West Country Water Resources

Assessment of Water Demand in Private Water Supply, Agriculture (Livestock) and Mining sub sectors to inform the Regional Plan

Final Report

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Executive Summary

The National Water Resources Framework sets out the need for integrated and multi-sector water resources planning, including the development of regional water resources plans by groups such as West Country Water Resources (WCWR).

WCWR has set out the challenges facing the region in its recent emerging plan for consultation (WCWR, 2022)[1] which summarises the key challenges at a regional level, the current supply-demand position and the potential changes to this position in different potential futures.

The WCWR group will publish its draft regional plan in November 2022. This draft report supports the need to improve the evidence base and confidence in the demand for water from three critical sub-sectors in the region:

1. Private Water Supplies (PvWS);
2. Agriculture (livestock); and
3. Mining & minerals extraction.

This draft report provides the following information:

- A 'deeper' dive into the levels of demand in these sub-sectors using up to date information from Environment Agency licences, Local Authority Private Water Supply Registers and informed where possible by targeted Stakeholder Engagement and local knowledge;
- Improving the granularity of the demand estimates in these sub-sectors over the work delivered by DEFRA (2020) to inform the National Water Resources Framework;
- Inform the levels of uncertainty in the demand in these sectors to inform the Regional Plan;
- A narrative on the potential pressures on demand for water in these sectors; and,
- Some recommendations to improve the robustness of these demand estimates in future Regional Planning

The provisional results of this assessment are summarised in the Table below:

Summary of sector water demands (Ml/d)

	South West Water	Bristol Water	Wessex Water	Bournemouth Water	Total from this study	National Framework 2022 Estimate
Total PvWS Estimate (Ml/d)	32.0	19.2	20.6	0.3	**72.2**	**3**

[1] West Country Water Resources (WCWR) (2022): Emerging Plan for Consultation

	South West Water	Bristol Water	Wessex Water	Bournemouth Water	Total from this study	National Framework 2022 Estimate
ALL Livestock Demand (Ml/d)	78.10	16.46	45.59	1.98	**142.1**	**43**
Mining / Extraction	-	-	-	-	**67**	**111**

The assessment of Private Water Supply (PvWS) demand is of particular note given that based on the registered demands provided by the Drinking Water Inspectorate the combined commercial and domestic estimate is 49.1 Ml/d. This project has identified a potential additional 23.15 Ml/d 'domestic' demand using a method which makes assumptions on the number of properties and consumption not connected to the water company supply grid. The actual use of this water for purposes other than 'domestic' in meeting the demand for water on farms for example is a key uncertainty. This report makes some key recommendations to try and understand this issue further

Summary of PvWS demands outside of the water industry, excludes unregistered[2] commercial property demands due to uncertainties around estimation of demands

Source	Demand Unit	Bournemouth Water	Bristol Water	South West Water	Wessex Water	Total
Registered PvWS (Commercial & Unknown)	Ml/d	0.1	15.1	14.4	11.3	**40.9**
Registered PvWS (Domestic)	Ml/d	0.05	0.3	5.6	2.2	**8.15**
Unregistered (Domestic)	Ml/d	0.2	3.8	12.0	7.1	**23.15**
Total	**Ml/d**	**0.4**	**19.2**	**32.0**	**20.6**	**72.2**

[2] 'Unregistered' in this context refers to properties identified in this study which may potentially have a PvWS that hasn't been registered with the Local Authority or Drinking Water Inspectorate.

1 Introduction

The West Country includes the counties of Cornwall, Devon, Somerset, Dorset, parts of Wiltshire, Hampshire and Gloucestershire and the City of Bristol. Water is supplied from three water companies: South West Water (including Bournemouth Water), Bristol Water and Wessex Water (Figure 1). Along with the Environment Agency, these three water companies form the core membership of the West Country Water Resources group (WCWR).

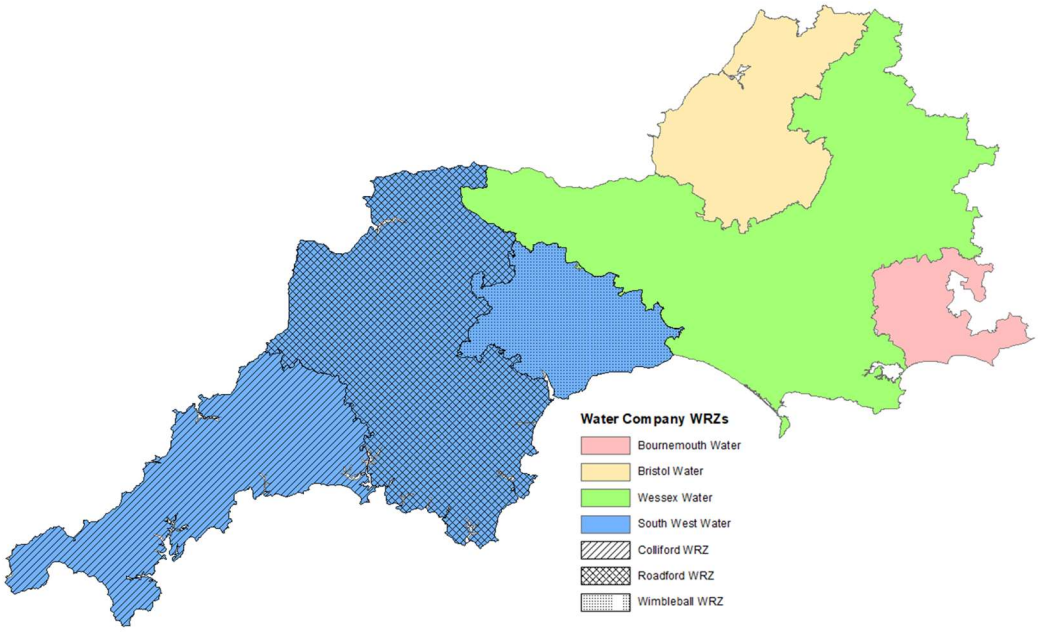

Figure 1: Water company supply areas in the West Country

The National Framework for Water Resources sets out the challenges facing the future supply and demand of water in England from pressures including climate change, population growth, environmental trends and other socio-economic factors.

A key element of this framework is the need for integrated and multi-sector water resources planning, including the development of regional water resources plans by groups such as WCWR.

WCWR has set out the challenges facing the region in its recent emerging plan for consultation (WCWR, 2022)[3] which summarises the key challenges at a regional level, the current supply-demand position and the potential changes to this position in different potential futures.

The WCWR group will publish its draft regional plan in November 2022. This report sets out to improve the evidence base and confidence in the demand for water from three critical sub-sectors in the region:

- Private Water Supplies (PvWS);

[3] West Country Water Resources (WCWR) (2022): Emerging Plan for Consultation

- Agriculture (livestock); and
- Mining & minerals extraction.

1.1 Scope

The assessment of the demand for water in these sub-sectors is key to developing a resilient water plan for the West Country region and our methods will consider several sub-objectives which are considered important outcomes and success criteria for this project.

- A ‘deeper’ dive into the levels of demand in these sub-sectors using up to date information from Environment Agency licences, Local Authority Private Water Supply Registers and informed where possible by targeted Stakeholder Engagement and local knowledge;
- Improving the granularity of the demand estimates in these sub-sectors over the work delivered by DEFRA (2020) to inform the National Water Resources Framework;
- Inform the levels of uncertainty in the demand in these sectors to inform the Regional Plan;
- Provide support to the assessment of specific catchment investigations including any specific challenges from the seasonality and levels of demand; and
- Including any specific knowledge and experiences from dry weather events in 2018 and the high demand in early 2020 from the Covid situation.

