay to create a risk profile for the average irrigator in the Peel Valley[12].

The risk profile for the average farmer in the region was calculated using the average per hectare returns for each agricultural land use (i.e., livestock, lucerne, sorghum, maize, dryland cropping, durum wheat) and how they varied from the Gross Value of Agricultural production per hectare returns. The risk a farmer faces across all land used for agricultural production is determined by the number of different land uses, the price volatility and the relative area allocated to each land use. Each land use price volatility is weighted by the proportion of land dedicated to the land use to create a risk profile. The various risk profiles are added together to determine the overall agricultural production risk.

[12] Land use data was taken from ABARES for the region and market price data was taken from ABS commodity price data

For example, livestock has a lower rate of return per hectare than canola. Mung beans experiences more global price fluctuations, and therefore has a higher variability in returns than livestock production. Increasing the land allocated to mung beans increases the risk of changes to income realised at the end of the production period. More land allocated to mung beans is associated with a farmer who has a higher tolerance to risk. This can be mitigated by allocating land to fodder or grazing livestock which have lower price volatility and will reduce the farmers overall risk exposure.

Like financial investments, farmers can mitigate risks to land use returns by diversifying the types of land uses. The average risk profile for a farmer in the region was constructed using used ABS data and the average rate of return from individual land uses (ABS, 2016). The risk profile for an average farmer was used to estimate how land use varies with water allocation variation and estimate how future water demand may change in response to commodity market price variations. Current irrigation is used for relatively stable hay and fodder crop production, where prices increase with drought conditions but are otherwise relatively stable.

From stakeholder consultation two thirds of farmers are risk averse to risk neutral, choosing a range of land uses to ensure they are not overly exposed to climate, market, or production risks in any particular land use. Risk neutral to risk averse farmers generated off farm income, reducing the impact of negative returns on their overall income. A third of farmers were risk takers, which can be characterised by solely relying on one land use, many of these were wholly reliant on the income from irrigated land use and significantly exposed to any reduction in water allocations, climate, or price shock. A weighted risk profile was created combining the two risk profile to predict land allocation with varied water availability, variation in farmer risk profile, market output and input prices, to determine the most likely land use and water demand in the Peel Valley.

5.6 Future agricultural land use

Modelling was undertaken to investigate how farmers change land use, using the weighted risk profile for the region. Livestock has lower profits per unit but provide a more stable income and has a relatively low risk, similarly wheat has less price volatility but is mor exposed to climatic production risks, compared to fodder crops or livestock. Pulses such as mung beans and fodder crops (such as lucerne) are subject to larger global market price fluctuations, with fodder crops in the Peel Valley reliant on irrigation to ensure stable supply to meet consumer demand.

Table 3. Land use annual water demand (DPI, 2013)

Water demand (ML/ha/yr)	Low	Most Likely	High
Lucerne and hay	4.0	7.0	8.4
Irrigated sorghum	3.0	3.8	4.6
Irrigated maize	5.7	7.2	8.6
Irrigated mung beans	1.2	1.5	1.8
Durum wheat (spray irrigated)	1.6	2.0	2.4
Bread wheat (spray irrigated)	2.0	2.5	3.0
Livestock	0.002	0.010	0.012

Water demand per hectare of land for each land use type presented in Table 3 is taken from the Department of Primary Industries (DPI) 2013 farm budget and production estimates. Land use water demand was modelled using a range, with the most likely water demand derived using Monte Carlo simulations with 1,000 simulations selecting a number randomly between the lowest expected water use and highest expected water use. The results were then used to determine the most likely volume of water for each land use type. These results were

validated through stakeholder consultation which is discussed in Section 6. The most likely water demand was used with the capacity to pay for each individual land use and the profit from each land use.

Agricultural water demand in Table 4 for the Peel Valley was simulated using a range of risk levels, climatic conditions, varied production costs, crop water demand, market prices and water allocations. Low water demand is associated with ongoing low water allocations or an increase in production costs combined with a decrease in market prices. Both scenarios result in the entire region converted to dryland livestock and crop production.

High water demand uses the farmer risk profile to determine land allocation and water use, with varied production costs, market prices and water allocations. It is predicted that farmers will increase lucerne, sorghum and bread wheat production in the high water demand scenario leading to net annual water demand in the Peel Valley exceeding the current LTAAEL.

The most likely scenario uses the farmer risk profile with current production costs and the most likely crop water demand. Water demand is predicted to be 8,413 ML/year in the most likely scenario utilised for agricultural production, with the majority of water used for lucerne, hay and sorghum production and a smaller amount of bread wheat. The most likely scenario is consistent with historical water demand discussed in Section 2.

Table 4. Peel Valley estimated annual irrigation water demand (ML/year) (Alluvium estimate)

Land use	Low	Most Likely	High
Lucerne & hay	0	3,216.4	12,480.0
Sorghum	0	3,356.2	9,329.0
Maize	0	0.0	201.4
Mung beans	0	0.0	69.0
Durum wheat	0	0.0	249.8
Bread wheat	0	1,590.8	5,206.0
Livestock	0	249.7	306.6
Dryland cropping	0	0.0	0.0
Total water demand	**0**	**8,413.1**	**27,841.8**

The range presented in Table 4 accounts for water demand variation, which will occur with climatic and market price variation as discussed in Section 2. It is expected that farmers will try to reduce the variability in their income derived from land use. It is expected that dryland livestock and crop production will remain the dominant land use in the Peel Valley with a smaller area of irrigated land, consistent with the existing land uses.

It is expected that some variation in the crops irrigated may occur with some future irrigated crop production, influenced by shifting market demand and increasing areas devoted to irrigated wheat. Farmers will continue to utilise smaller areas of irrigated land to diversify their income streams and risk exposure to global commodity markets.

5.7 Estimated licence activation to 2035

As illustrated in Figure 21, licence activation in 2035 is projected under a range of scenarios as follows:

- Current average water use
- The base case, including predicted population growth on water demand

- Expanded irrigation land use increasing water demand, minor urban water demand increase
- Base case with climate change impacts on water demand
- All licences activated