2 Evidence Review

2.1 Recent studies

The following section summarise reports which have been reviewed in the context of this study to better understand the water demands in the West Country.

WCWR (2022) Emerging Plan for Consultation and Comment January 2022

The emerging regional plan for the WCWR group presents the following estimates of water demand for non-public water supply abstractors (Figure 2) and recognises the need to investigate this issue further which is the scope of this current project. Note many of these figures, with the exception of the Public Water Supply value, came from the Wood (2020) study.

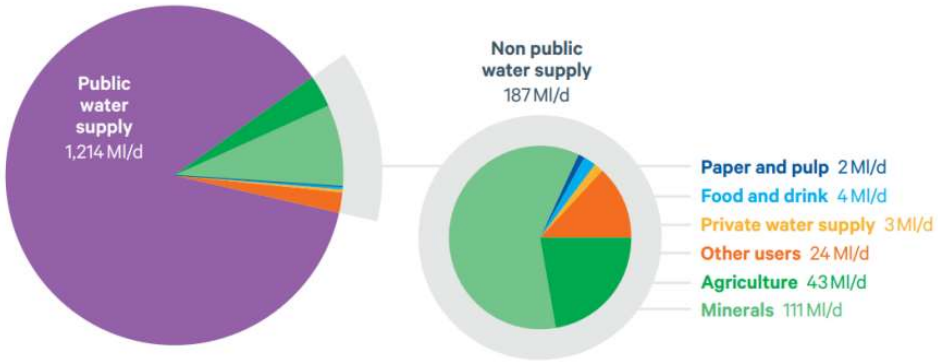

Figure 2: Non-PWS abstraction in the West Country. These numbers included both consumptive, and non-consumptive abstraction. Taken from WCWR (2022) Figure 13.

Wood (2020) Understanding future water demand outside of the water industry[4]

The aim of this study was to deliver an updated understanding of the uncertainties in water demand outside the water industry, focusing on sub-sectors within agriculture, manufacturing and electricity production. The study focused on direct abstractions and the findings will be used to inform the English Water Resources National Framework.

The seven sub-sectors analysed were:

- Agriculture:
    1. Spray irrigation;
    2. Livestock; and
    3. Protected edibles / covered cropping.

[4] DEFRA/Wood (2020) Understanding future water demand outside of the water industry- Final Report

- Industry/Manufacturing:
    4. Paper and pulp;
    5. Chemicals manufacturing; and
    6. Food and drink.
- Power:
    7. Electricity generation.

For each of the sub-sectors an overview was provided for water use and geographic distribution. Key factors affecting water demand and likely drivers for change in water demand in the future were also identified. These drivers included the UK population, climate change impacts, product demand and process efficiency.

In order to quantify the changes in future demand, the study estimated growth factors (a proportional increase to the existing abstractions) for the sub-sectors. These were derived using the drivers for change identified and socio-economic scenarios. The best estimates indicate an increase in demand across England varying from 63.9% to 163.1%.

This project is intended to build on these studies, improving understanding of water demand in the sectors of interest, by estimating *unknown* water demands.

Arup (2020) Research project furthering our understanding of future water demands from sectors outside the Water Industry

The Welsh Government commissioned Arup for a research project with the aim of improving the confidence in the estimates of demands and trends in use for sectors outside of the water industry. The study was made up of three stages: a literature review, stakeholder engagement and an assessment of future water demand across sectors.

The study found that outside the water industry, electricity generation is the greatest user of water within Wales. Although many of the processes for electricity generation are non-consumptive, the volume of water is still required for initial abstraction and use. Other notable users were found to include the metal, paper, minerals and the food and drink industries.

In terms of PvWS, this study found that they make up a small percentage (<1%) of the total licensed volume of water. From a consumptive viewpoint, PvWS make up approximately 3% of the licensed volume. A key observation from this study was that there are many unregistered PvWS in Wales, leading to uncertainties in demand estimates.

On the 01 January 2018 legislative changes, set out in the Water Act 2003, required previously exempt Water Abstractions to be licenced. The majority of Transitional Licences are non-consumptive, e.g. dewatering of mines and quarries. This process of licensing what are known as Transitional Licences is still ongoing. To date the quantities associated with these Transitional Licences have

not been determined (*ratified*). This demand will need considering once the data has been ratified.

The study utilised the DWI database (2018) containing the registered PvWS in Wales to visually represent the distribution of PvWS demands across Wales. The study, along with Stakeholder feedback, concluded that the number of registered PvWS and volumes presented are likely to be a significant underestimate.

3 Private water supplies

3.1 Data review

Datasets to inform this study were identified and requested from stakeholders such as the Environment Agency, Drinking Water Inspectorate (DWI) and water companies from within the West Country.

The datasets identified were required to build a picture of the supply network and water demands in the West Country. These included datasets required to identify properties that were not linked to the mains network, registered as having a PvWS, or listed in the Environment Agency National Abstraction License Database (NALD), across all sectors.

3.1.1 Water Company

The data outlined in Table 1 were requested from the water companies serving the West Country (Figure 1) to understand which properties are likely to be connected to the public water supply network. From the process of elimination an assessment was then made as to properties not connected to the mains and that are likely to have a PvWS.

Table 1: Water company datasets used in this study

Data	Purpose
Public Water Supply Mains Network	To help identify properties that are / are not supplied by mains water. Note that mains network data are not available from Wessex Water
All Address points	All registered addresses with the supply area to identify whether a water supply would be required
Supply Points	All properties supplied by Wessex Water
Non-supply points	All properties not supplied by Wessex Water
Demand estimates (l/h/d)	Allow estimates to be made where PvWS abstraction data is not available. Only applicable to residential properties.

Table 2 provides a summary of the address data in each of the water company supply areas. This has been divided into residential and commercial addresses where data permits.

Table 2: Number of address points in each water company supply boundary

	Bournemouth Water	Bristol Water	South West Water	Wessex Water
Commercial / other	24,360	34,755	89,061	-
Domestic	220,089	379,934	903,694	-
Total	**244,449**	**414,689**	**992,755**	**680,767**

Table 3 provides the range of per capita consumption (PCC) values in litres per head per day (l/h/d) as provided by each water company. These values are to be used in assessing demand from the unregistered address points identified through this assessment. It should be noted at this stage there are a range of values that could be used to calculate this demand, and that actual PCC values for a PvWS might be markedly different.

Table 3: Water company per capita consumption (PCC)

Water Company	Average PCC[5]	Average Household PCC	Measured Household PCC	Unmeasured Household PCC
	Litres per Head per Day (l/h/d)			
Bournemouth Water	146	153	128	255[6]
Bristol Water	132	161	147	177[7]
South West Water	123	153	128	255[6]
Wessex Water	137	152	140	171[8]
National Average	*129*	-	-	-

3.1.2 Local Authorities and DWI

The Local Authorities and the Drinking Water Inspectorate (DWI) manage a register of PvWS used for drinking water. As noted previously, this register is largely voluntary and there are known omissions and estimates; but it is a valuable dataset to help understand PvWS. However, the British Geological Survey (2020)[9] noted in their investigation in Wales that local authorities had little confidence in the location of around 50% of the registered PvWS in their region. This dataset (Table 4) was loaded into a GIS (Figure 3) to map out all the data points. It was observed that there were a few outliers with some data points being situated outside of the land boundary of England. These outliers were reviewed, and where possible their co-ordinates updated so that they were situated in the correct place geographically.

Table 5 provides a breakdown of the registered PvWS by type where data was provided; this demonstrates that the majority are for residential properties. The demands calculated for each registered PvWS are largely based on an assumed occupancy level based on property size, and PCC value of 200 l/h/d; giving some uncertainty around their true values.

[5] https://discoverwater.co.uk/amount-we-use
[6] Pers. Comms. with Paul Merchant, Supply Demand Manager, South West Water / Bournemouth Water
[7] Pers. Comms. with Liz Cornwell, Water Resource Manager, Bristol Water
[8] Pers. Comms. with Chris Hutton, Water Resource Manager, Wessex Water
[9] BGS Society/Public Health Wales. Ander *et. al.* (2020) Private Water Supplies in Wales: information to support public health priorities

Table 4: Local Authority and Drinking Water Inspectorate data

Data	Owner	Purpose
PvWS dataset including: - Geographical location of private water supply - Type of premises supplied - Type of source - Detail of any treatment process - Estimate of demand	Local Authority	To identify registered PvWS, primarily for human consumption, along with specific details regarding supply. To be cross referenced against mains network to identify gaps and possible dual supply properties.

Table 5: Summary of registered private water supplies within in each water company supply boundary. Note volumes largely estimated using 200 l/h/d where data doesn't exist.

		Bournemouth Water	Bristol Water	South West Water				Wessex Water
				Wimbleball	Colliford	Roadford	Total	
Commercial	No.	5	76	329	663	710	1,702	572
	Volume (Ml/d)	0.07	15.08	2.15	1.00	10.86	14.01	11.13
Domestic	No.	45	227	1,169	2,652	3,043	6,864	1,743
	Volume (Ml/d)	0.05	0.31	1.57	0.82	3.20	5.59	2.21
Unknown	No.	-	-	74	0	192	266	315
	Volume (Ml/d)	-	-	0.17	0	0.17	0.34	0.17
Total	**No.**	**50**	**303**	**1,572**	**3,315**	**3,945**	**8,832**	**2,630**
	Volume (Ml/d)	**0.12**	**15.39**	**3.89**	**1.83**	**14.22**	**19.95**	**13.51**

The data on registered PvWS also presents an opportunity to understand the sources of water; it can be seen from the data that the majority are supplied from ground water sources.

Table 6: Sources of registered private water supply and associated estimated volumes

		Bournemouth Water	Bristol Water	South West Water	Wessex Water
Borehole (BHW)	No.	38	150	3,581	987
	Volume (m^3/d)	86	3,850	8,023	4,563
	No.	-	-	2	10

		Bournemouth Water	Bristol Water	South West Water	Wessex Water
Borehole influenced by surface water (MXW)	Volume (m^3/d)	-	-	1	95
Multiple sources which are a combination of Borehole and spring (MMS)	No.	-	-	57	30
	Volume (m^3/d)	-	-	285	121
Estuarine or Brackish Water (EBW)	No.	-	-	1	-
	Volume (m^3/d)	-	-	1	-
Public Supply (Reg 8.)[10] (PMW)	No.	1	7	7	23
	Volume (m^3/d)	31	11,250	5	6,276
Spring (SPW)	No.	-	1	2,106	674
	Volume (m^3/d)	-	1	6,682	797
Surface Water (SFW)	No.	-	115	569	204
	Volume (m^3/d)	-	255	2,881	1,079
Rainwater (RNW)	No.	-	-	4	3
	Volume (m^3/d)	-	-	2	1
Well (WEL)	No.	11	30	1,531	428
	Volume (m^3/d)	0	34	1,556	512
Unknown (UNK)	No.	-	-	974	271
	Volume (m^3/d)	-	-	511	62

[10] A Regulation 8 supply tends to arise when a parcel of land on an estate is sold and the water supply continues to be provided by the estate because the new owner has not arranged for a separate public mains water supply connection. https://www.dwi.gov.uk/private-water-supplies/local-authorities/local-authorities-case-studies/regulation-8-supplies/#:~:text=A%20Regulation%208%20supply%20tends,public%20mains%20water%20supply%20connection.

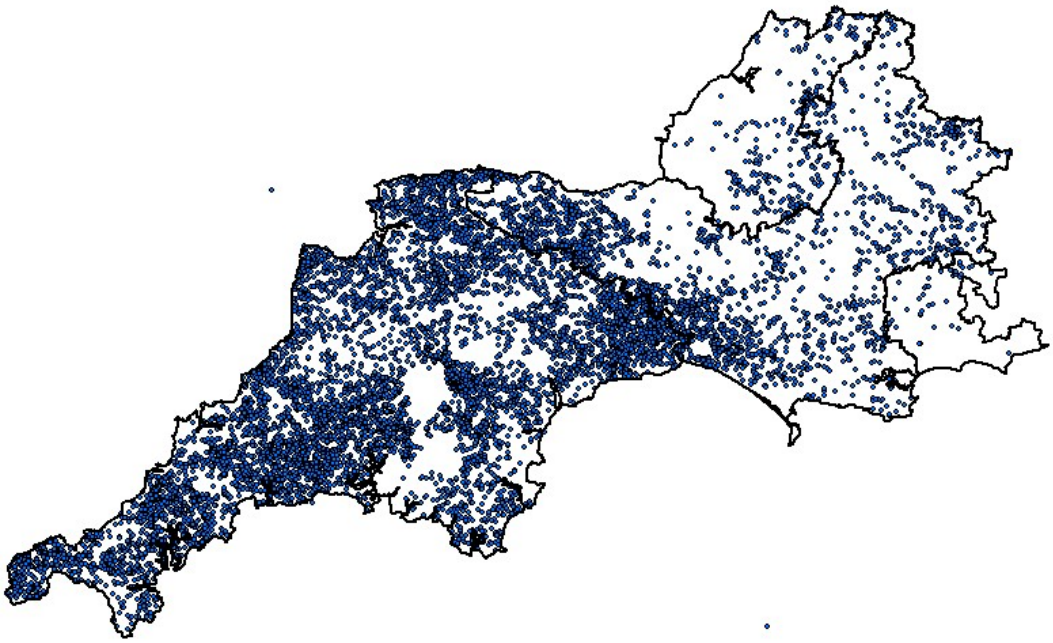

Figure 3: PvWS registered, as of 2019, with Local Authorities

3.1.3 Environment Agency

The Environment Agency hold a number of datasets (Table 7) on catchment areas, water resource availability and licensed abstractions (Figure 4). All of these were used in this assessment. A more detailed breakdown of the licensed abstraction by sector has been presented in Table 8. From this it can be seen that licensed abstraction volumes are dominated by agriculture, public water supply and power generation.

Table 7: Environment Agency data sets

Data	Purpose
National Abstractions License Database (NALD)	Identify all licensed abstractions
CAMS and WFD catchments and water availability	For spatial disaggregation of the data and to identify resource constrained catchments
New Authorisations	To date the quantities associated with these Transitional Applications have not been determined (ratified) so has not been included within this assessment.