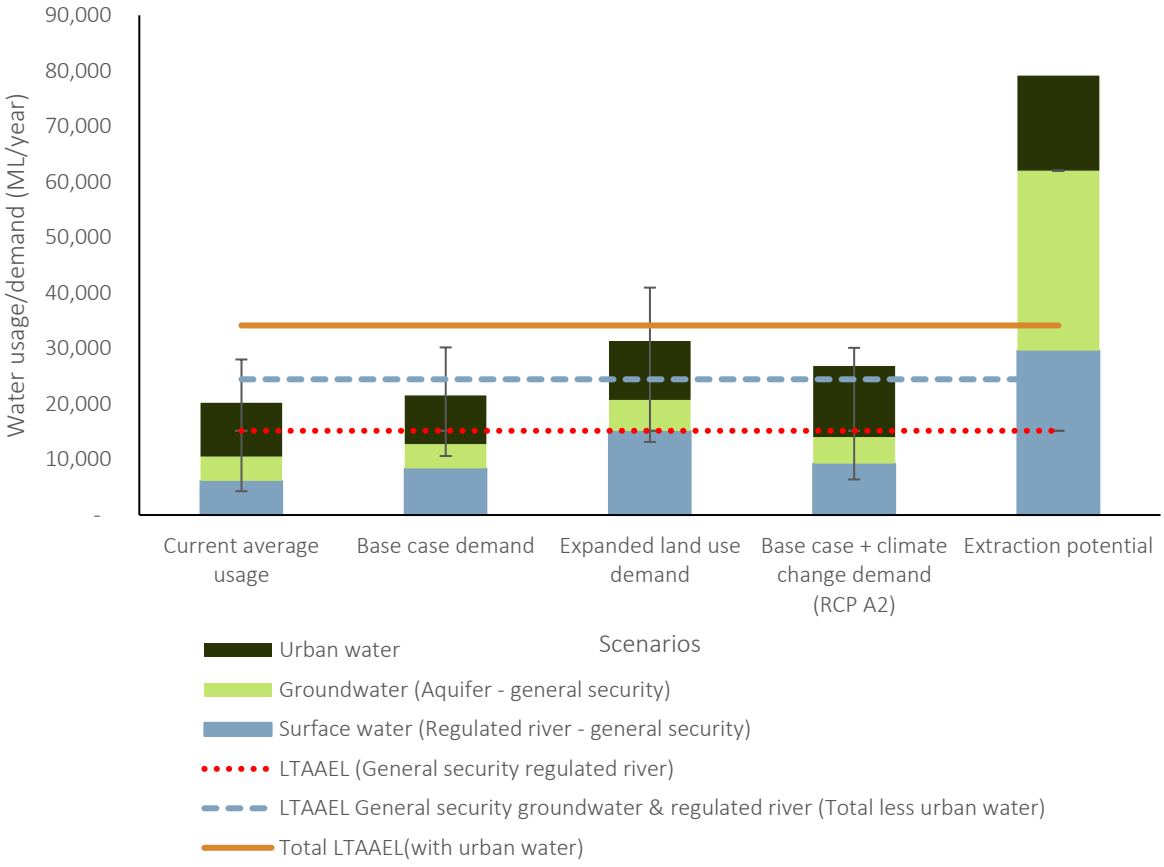

Figure 21.Future Peel Valley regulated river and aquifer estimated future annual water demand (Alluvium estimate)

Utilising the outcomes of stakeholder consultation, together with historical water use data and economic analysis, the likely demand for general security regulated river and alluvial water (presented in Table 4) was combined with current urban water usage to predict a base case scenario, where some irrigated livestock and bread wheat production fodder occurs, with fodder production maintained to offset wheat climate production risks.

An expanded land use scenario was developed (incorporating a threshold on land able to be irrigated to reflect geographical constraints in the Peel valley, with water allocations restricted to the LTAAEL, with all other modelling assumptions used in the base case scenario applied), to investigate the impact of the 8 out of the 25 survey respondents who were considering increasing water usage to expand their irrigation area on net water demand. The most likely outcome is shown in Figure 21, with water demand increasing, but remaining below the LTAAEL.

A simple, high-level evaluation of the impact of climate change on water demand was also undertaken, with projected climate change impacts captured through a factor which incorporated rainfall reduction and heat stress and varied the base case scenario water demand (base case + climate change demand scenario). The climate change factor was developed using the predicted impacts of climate change on rainfall in the Peel Valley taken from the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources Order 2020*. Crop

evapotranspiration and climate change impacts on water supply were not considered in this scenario analysis as a detailed analysis of this nature was out of scope

The final scenario developed was one where all licences were activated regardless of farmer risk profile, water demand or land usage. In this scenario water demand would exceed the LTAAEL water significantly as indicated by the last column in Figure 21.

5.8 Estimated future demand

The current market demand for general security water in the Peel Valley fluctuates considerably from year to year. Increased demand is linked to a decline in rainfall. Farmers activate water licences as a risk mitigation strategy to irrigate lucerne and hay to maintain production and ensure sufficient supply to fulfill long term contracts with consumers.

Groundwater is considered more reliable, which is considered important with long term supply contracts, however with drought the average recharge rate declines. WaterNSW (2020) found that the Peel Valley aquifer declined significantly over the 2017-2020 drought. The decline in available groundwater, reduced groundwater allocations and increased the licence activation rate. After the drought broke in 2019 water demand decreased to the lowest point in the past decade, consistent with the findings that water licences are retained as a method to offset the risk of drought impacting fodder production.

Current irrigation water use is constrained by available water allocations which vary depending on annual rainfall and runoff. Agricultural demand given supply constraints was modelled for groundwater and regulated river general security water licences.

Increased urban demand arising from forecast population growth will constrain future water availability and negatively impact the reliability of general security river water, noting that the proposed expansion of the Dungowan Dam only provides a limited increase in both storage capacity and reliability of supply. Modelling undertaken suggested that water use expands with favourable market conditions or a prolonged drought, however it is expected that it will remain below the LTAAEL under all modelled scenarios.

6 Stakeholder consultation

6.1 Engagement and Analysis

Consultation is a critical part of the Peel Valley Licence Activation demand modelling process to ensure stakeholders have input into and ownership of outcomes. Key stakeholders include direct water users (e.g., irrigators) and indirect stakeholders (e.g., local business community, environmental organisations, local government, and cultural heritage representatives).

Box 1 provides the major themes explored in consultation.

Box 1. Key themes used for consultation activities and stakeholder engagement

- Market drivers of growth, market risks, domestic vs export focus, region's competitive advantages.
- The underlying economics (e.g., production, revenues, establishment costs, ongoing costs).
- Water requirements (e.g., volumes, reliability, announced allocations throughout the water year, managing allocation risks, use of groundwater).
- Expansion opportunities vs dryland production.

- Impediments to growth (e.g., distribution system constraints, water service charges, access to financial capital, access to processing facilities and downstream supply chain capacity, regulatory environment, efficiency of supply chain).
- Future opportunities in the region that may require additional water use or change water use.
- Climate change impacts on agricultural business and urban water use.

6.2 Consultation process

Consultation was undertaken to validate the outcomes of the economic analysis undertaken in Section 5. The consultation process involved the design and delivery of an online survey together with a series of interviews with stakeholders in the region. Individual interviews ranging from half an hour to just under 2 hours were undertaken with 12 individuals located in the Peel Valley. The survey design and interview process are discussed below with the outcomes of the consultation process.

6.3 Survey design

A survey was created and published online; the survey is available in **Attachment 1**. The survey link was shared by the DPE WATER communications team through social media platforms targeting groups and individuals in the region. The Peel Valley Water Users Association members were contacted via email, with the email containing a link to the online survey and inviting members to complete the survey.

The survey questions focussed on existing land use, existing water use, and how likely it was for either of these to change. Survey participants were asked about whether they would sell water licences, and if their water allocation during drought conditions impacted their water use. The survey tried to elicit individuals risk profile through indirect questions on asset holdings and market commodity price activity. The survey results are presented in Section 6.5.

6.4 Interview process

A series of phone and online interviews were undertaken with stakeholders in the region. The president of the Peel Valley Water Users Association was contacted and provided some contact details of members. Individual farmers that were not members of the Peel Valley Water Users Association were approached and asked if they would be interested in participating in an interview discussing current and future water use in the Peel Valley.

Interviewees that agreed to participate were offered the choice of either a virtual catch up or a phone discussion and asked what time and day was suitable for a discussion. On the agreed time and day, the interviewees were contacted, and an interview was held.

The core themes covered in the interview were:

- Current irrigated water demand
- Current land use
- Future water demand
- The likelihood of changing land use
- Factors impacting individual water use
- Their perception of the impact of projected population growth in Tamworth on water supply
- What they think the impact of proposed intensive chicken production plants in the region on water supply will be
- Do they think the increase in smaller land holdings (also known as ‘hobby farms’) closer to Tamworth will impact water supply, and how likely are these landholders to activate their water licences

- Will proposed recycled water infrastructure developments improve water supply or increase licence activation

The information shared in the interview was recorded and is summarised in Section 3.

6.5 Survey results

Survey key outcomes

- Hay / Fodder crops are the dominant land use, with dairy cattle the second largest land use
- Groundwater was the most preferred water source, with regulated surface water irrigation allocations the second most preferred option
- Half of the respondents used 50% or less of their licensed water allocation annually
- 9 of the 25 respondents were concerned that overallocation of water licenses was a risk to their business
- 8 of the 25 irrigators had plans to expand the areas irrigated in the next 12 months, increasing fodder or dairy production irrigation area
- Farmers surveyed had 'risk averse' to 'neutral' risk profiles
- Half the respondents have off farm investments and half do not. Farmers without off farm investments are more vulnerable to water allocation variation and were more concerned with commodity price fluctuations
- Climate change, labour shortages and market price volatility were listed as the biggest challenges facing farming operation in the Peel Valley in the future

6.6 Survey respondents' characteristics

The surveyed participants used the land for a range of purposes however the dominant purpose was for hay or cattle production (Figure 22). Cattle production includes dairy and livestock production. There was a smaller number of respondents allocating land to dryland production processes which includes horses, wool, or durum wheat. Irrigated land use focussed on fodder, grains, and cattle (dairy) production.

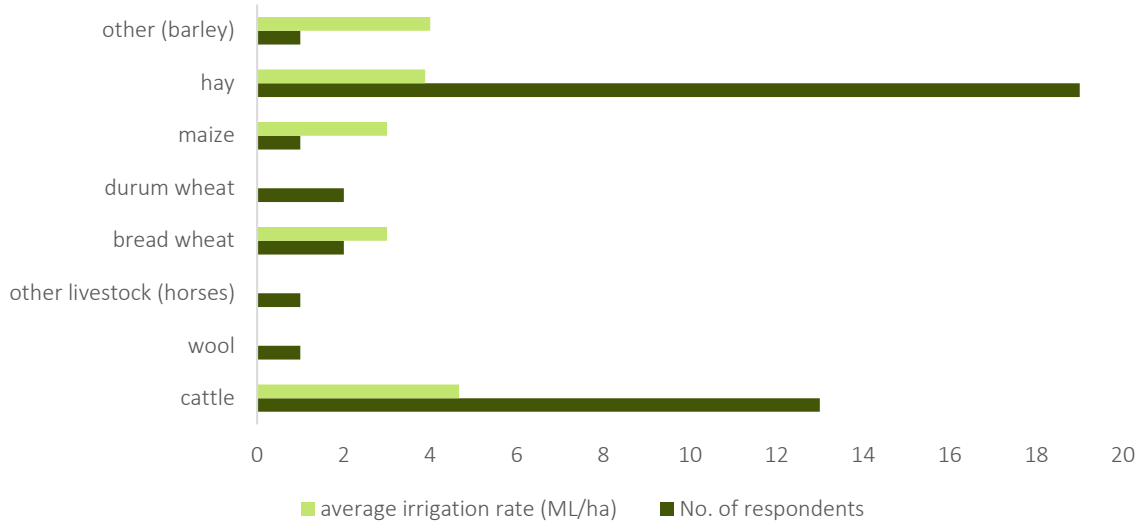

Figure 22. Survey participant land use and irrigation volume (ML/ha)

The average rate or irrigation was largest for cattle using just under 5 ML/ha. The remaining crops irrigated used between 2 – 4.5ML/ha. In the survey data there were some outliers with 2 respondents using 10ML/ha of water to irrigate for cattle production, with the remaining respondents using 1-3 ML/ha. Similarly, 1 respondent used 8 ML/ha to irrigate lucerne with the remaining respondents utilising between 1.6 – 4 ML/ha. It suggests that the majority of water users in the region have fairly similar application processes.

Groundwater and irrigation water are the dominant sources of water used for agricultural use in the Peel Valley, with 14 of the 25 respondents utilising groundwater in the production processes, as illustrated in Figure 23. Ten of the twenty five respondents also used regulated surface water irrigation allocations, hereafter referred to as 'irrigation water' in their production processes. Only 4 respondents used on farm dams, with 6 respondents using unsupplemented surface water. The results suggest groundwater and irrigation water are relied on by the farmers in the Peel Valley to undertake farming processes.

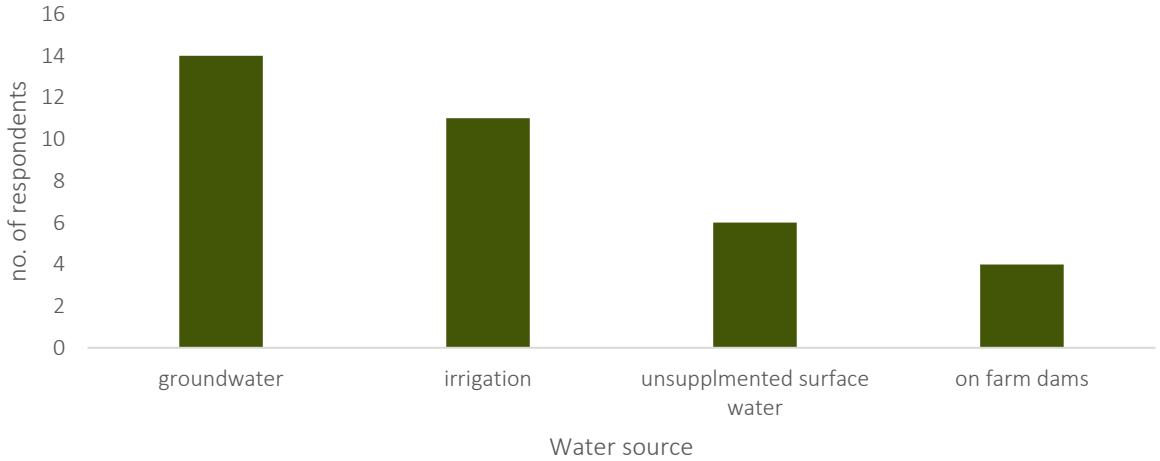

Figure 23. Source of water used in agricultural production[13]