Table 8: Summary of licensed abstractions within each water company supply boundary

Sector		Bournemouth Water	Bristol Water	South West Water	Wessex Water
Agriculture	No.	138	74	621	906
	Licensed Volume (Ml/a)	1,051,792	5,324	345,802	482,821

Sector		Bournemouth Water	Bristol Water	South West Water	Wessex Water
Amenity	No.	6	5	67	53
	Licensed Volume (Ml/a)	2,231	27	388,895	70,666
Environment	No.	8	27	46	31
	Licensed Volume (Ml/a)	9,557	13,348	15,754	76,485
Industrial, Commercial and Public Services	No.	24	64	457	181
	Licensed Volume (Ml/a)	1,548	16,243	201,639	56,672
Production of Energy	No.	1	16	149	83
	Licensed Volume (Ml/a)	1,305	571,898	1,445,623	993,352
Water Supply	No.	29	62	254	388
	Licensed Volume (Ml/a)	322,455	239,642	486,253	598,287
Total	**No.**	**206**	**248**	**1,594**	**1,642**
	Licensed Volume (Ml/a)	**1,388,888**	**846,482**	**2,883,965**	**2,278,282**

Given recent changes to the licensing system previously exempt abstractions now require a license; those that have submitted an application have been summarised in Table 9; but these are yet to be ratified.

Table 9: Additional licensing information on New Authorisations

		Bournemouth Water	Bristol Water	South West Water	Wessex Water
New Authorisations	No.	4	30	31	26
	Licensed Volume (Ml/a)	1,018	40,109	20,670	443,931

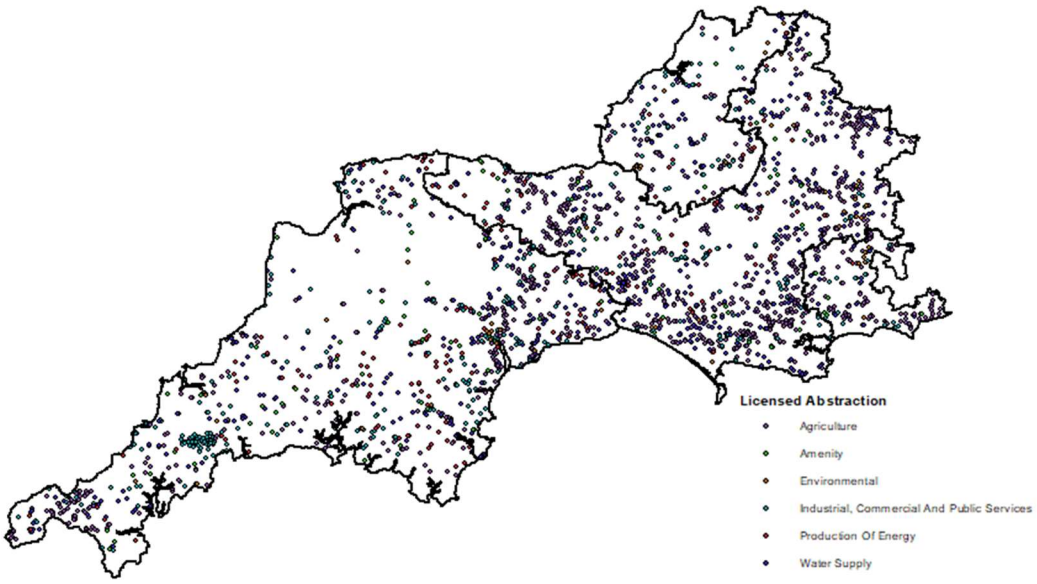

Figure 4: Environment Agency NALD Licensed Abstraction data for all licensed abstraction across the West Country, categorised by sector

3.2 Identifying the 'unregistered'

In the absence of information surrounding the supply type to every property, exceptions being for some properties in the Wessex Water supply area, to inform the identification process, several assumptions were made with respect to the datasets used.

- Address data being filtered to remove 'non-properties', such as sign posts, ATMs and post boxes which would not require a water supply. Wessex Water completed this in-house and provided data on properties which were not supplied by them.
- Address points connected to a mains network are likely to be within 150m of a distribution main or service pipe. This is a conservative approach as it is acknowledged that some farms can be situated in excess of 1.5km from the mains network yet can still have a mains supply.
- DWI registered PvWS points are in general likely to be within 100m of the address points they supply water to.
- Licensed abstraction will supply properties within a 250m buffer. This buffer is larger than PvWS under the assumption that these are larger abstractions and likely to be used a greater distance away from the source.
- Any address points that lay outside these buffers were highlighted and were assumed to not be linked to the mains network or have a registered PvWS and

were therefore considered to be 'unregistered' in terms of supply source (Figure 5).

- Where data permitted, the list of unregistered addresses was sorted by the class type[11] (Table 10) which gives an indication of the function of each address point.

Table 10: Initial estimate of number of properties identified as potentially having an unregistered water supply

	Bournemouth Water	Bristol Water	South West Water				Wessex Water[12]
			Wimbleball	Colliford	Roadford	Total	
Domestic	618	9,907	*8,058*	*13,756*	*11,250*	33,064	*19,626*
Commercial / other	186	2,000	*1,485*	*1,484*	*3,584*	6,553	*3,890*
Total	**804**	**11,907**	*9,529*	*15,226*	*14,820*	**39,617**	**23,516**

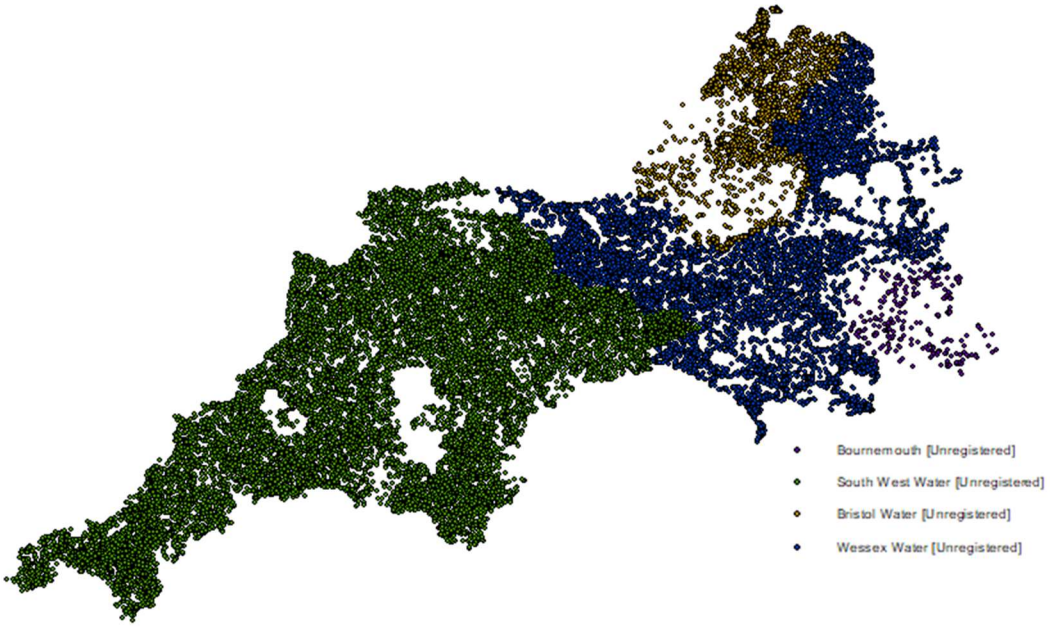

Figure 5: Properties identified as potentially having an unregistered water supply

The possible situations where PvWS abstractions could be 'unregistered' include:

- Those (previously exempt) abstractions that are greater than 20m³/day that have applied for a Transitional Licence but this hasn't been determined yet (Table 9);

[11] DWI (2020) AddressBase-product-classification-scheme.xls
[12] No data available for address type for Wessex Water, so proportions of total unregistered addresses used based on the average proportions found in other water company areas

- Those that are abstracting over 20m³/day but have not applied for a Transitional Licence and should now apply for a standard licence;
- Those less than 20m³/day and/or for activities that remain exempt and therefore exempt from needing a licence; or
- Those that are abstracting over 20m³/day but have not applied for a standard licence i.e. illegally abstracting and should now apply.