[13] Irrigation refers to regulated surface water irrigation allocations

Ground water and irrigation water are the most preferred water sources, with irrigation water the most preferred water source, as shown in Figure 24. On farm dams are the least preferred water source by 5 respondents, with no respondent choosing it as their most preferred water source. Unsupplemented surface water is the most preferred option by 4 of the 25 respondents, which was also the respondents who named dryland uses in the land use response illustrated in Figure 22. Respondents who selected groundwater or irrigation water produce hay or cattle (dairy farming).

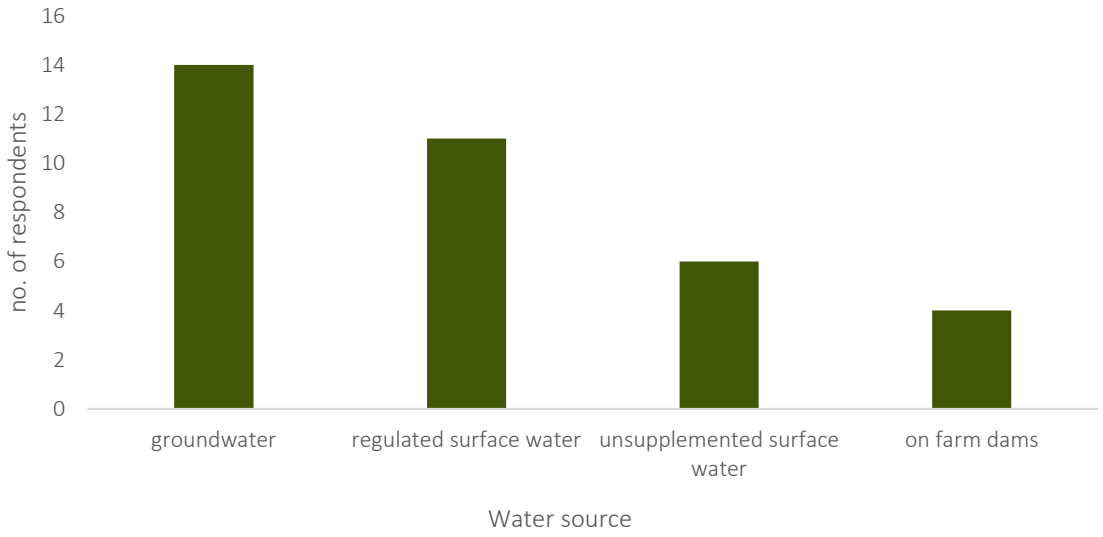

Figure 24. Rank the general security water source according to preference

6.7 Water management

Only 5 of the 25 respondents utilise 75% or more of their water allocation annually, more than half the respondents use 50% or less of their water allocation. 6 of the 25 respondents (or almost a quarter) use less than 25% of the annual water allocation, as shown in Figure 25.

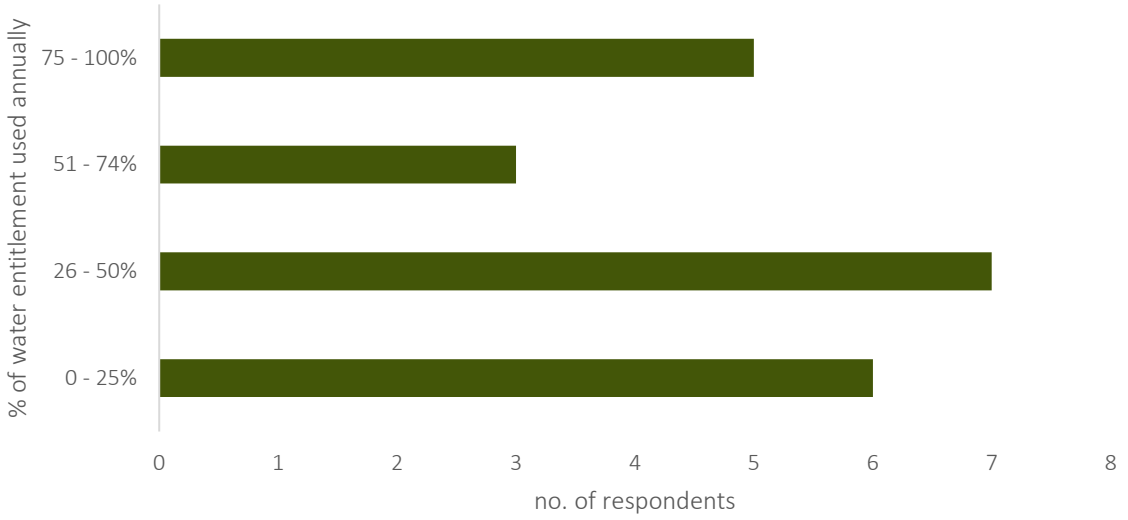

Figure 25. The percentage of water allocation used annually

A third of survey respondents (8 of the 25) have plans to increase the area under irrigation in the next 12 months, as shown in Table 5. Only 2 of the 25 responses indicating they were considering deactivating their licences in the next 12 months, citing health reasons and no use for the licences they held. The imposition of water meters to regulate water use did not impact water demand, however 9 of the 25 respondents felt that the current overallocation of licences represented a risk to their farming business operations.

Table 5. Water market participation

	Yes	No	No response
Water meters implementation cost impacts water demand	2	20	3
Overallocation of licences present a risk to business operations	9	15	0
Does the respondent have plans to increase irrigation in the next 12 months?	8	15	2
Are you considering deactivation your licence in the next 12 months?	2	21	2

6.8 Farm risk exposure and impact on current and future water demand

Using commodity prices to determine farmer risk profiles it is evident that the price volatility of commodities has a minor influence on land use with 42% stating they had some influence on land use and 33% stating they had a strong impact on land use (Figure 26). Only 8% stated that commodity prices had a very strong impact on land use with 17% stating that commodity prices did not impact land use decision making at all. Of the respondents that stated commodity prices strongly or very strongly impacted land use, 40% felt that water licences were overallocated and presented a risk to their farming operations and 60% checked commodity prices at least once a week. Half of the respondents that stated that commodity prices strongly or very strongly impacted land use had plans to expand the areas irrigated in the next 12 months with 40% were also considering purchasing temporary or permanent water in the next 12 months, 60% indicated they used surface irrigation allocations and 40% utilised groundwater.

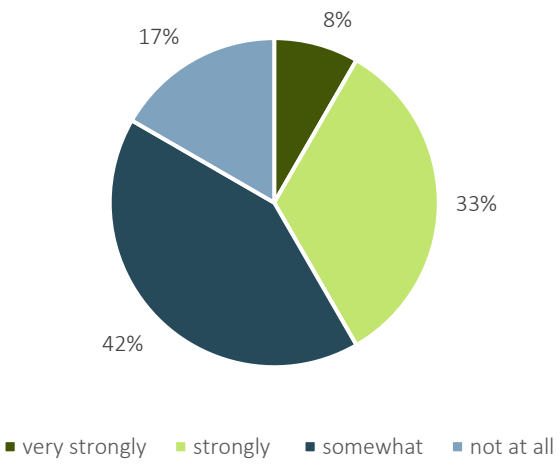

Figure 26. How do commodity prices impact your land use decisions?

Table 6. Land use for survey respondents who stated commodity prices strongly or very strongly impacted land use decisions

Land area (ha)	no. of respondents	Land use[14]
0 - 19	0	N/A
20 - 49	3	livestock (2), lucerne (1)
50 - 149	2	livestock & horses (1), livestock (1)
150 - 299	1	livestock, maize, lucerne (1)
300 or more	4	livestock, wool, bread wheat (1), livestock & durum wheat (1), durum wheat, lucerne (1), no answer (1)

As illustrated in Table 6, 40% of farmers that are more likely to consider commodity prices in land use decisions have 300 or more hectares with a diversified land use. Smaller land holdings (20 – 49 ha) had a single land use. Only 2 of the 7 respondents in Table 6 with land area exceeding 50 ha devoting all their production area to one land use, which in both instances was lucerne. This suggests farmers in Table 6 use commodity prices to determine the most profitable land use and adjust their production areas accordingly. Of the 4 respondents with 300ha or more, 50% had off farm income and were considering expanding the areas irrigated, 25% had no response and were most concerned about succession planning and 25% relied solely on income derived from the land and was not planning on increasing the area irrigated, expressing concern that livestock and commodity price volatility together with labour shortages may impact future farm production.

The impact of commodity prices and frequency farmers view the commodity price markets can be used as a proxy for farmers risk tolerance. Figure 27 shows that 50% of respondents check commodity prices at least weekly. One quarter of survey respondents check commodity prices every 6 months or less, with 12% checking every month and 13% checking every 3 months. Half of the respondents indicated they had off farm investments primarily in shares and property, the other half of respondents indicated they did not have any off-farm investments.

[14] The number of survey respondents for the identical land use is shown in brackets. For example, if 2 farmers indicated they used their land for lucerne and livestock production this is shown in brackets (2)

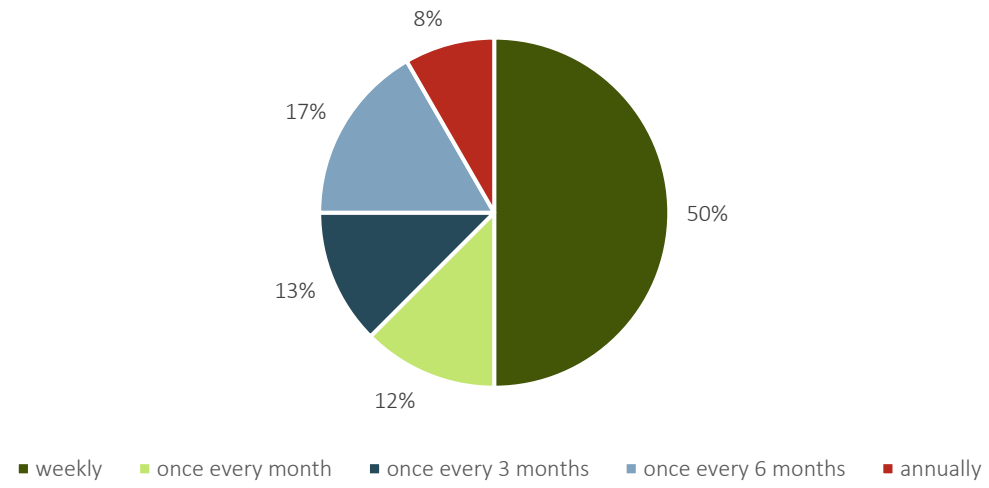

Figure 27. How often do you check commodity prices?

6.9 Future land use

As illustrated in Table 7 concerns land users have for future production are centred around price volatility with almost 2/3^{rds} of the survey respondents citing this as the largest concern they had with the future land use. The second largest concern survey respondents had was the impact of climate change on their operations. This was closely followed by changing market demand for the products they were producing and labour shortages. Succession planning and farm equipment financing were the smallest concern to respondents.

Table 7. Constraints or concerns for future land use

Biggest issues facing farmers	no. of respondents
Price volatility	15
Market demand for products	6
Farm equipment financing	3
Labour shortages	7
Land degradation	5
Climate change	8
Succession planning	2

6.10 Stakeholder interviews

Key outcomes from stakeholder interviews are summarised below:

Interview key outcomes

- Current license holders highly value water licenses
- Water licenses are seen as a tool to manage farm productivity
- Water license use is constrained by water allocation
- Water licenses are commonly activated to irrigate fodder crops which are grown for local consumption and export into North East New England and coastal region
- Tamworth town water use seen as a constraint to activation of water licenses, town water use perceived as reducing irrigator water allocations
- The poultry processing plant is not perceived to be a threat to water allocations
- Water meter installation cost has increased irrigation operation costs, which was a large, fixed cost borne by irrigators
- Demand for fodder crops was expected to remain strong and irrigators have long term contracts to supply fodder crops weekly to consumers in the coastal and North East New England region
- It was expected that the increased climate variability with floods and droughts would maintain high demand for fodder crops, therefore irrigators had no plans to change land use or irrigation water use
- Groundwater was perceived to be more reliable however has slower recharge rates and higher pumping costs per ML, with rising energy costs it is less attractive than surface water for irrigation
- Groundwater is seen as a resource to mitigate the impact of reduced water allocations on farming operations and was used during the drought 2016 – 2019 to overcome low (or no) water allocations
- Some farmers expressed interest in developing hemp crops and would activate 'sleeper' licenses to facilitate production if hemp were freely able to be commercially produced
- Strong support was issued for increasing dam capacity to harvest flood waters for use in drier periods to mitigate climate change water access variability
- Water recycling is seen to be expensive but may generate more support if it was shown to increase irrigation water reliability and access, especially during drought periods
- The smaller landholdings or 'hobby farms' were not perceived to be a threat to irrigators with little expectation that these landholdings would activate or use licenses attached to the property
- Water licenses were perceived as adding wealth or value to a landholding and no one interviewed expressed any desire to trade any of their current license holdings
- Environmental water flows were felt to impact water availability and impact negatively on water allocations for irrigation

6.11 Economic value of maintaining current levels of water security

There were conflicting perceptions of the value of current water use, some interviewees highlighted the unsustainability of current licensing. This was linked to a change in land management and the production process of lucerne bales of hay over the past 25 years. Lucerne is a key crop in the region and stakeholders have long term contracts to export fodder to the NSW coast and North East area of the New England.