3.2.1 Dual supplies

Using the DWI registered PvWS dataset (Table 4), an additional check was carried out to identify potential dual supplies. For this study a dual supply implies that the property is connected to the mains network and also has a PvWS; this analysis links into the resilience discussion later in this report. The DWI dataset was used as all data entries are confirmed as PvWS.

Analysis was undertaken to identify the number of DWI registered PvWS that were within 150m of the mains network (Table 11). This analysis found that 2,172 of the PvWS were within the mains buffer and were considered to have potential dual supplies; within the Bristol Water, South West Water and Bournemouth Water supply zones. These properties may have the potential to switch from their PvWS to the mains supply if local resources are unable to meet demand, or vice versa. Given the datasets available a similar assessment was unable to be completed for Wessex Water.

Table 11: Potential Dual Supply properties

Water Company	No. of potential Dual Supply properties
Bournemouth Water	**20**
Bristol Water	**72**
Wimbleball	*392*
Colliford	*805*
Roadford	*853*
South West Water	**2,080**
Wessex Water[13]	-

[13] Unable to complete analysis with datasets available

3.3 Summary of private water supply demand estimates

The outcome from this initial assessment to identify **unregistered** water supplies has been summarised in Table 12. A more complete picture of water supply across all sources has been presented in Table 13.

Table 12: Initial estimate of properties identified as potentially having an **unregistered** water supply and estimated demands based on occupancy average from Census (2.37[14]) and average water company PCC estimates (Table 3)

		Bournemouth Water	Bristol Water	South West Water				Wessex Water
				Wimbleball	Colliford	Roadford	Total	
Domestic	No. of unregistered properties	618	9,907	*8,058*	*13,756*	*11,250*	33,064	*19,626 **
	PCC (l/h/d)	153	161	153				152
	Estimated demand (Ml/d)	0.2	3.8	*2.9*	*5.0*	*4.1*	12.0	7.1
	Estimated demand (Ml/a)	82	1,380	*1,067*	*1,821*	*1,489*	4,376	2,581
Commercial / other	No. of unregistered properties	186	2,000	*1,485*	*1,484*	*3,584*	6,553	*3,890**

* data provided by Wessex Water on addresses did not allow for type of property to be identified, therefore the proportion of unregistered domestic addresses from the total number of unregistered addresses from the other water company addresses was used, assuming a similar proportion would be found in Wessex

Table 13 summarises the PvWS estimates of demands across the West Country; giving a total of 72.2 Ml/d. It can be seen that demands are dominated by the registered commercial PvWS, which total 40.9 Ml/d; based on the DWI estimates. The registered domestic PvWS demand estimates only account of 8.15 Ml/d. This

[14] ONS Labour Force Survey, 15 November 2019 https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/datasets/familiesandhouseholdsfamiliesandhouseholds)

study has identified an estimated further 23.1 Ml/d of domestic PvWS which may not have been considered in other water resource assessments.

Table 13: Summary of PvWS demands outside of the water industry, excludes unregistered commercial properties demands due to uncertainties around estimation of demands

Source	Demand Unit	Bournemouth Water	Bristol Water	South West Water				Wessex Water	Total
				Wimbleball	Colliford	Roadford	Total		
Registered PvWS (Commercial & Unknown)	Ml/d	0.1	15.1	2.3	1.0	11.0	14.4	11.3	**40.9**
Registered PvWS (Domestic)	Ml/d	0.05	0.3	1.6	0.8	3.2	5.6	2.2	**8.2**
Unregistered (Domestic)	Ml/d	0.2	3.8	2.9	5.0	4.1	12.0	7.1	**23.1**
Total	**Ml/d**	**0.4**	**19.2**	**6.8**	**6.8**	**18.3**	**32.0**	**20.6**	**72.2**

When comparing the estimated values presented in Table 13 with the regionally estimated values from Wood (2020) (3 Ml/d); it can be seen that there is potentially a significant underestimate of demands. However, the methodology applied in deriving these revised estimates in Table 13 has considerable uncertainty and later in this report we provide some recommendations to help understand this uncertainty further for the purpose of the finalisation of the Regional Plan. In addition to the uncertainty around identifying the unregistered properties , another area of uncertainty is the assumption around occupancy, Census average[14], and PCC for the private water supply sub-sector and if, for

example a different PCC figure taken from Table 5 is applied, there are significant differences in the estimated unregistered domestic PvWS demand (Table 14).

Table 14: Comparison of potential demands based on various PCC values for each water company

Water Company		**Bournemouth Water**	**Bristol Water**	**South West Water**				**Wessex Water**
				Wimbleball	**Colliford**	**Roadford**	**Total**	
No. of unregistered domestic properties		**618**	**9,907**	8,058	13,756	11,250	**33,064**	***19,626***
Average Household PCC	PCC l/h/d	153	161	153				152
	Demand Ml/d	0.2	3.8	2.9	5.0	4.1	12.0	7.1
Measured Household PCC	PCC l/h/d	128	147	128				140
	Demand Ml/d	0.2	3.5	2.4	4.2	3.4	10.0	6.5
Unmeasured Household PCC	PCC l/h/d	255	177	255				171
	Demand Ml/d	0.4	4.2	4.9	8.3	6.8	20.0	8.0

Similarly, there are some large uncertainties with the DWI registered PvWS demand estimates, with a standard demand of 200 l/h/d being used where actual rates are unknown. If the more robust PCC figures from the water companies are used then again there is a notable reduction in the registered PvWS domestic demands (Table 15).

Table 15: Potential range of demands from registered PvWS if Water Company PCC estimates used instead of DWI 200l/h/d estimate

Domestic PvWS		**Bournemouth Water**	**Bristol Water**	**South West Water**				**Wessex Water**
				Wimbleball	**Colliford**	**Roadford**	**Total**	
	No.	*45*	*227*	*1,169*	*2,652*	*3,043*	*6,864*	*1,743*
DWI – 200 l/h/d	Volume (Ml/d)	0.05	0.31	1.57	0.82	3.20	5.59	2.21

Domestic PvWS		Bournemouth Water	Bristol Water	South West Water				Wessex Water
				Wimbleball	Colliford	Roadford	Total	
Average Household PCC (Table 3)	Volume (Ml/d)	0.02	0.09	0.42	0.96	1.10	2.49	0.63
Measured Household PCC (Table 3)	Volume (Ml/d)	0.01	0.08	0.35	0.80	0.92	2.08	0.58
Unmeasured Household PCC (Table 3)	Volume (Ml/d)	0.03	0.10	0.71	1.60	1.84	4.15	0.71

4 Agriculture

This assessment of demands from agriculture is focusing on livestock (drinking water) demands, rather than wider agricultural demands from the other activities such as irrigation. The larger volumes of water used for irrigation, particularly spray irrigation, is captured under the Environment Agency licensing regulation.