Farmers have contracts to supply feed (particularly lucerne and corn). To meet these contractual arrangements the farmers have invested in irrigation infrastructure which has resulted in significant capital expenditure. The capital expenditure has regular servicing requirements, which are met through contracts to supply lucerne, hay and other feed crops. These contracts provide stable reliable income however are reliant on farmers producing

a regular supply of fodder crops, increasing demand for water in the Peel Valley. Maintaining water security was a key concern for some individuals interviewed to ensure they meet their financial commitments.

Individual water use was dependent on land use, with larger primarily fodder cropping landholdings not planning to reduce water use to 2035. Many water users had no plans to vary land use or water demand. A minority of individuals interviewed were less reliant on irrigation water, undertaking dryland cropping and livestock production. These landholders however had no intention of trading water rights or activating their water licences to 2035.

6.12 Barriers to water use preventing licence activation

A significant barrier to water use identified across individuals interviewed was the availability of water when it was required. A number of individuals cited the recent drought, where in 2019 the Tamworth Regional Council constructed a temporary weir in the Peel River to supply Tamworth with water (Figure 28). Chaffey Dam was at 16% and the Peel River flow was cut off to ensure any remaining water was supplied to the Tamworth town. This was not well received by irrigators with significant discussion on the allocation of water from the Chaffey Dam to Tamworth, industry, and irrigators. A number of irrigators felt that decisions on prioritising Tamworth water over irrigation use did not adequately consider the economic impacts on farmers and the wider community. Dairy farmers were significantly impacted by the 2017-2020 drought with reduced water allocations necessitating the import of fodder. The drought and inability to access water placed a significant financial burden on many farmers. Water availability and water allocations are seen as a significant barrier to licence activation.

Figure 28. Tamworth temporary weir in 2019 (Bendigo Advertiser)

The timing of water allocations and volume allocated to licence holders had a significant impact on license activation. Farmers holding a larger number of licences were unable to activate licences when they wished to

purchase water due to the volume of water allocated to their licenses. Irrigators have felt there is a disconnect between water demand and water supply, when there is demand for water, the supply is constrained, and they are unable to access the volumes they require. Water allocations have been at 100% in 2021-22, however the demand for water has been a lot lower with flood events experienced in the region.

Irrigators have felt capturing more water when the supply is plentiful (i.e., During flood or heavy rainfall events) and increasing or building more storage capacity can help mitigate the impacts of flooding and provide greater water supply security for drought events. There have been several plans to increase the water security in the Peel Valley discussed with the individuals interviewed and there were a range of views about which proposal was the most beneficial. One clear outcome was that the majority of people interviewed felt that water availability needed to be improved.

6.13 Future land and water use

The majority of people interviewed did not feel they would change land use, with the exception of one landowner who indicated if hemp became a commercially produced product, they would change some of their current dryland livestock production land use to hemp production and activate 'sleeper' licences. People cited the long history of hay and fodder production in the region, together with the strong dairy industry, including the Peel Valley Milk processing facility when discussing how they had no plans to change their land use in the future.

Future water use was not expected to change across more of the survey respondents. One person interviewed discussed how land use had changed in the past 25 years and was linked to the increased water efficiency and ability to pump water longer distance due to irrigation technology development. The increased irrigation efficiency has increased the area irrigated and concerns were raised that the capital investments made to facilitate this would drive further expansion of areas irrigated and water demand.

6.14 Other key factors impacting water supply

Farmers use groundwater to supplement irrigation water. Groundwater is perceived to be more reliable however has slow recharge rates and is more expensive to pump than irrigation water. Farmers stated that groundwater was the dominant water supply until the development of irrigation technology in the 1950's.

The current water demand by Tamworth is perceived to be a significant threat to water supply to irrigators. Irrigators felt the system allocating water to Tamworth and irrigators does not fairly allocate water resources. The reservation of water in the Chaffey Dam for town use, reducing water allocations to irrigators and water availability received negative feedback as stated previously in section. The forecast population growth of Tamworth is viewed as a threat to irrigators water availability and water supply. A popular solution to increasing water supply was the creation of a water recycling plant to supply irrigators with recycled town water.

The industrial chicken processing plant was not viewed as a threat to water supply with the plant installing systems to recycle up to 95% of the water it uses. Further development of the chicken plant was not viewed as a threat to future water supply or water availability.

Smaller landholdings that are located on the Peel River closer to Tamworth (also known as 'hobby farms') were not perceived as being a threat to water availability. The hobby farms generally utilised irrigation water for domestic stock and garden purposes with many licence holders not activating licence, instead utilising their 5ML water allocation attached to the land holding to fulfill their water requirements.

Some landholders were concerned about environmental water releases since 2016 and the timing, volume, and purpose of these water releases.

7 Synthesis of demand modelling and stakeholder consultation

The economic model suggests that farmers will undertake limited expansion of irrigated areas, with constraints discussed in Section 3.3 including the geography and pumping costs limiting irrigation expansion. Sensitivity testing of these outcomes suggested that the findings were robust across varied input and output prices, water availability and farmer risk preferences.

Farmers that were expected to continue to irrigate land regardless of cost or commodity market prices typically were more concerned about future availability and did not have off farm investments. Farmers surveyed with diversified income streams were less likely to be interested in purchasing additional water licences or expanding irrigated land use. Potentially land use is one of several income sources with agricultural income used to mitigate risks farmers are exposed to in other assets, such as stock markets.

Stakeholders interviewed largely were not considering varying land use or water consumption. Stakeholders interviewed suggested that the commercial development of crops such as hemp production would be the only trigger to increase irrigated land use. A number of farmers interviewed had long term contracts to supply fodder to farmers in North East New England or coastal NSW. The long term contracts constrain land and water use, with farmers reliant on regulated river and groundwater to ensure they can produce sufficient fodder to fulfill their contractual obligations. Long term contracts are used to provide a stable income which is less vulnerable to market price risks and reduces any marketing costs to the farmer.