4.1 Agriculture in the West Country

Agriculture in the West Country has been summarised by DEFRA[15] but headlines from 2019 include:

- Total income from farming increased by 46% between 2015 and 2019 to £644 million.
- The biggest contributors to the value of the output (£4.1 billion), were milk (£1.1 billion), plants and flowers (£545 million), cattle for meat (£357 million) and poultry meat (£304 million), together accounting for 57%.
- In the West Country the average farm size in 2019 was 68 hectares (ha). This is smaller than the English average of 87 ha.
- Predominant farm types in the West Country region in 2019 were Grazing Livestock farms which accounted for 36% of farmed area in the region, Cereals farms and dairy farms covered an additional 20% and 18% of farmed area each.

Data from 2019 has been reproduced in Table 16 to summarise the main land use in the West Country. This indicates the importance of pastures, occupying nearly half of all farmland.

Table 16: Summary of agricultural land in the West Country (2019)

	England	**West Country**
Total farmed area ('000s ha)	9,206	**1,789**
Average farm size (ha)	87	**68**
% of farmed area that is permanent pasture	36%	**48%**
% of farmed area considered to be Severely Disadvantaged[16]	13%	**7%**

15 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/972089/regionalstatistics_southwest_23mar21.pdfhttps://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/972089/regionalstatistics_southwest_23mar21.pdf

16 In general terms **Severely Disadvantaged Areas** (SDA) tend to be given over to the farming of livestock.

Table 17 provides a summary of the licensed agricultural abstractions in the West Country. As can be seen from the sub-sectors listed not all are relevant to livestock and drinking water.

Table 17: NALD summary of agricultural abstraction licenses

Type of agricultural abstraction	Bournemouth Water		Bristol Water		South West Water		Wessex Water	
	No. of Licenses	Licensed Volume (Ml/a)	No. of Licenses	Licensed Volume (Ml/a)	No. of Licenses	Licensed Volume (Ml/a)	No. of Licenses	Licensed Volume (Ml/a)
Aquaculture Fish	31	1,041,622	9	3,936	128	259,113	86	317,133
Aquaculture Plant	3	7,451	1	248	-	-	62	129,301
Forestry	-	-	-	-	-	-	1	2
General Agriculture	96	2,522	55	1,104	481	86,562	725	35,269
Of which is Spray Irrigation	*83*	*2,312*	*26*	*455*	*182*	*1,822*	*219*	*4,607*
Horticulture And Nurseries	7	188	9	36	11	75	31	1,069
Orchards	1	10	-	-	-	-	1	46
Zoos / Kennels / Stables	-	-	-	-	1	53	-	-
Lake & Pond Throughflow	-	-	-	-	1	53	-	-
Total	**138**	**1,051,792**	**74**	**5,324**	**621**	**345,802**	**906**	**482,821**

As noted in Table 17 the dominant abstraction volumes within agriculture are related to aquaculture fisheries. A more focused breakdown of general agriculture indicates that the spray irrigation is the second largest user of water. Note the additional breakdown of the 'General Agriculture' sub-sector which identifies the licenses and volumes associated with spray irrigation.

Data from 2019 has been reproduced in Table 18 to show the main livestock types in the West Country. This indicates the importance of cattle farming in the West Country; with the region having 39% of the English dairy herds and 27% of the beef herds.

Table 18: Livestock numbers in the West Country (2019)

Livestock Types	England ('000s)	West Country ('000s)
Dairy cattle	1,102	428 (39%)
Beef cattle	675	182 (27%)
All cattle	5,100	1,708 (33%)
Sheep	15,390	3,159 (21%)

Livestock Types	England ('000s)	West Country ('000s)
Pigs	4,060	449 (11%)
Poultry	138,850	20,227 (15%)
Figures in brackets denote the proportion which the region contributes to the English total		

Livestock numbers were taken from the 'Structure of the agricultural industry in England and the UK at June' statistics, last updated in 2010. These data are updated on 10-year cycles. However, regional data collection for 2020 was disrupted by Covid-19 and therefore, 2020 results have not been produced for this level of data. Datasets are expected to be updated to include 2021 results in late 2021/early 2022[17]. The need to update these estimates using the revised livestock numbers is a key recommendation for the finalisation of the Regional Plan.

The livestock numbers by type have been presented in Figure 6 to Figure 10 and show the concentrations and spreads of various types across the West Country.