It is expected that as water costs increase farmers decrease irrigated land and increase dryland crop production. This is largely consistent with interviewees discussions, where farmers with higher operating costs indicated they were more likely to maintain their irrigated land area than to expand. Possibly, these interviewees have less diversified income, and hence less access to capital, as was suggested in the survey results.

Water allocations are determined by the NSW government and are dependent on climatic conditions. Water allocations are a significant driver of licence activation and water use. In seasons with lower rainfall water usage and licence activation increases. A number of farmers interviewed stated they held inactive licences as a risk mitigation strategy to ensure they could access sufficient water allocations during drought periods. Farmers stated they were unwilling to trade or surrender these licenses and felt they were a critical part of their drought risk mitigation strategy.

Climate modelling undertaken for the NSW government suggested that there would be limited impact on rainfall in the Peel Valley. It expected that population growth in Tamworth will have a far greater impact on agricultural water supply, with urban water usage given first consumptive rights. This sentiment was echoed by the stakeholders interviewed, there is significant concern around water availability with the expected population growth. Stakeholders were less concerned about 'sleeper' or 'dozer' licences being activated and impacting their water allocations than they were with population growth in Tamworth impacting their water allocations and ability to mitigate drought impacts on their production processes.

Other stakeholders interviewed use suggested that they placed higher reliance on groundwater access during drier conditions when regulated river water allocations were restricted. Farmers perceived the regulated river water as less reliable than groundwater with urban water given priority over irrigation allocations, despite higher pumping costs and recharge rates constraining usage. The regulated river water licenses were used to supplement groundwater licences and mitigate the impact of slower aquifer recharge rates during drought periods. Noting that water trade is restricted to the Peel valley area, no-one surveyed or interviewed had any intention of selling water licences either temporarily or permanently.

The landholders most likely to activate licenses are the farmers most exposed to market risks, and the survey identified this group as having no off-farm investments. This group is more exposed to price volatility in market returns and reduced water allocations impacting their farming operations. They seek to reduce their risk exposure by holding larger volumes of water licences, meaning they are able to access higher volumes of water at times when allocations are reduced.

Landholders who have income from a range of off farm sources are more likely to have diversified land use, consistent with economic modelling undertaken in Section 5. These individuals are less likely to use inactive licences and stakeholders interviewed perceived them as an asset that added value to their landholding. They had no intention of trading or activating the licences but stated a preference for retaining them as their existence added value to the property and gave them options for future variation in land use.

There was a third of survey respondents (8 of the 25) that have plans to increase the area under irrigation in the next 12 months. Those that were considering irrigation expansion used irrigation water solely for fodder production and therefore more exposed to climate and market risks. The consultation process found that the dominant land use for farmers considering expanding irrigation was additional hay or fodder production land use. This is consistent with economic modelling, farmers considering irrigation expansion may be using it as a risk mitigation measure to ensure they can continue to fulfill long term fodder supply contracts. Economic modelling suggests that expansion will be limited and water demand will remain within the LTAAEL.

Economic modelling suggested that regardless of the scenario, farmers vary land use to mitigate risks and variability in returns. This is consistent with survey data with the majority of respondents indicating they had a range of land uses. Survey response data on the frequency of farmers checking commodity prices can be used as a proxy for farmers risk profiles, with individuals checking prices being more risk averse. In this regard, a large proportion of the survey respondents checked commodity prices at least monthly with some checking every week. The survey data suggests that the somewhat risk averse profile used in economic modelling is characteristic of the average farmer in the Peel Valley.

Overall, the outcomes of the economic modelling and consultation process are consistent finding that, broadly speaking, it is expected that farmers will continue to have similar land uses, with future irrigation water demand broadly consistent with existing water demand.

8 Conclusion

Irrigation water in the Peel Valley is mainly used for fodder and livestock production. The survey results and interviews suggest that fodder production is likely to remain the dominant irrigation water use in the future with limited irrigation water use for wheat production. Irrigation water demand is closely linked to the climatic conditions, with expansion of demand limited by land suitability, access to irrigation water and land use profitability.

Water storage availability, water supply and competing demands for water (urban, industrial, and environmental) represent important issues of concern for Peel Valley irrigators. To address this concern inactive water licences are held by farmers, with licences considered a valuable asset that enhanced the value of their landholding. Inactive licences are a mechanism to increase access to water during times of drought when seasonal allocations are low, and hence maximise farmers ability to maintain their existing fodder production land use. Groundwater is perceived as more reliable than surface water, with farmers using groundwater to maintain crops during times when surface water allocations are low.

Farmers are somewhat exposed to market risks, with half the farmers surveyed indicating they did not have any off-farm investments or income. These farmers also indicated they had higher concern about commodity market price volatility and plans to expand areas irrigated. The consultation process identified a link between farmers lacking diversified income streams, commodity prices and expansion of irrigated land use. Farmers that have diversified their land use and hold off-farm assets have lower reliance on water allocations, are less concerned about future water availability and are less likely to enter the temporary water market to purchase seasonal allocation.

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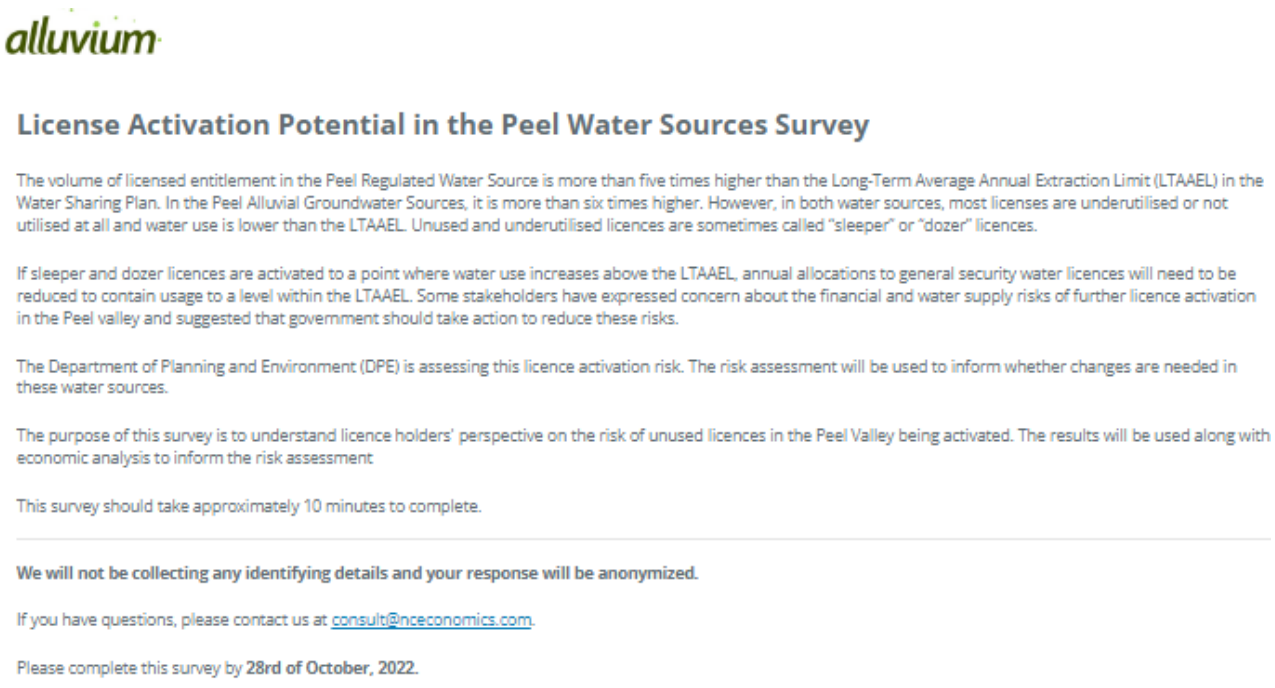
Attachment 1. Online Survey Questions

Survey

The questions asked in the onlien survey and the format used are resented below:



alluvium

License Activation Potential in the Peel Water Sources Survey

The volume of licensed entitlement in the Peel Regulated Water Source is more than five times higher than the Long-Term Average Annual Extraction Limit (LTAAEL) in the Water Sharing Plan. In the Peel Alluvial Groundwater Sources, it is more than six times higher. However, in both water sources, most licenses are underutilised or not utilised at all and water use is lower than the LTAAEL. Unused and underutilised licences are sometimes called "sleeper" or "dozer" licences.

If sleeper and dozer licences are activated to a point where water use increases above the LTAAEL, annual allocations to general security water licences will need to be reduced to contain usage to a level within the LTAAEL. Some stakeholders have expressed concern about the financial and water supply risks of further licence activation in the Peel valley and suggested that government should take action to reduce these risks.

The Department of Planning and Environment (DPE) is assessing this licence activation risk. The risk assessment will be used to inform whether changes are needed in these water sources.

The purpose of this survey is to understand licence holders' perspective on the risk of unused licences in the Peel Valley being activated. The results will be used along with economic analysis to inform the risk assessment

This survey should take approximately 10 minutes to complete.

We will not be collecting any identifying details and your response will be anonymized.

If you have questions, please contact us at consult@nceconomics.com.

Please complete this survey by **28rd of October, 2022.**

Survey

Section A: About your farming business

A1. What is the combined area of your farm/s? Please select from the options below.

- ○ Less than 20 ha
- ○ 20 - 49 ha
- ○ 50 - 149 ha
- ○ 150 - 299 ha
- ○ More than 300 ha

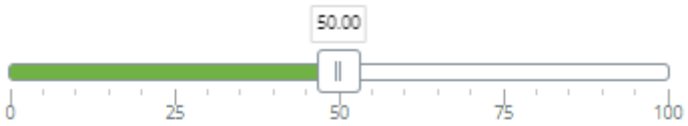
A2. What is the area (in hectares) you would have under different irrigation crops or livestock production in a typical year? Please only answer for the crops or livestock that you produce.

Livestock (cattle)	
Livestock (wool)	
Other livestock (please state)	
Bread wheat	
Durum wheat	
Mungbeans	
Maize	
Sorghum	
Lucerne & Hay	
Other (please state)	

A3. What is your typical annual irrigation application rate (ML per ha) for your crops or livestock production?

Livestock (cattle)	
Livestock (wool)	
Other livestock (please state)	
Bread wheat	
Durum wheat	
Mungbeans	
Maize	
Sorghum	
Lucerne & Hay	
Other (please state)	

A4. Approximately what % of your water entitlement do you use each year?



A5. Which water sources from the list below are available to you?

- [ ] Irrigation scheme
- [ ] Groundwater
- [ ] Unsupplemented surface water
- [ ] On-farm dams

A6. Please rank the water sources from 1 to 4, where 1 represents the source you most prefer and 4 represents the source you least prefer.

Move items here.

- Irrigation scheme +
- Groundwater +
- Unsupplemented surface water +
- On-farm dams +

Section B: Risk profile assessment

B1. How often do you look at agricultural commodity market prices?

- ○ Annually (or less frequently)
- ○ Once every 6 months or so
- ○ Once every 3 months
- ○ Once every month
- ○ Weekly (or more frequently)

B2. To what extent do commodity prices influence your land use or choice of crop/livestock?

- ○ Not at all
- ○ Somewhat
- ○ Strongly
- ○ Very strongly

B3. Do you have off-farm investments?

- ○ Yes
- ○ No

B5. What do you think has the biggest risk to your farming operations (check all that apply to you).

- ☐ Price volatility for grains and other crops
- ☐ Price volatility for livestock
- ☐ Future market demand for products
- ☐ Financing farm equipment
- ☐ Labour shortages
- ☐ Land degradation
- ☐ Climate change
- ☐ Succession planning

Section C: Thinking about the long term

In this section we want to understand your intentions in the future for any expansion or intensification of your current business, or your intention to establish a primary production business in the study area. It is important to understand your intentions in the long term (next 10-30 years).

Below are a several statements relating to key influences on farm investment that have been revealed through the project research and consultation process so far. Please tick the box that best represents your level of agreement or disagreement with each of the following statements.

C1. Do you anticipate increasing your area of irrigation?

- ○ Yes
- ○ No

C3. Would you ever consider buying or selling water on the temporary or permanent water market?

- ○ Yes
- ○ No

Issues that influence your farm investment decisions

The following questions are designed to understand your current thinking about future investments in your farm and the subsequent water use. Please rate your level of agreement with the statements below.

C6. My investment plans assume demand for product from the region will continue to grow at the same rate as in recent years.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree
- ○ Don't know

C8. My investment plans are subject to the availability of finance or investment capital (e.g. a loan or investor equity).

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree
- ○ Don't know

C9. Climate change in the future (changes to rainfall and runoff, increases in the frequency and/or intensity of hot days) will impact my investment decisions and how I use water on the farm.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly agree
- ○ Don't know

C10. During dry years, I use less water due to low allocations.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree not disagree
- ○ Somewhat agree
- ○ Strongly agree
- ○ Don't know

Section D: Wrapping up

D1. Do you think that overallocation of water licenses in the Peel Valley represents a risk to you and your business?

- ○ Yes
- ○ No

D3.Are you considering deactivating your licence and/or water supply works?

- ○ Yes
- ○ No

D5. Are you considering surrendering your licence and/or water supply works approval?

- ○ Yes
- ○ No

D7. Would a requirement to install or upgrade a water meter affect your future plans in irrigated agriculture?

- ○ Yes
- ○ No

D9. Is there anything else that you would like to add?

Thank you for taking time to complete this survey. If you have further questions, please contact us at consult@nceconomics.com.