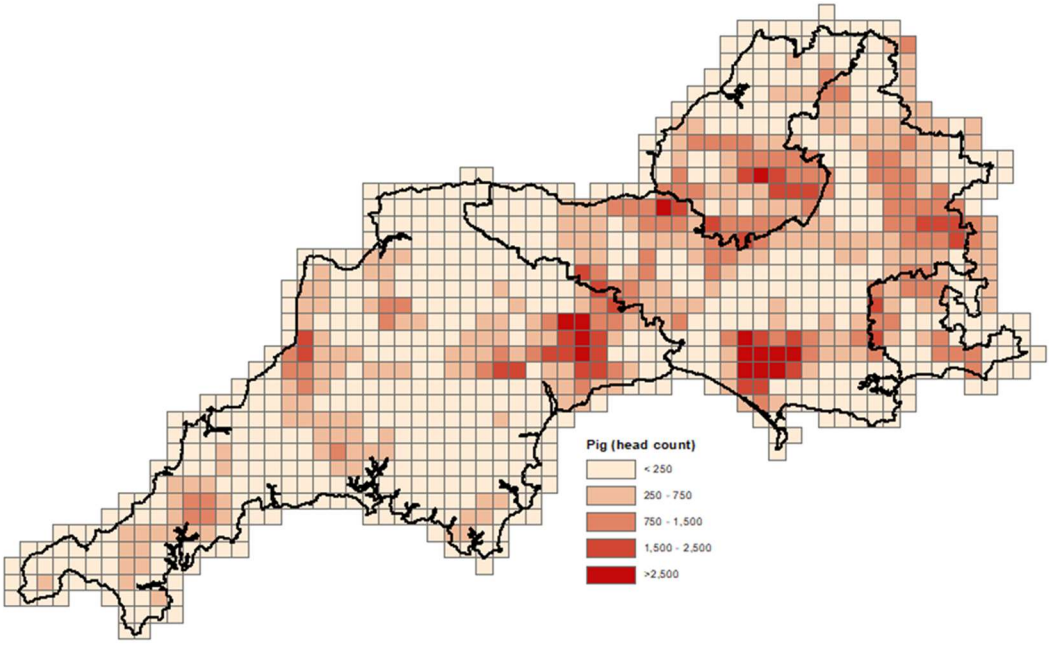

Figure 6: Pigs number in South-West, per 5km² grid

[17] https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june

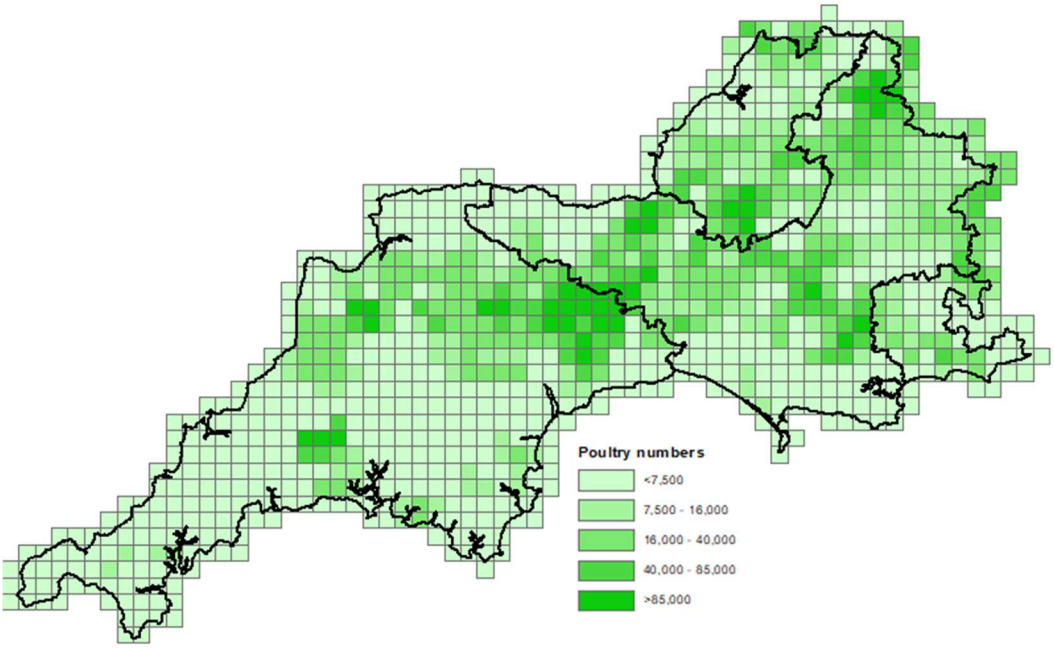

Figure 7: Poultry numbers in the South-West, per 5km² grid

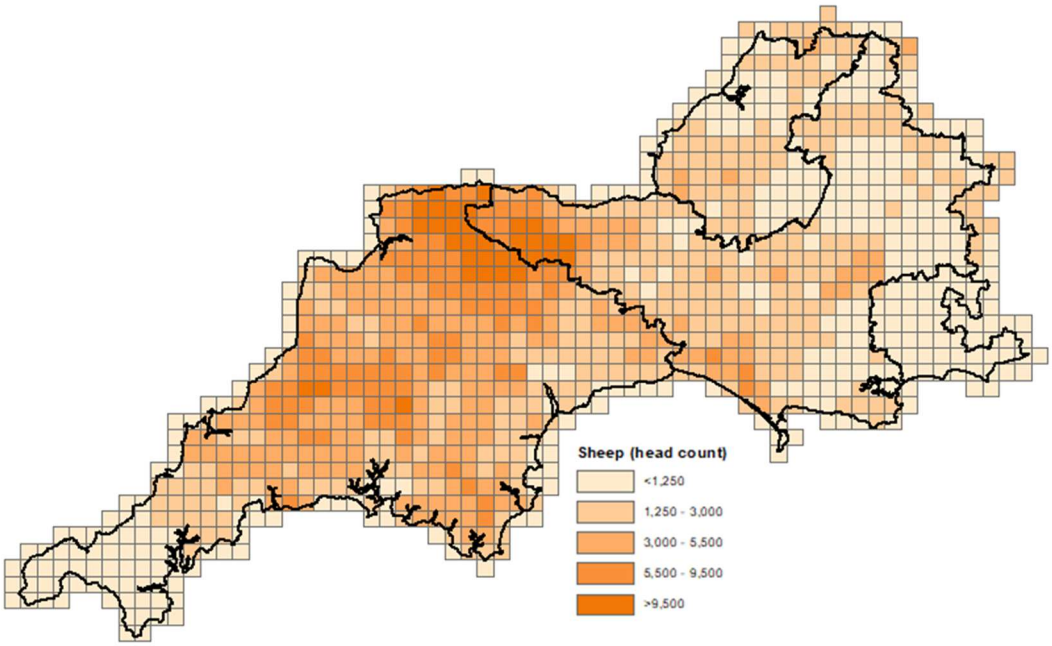

Figure 8: Sheep numbers in the South-West, per 5km² grid

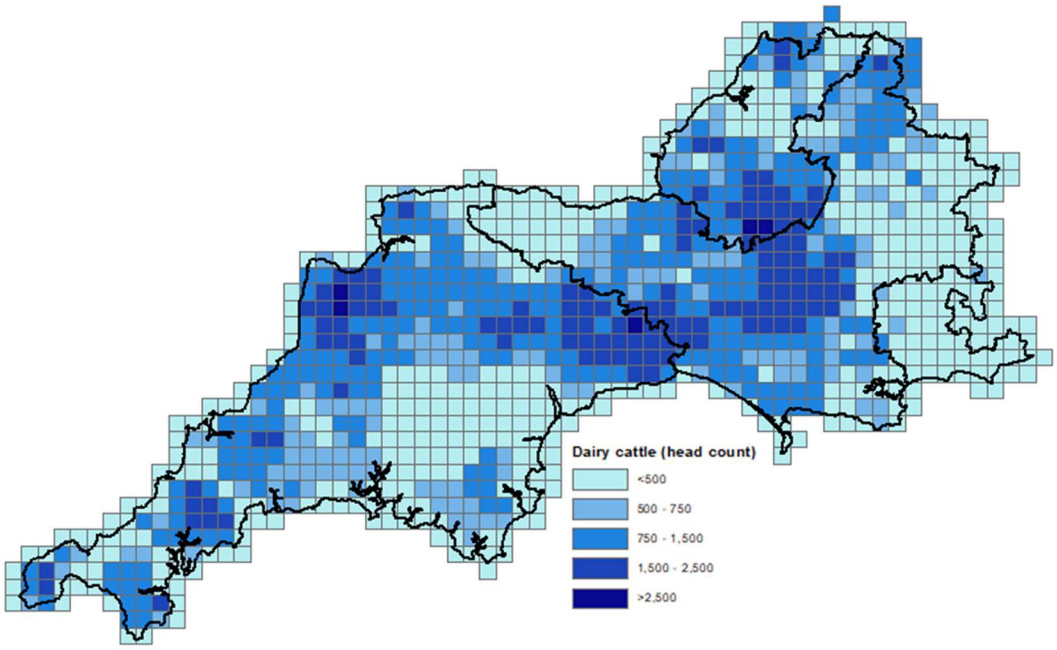

Figure 9: Dairy cattle in South-West, per 5km² grid

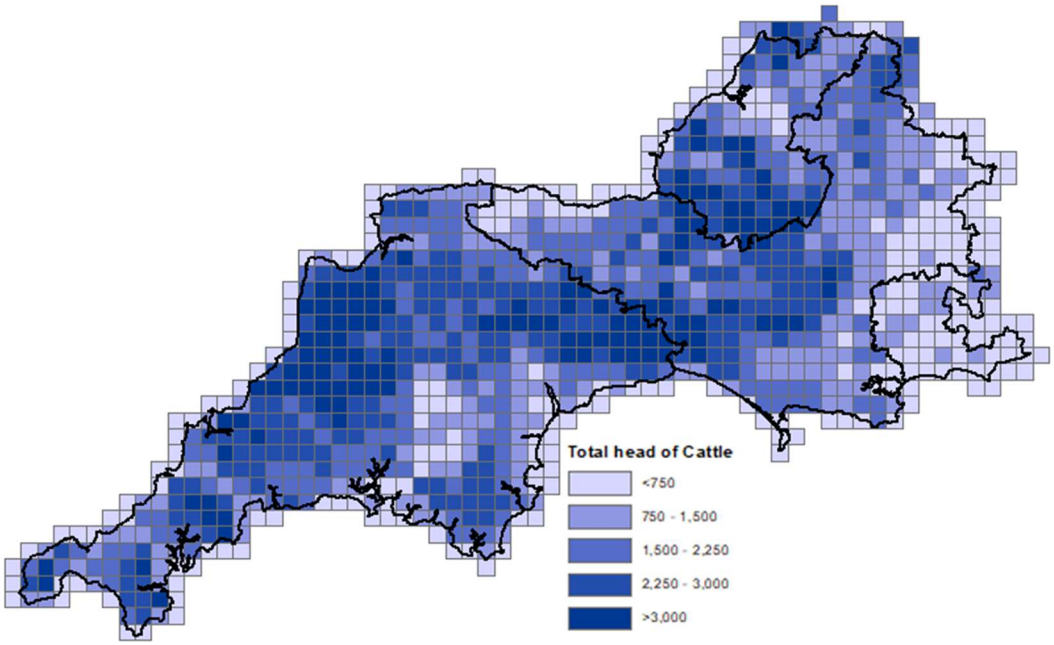

Figure 10: Total cattle numbers in south-west, per 5km² grid

4.2 Understanding of livestock water demands

Sources of Water on Farms

The DEFRA Water usage on farms survey[18] highlighted some key points relating to water use on farms including:

[18] DEFRA (2017) Water usage on farms: Results from the Farm Business Survey, England 2015/16. Available at:

- Mains supply continues to be the most common source of water on farms. It was recorded at 85% of the farms surveyed in 2015/16. This was most prevalent in the East of England and those farms located outside of Severely Disadvantaged Areas (SDA)[19].
- 31% of farms in England abstracted water from rivers/streams/springs for immediate use. This was predominantly used for grazing livestock in the South-West of England and for farms located in SDAs.
- 25% of farms surveyed in England used water from boreholes. These farms were likely to be specialist dairy farms, larger farms and farms in the West Country.

The DEFRA 2017 study in water usage on farms gives an indication of the water supply sources on different farming types across the country. From the data presented in Table 19 it is evident most farming types, with the exception of LFA grazing farms which rely heavily of direct abstraction from watercourses, have a mains connection. For the South West, on average 78% of farms are connected to the mains; 50% directly abstract from surface water sources and 42% have access to private boreholes; suggesting that farms will make use of numerous supplies to meet their demands.

Table 19: Percentage of farms using various water sources, England 2015/16[20]

Farming Type	Percentage of farm businesses in England containing each water supply source					
	Mains water	**Rivers, streams, springs for abstraction (immediate use)**	**Boreholes**	**Rainwater storage**	**Rivers, streams, springs for abstraction (storage)**	**Ponds/ lakes/ reservoirs**
Dairy (England)	89	29	50	13	8	2
LFA Grazing Livestock (England)	59	68	15	10	16	5
Lowland Grazing Livestock (England)	83	46	31	8	4	2
Pigs & Poultry (England)	90	5	33	3	1	0
Mixed (England)	90	36	19	5	6	1
South West	**78**	**50**	**42**	**11**	**8**	**1**

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/587296/fbs-wateruse-statsnotice-31jan16.pdf

[19] In general terms **Severely Disadvantaged Areas** (SDA) tend to be given over to the farming of livestock.

[20] DEFRA 2017 – Water usage on farms – results from survey stats.ods

Average proportions of water used per farm by source

- Responses from the 2015/16 farms surveyed indicated that on average, two thirds of farm water supplies were provided by main supply, 19% from boreholes and 12% was abstracted from rivers/streams/springs for immediate use.
- Cereal growers tended to source a greater proportion of their water supply from the mains network.
- Dairy farms, larger farms and those located in the South West of England, tended to source a greater proportion of their water from boreholes than when compared with other farms.
- Farms in Less Favoured Areas[21] (LFA) grazing livestock tended to abstract a greater proportion of their water, when compared with mains use, when compared with other farms.

Further data from the DEFRA (2017) study (Table 20) highlights that in the West Country 49% of the farming water demands is met by mains water; 32% from direct river abstraction and 14% from private boreholes. If only 49% is met by mains then this indicates a reliance on other sources to meet the farming water needs.

Table 20: Average proportion of water used, England 2015/16

Farming Type	Average proportion of water used (%) for each farming type and by source					
	Mains water	Rivers, streams, springs for abstraction (immediate use)	Boreholes	Rainwater storage	Rivers, streams, springs for abstraction (storage)	Ponds/ lakes/ reservoirs
Dairy (England)	50	36	9	3	1	2
LFA Grazing Livestock (England)	38	11	41	7	1	1
Lowland Grazing Livestock (England)	61	22	12	2	1	1
Pigs & Poultry (England)	72	24	2	0	0	2
Mixed (England)	72	14	11	2	0	1
South West	**49**	**32**	**14**	**3**	**1**	**1**

[21] A **less-favoured area** (LFA) is a term used to describe an area with natural handicaps (lack of water, climate, short crop season and tendencies of depopulation), or that is mountainous or hilly, as defined by its altitude and slope.
https://magic.defra.gov.uk/StaticMaps/Less%20Favoured%20Areas%20(England).pdf

Livestock water requirements

Water requirements for livestock varies considerably according to many factors such as species, breeds, age, growth rate, pregnancy of the animal, along with more other factors such as feed type, activity, production status and environment/climate.

There are a plethora of studies looking into the water requirements of livestock. The DEFRA Project WU0132: Sustainable water for Livestock (Appendices 1-4) provides a review and comparison of many of these sources.

The study considered livestock through the entire life cycle; particularly pigs and poultry. Demands have been presented to be representative at different stages of cycle; meaning that animal numbers can't simply be multiplied by a daily demand value to get an annual total.

Water availability and quantity are extremely important to the safe and successfully running of a farm. There are a number of hygiene and legal issues associated with alternative sources of water supply to livestock.

The quality of livestock drinking water is also specified in voluntary Assurance Schemes, for example the Red Tractor Farm Assurance Dairy Standards (AFS, 2010) states:

> *Stock must have adequate access to a supply of fresh, clean drinking water. Whilst at pasture or outdoors, all livestock must be provided with additional water troughs unless there are sufficient natural water sources, of sufficient quality, to ensure adequate daily access.*

This latter requirement indicates that "natural sources" are considered satisfactory provided they are considered to be "clean", although "clean" is not further defined in the assurance standards. Rainwater harvesting can be considered even though rainwater lacks some minerals but often there is no need for further treatment.

A range of potential water demands for various types of livestock (Table 21) were informed through close consultation with Peter Danks at Reading Agricultural Consultants (RAC).

Table 21: Range of demand values considered for each type of livestock

Livestock	**Demand per head (l/d)** [22]		
	Min (l/d)	**Avg (l/d)**	**Max (l/d)**
Breeding Ewes	*4*	*9*	*14*
Rams	*2*	*6*	*10*
Lambs	*2*	*5*	*7*

[22] Livestock demand values derived from a range of sources including the Agriculture and Horticulture Development Board (AHDB), Integrated Pollution Prevention and Control (IPPC) guidelines, National Equine Welfare Council (NEWC) and Per. Comms. held by Peter Danks (Reading Agricultural Consultants).

Livestock	Demand per head (l/d) [22]		
	Min (l/d)	Avg (l/d)	Max (l/d)
Other Sheep	*2*	*6*	*9*
Goats	5	10	15
Dairy Cows	*58*	*107*	*155*
Beef Cows	*28*	*41*	*55*
Calves	*5*	*8*	*10*
Other Cattle	*20*	*41*	*63*
Pigs*	1	8	30
Poultry*	0.1	0.3	0.4
* These livestock types were not further divided into different stages of their life cycles as the data on the split were not available from the statistics			

The DEFRA research and Table 21 show the huge range of calculated water demands across livestock types and being dependent upon many variables. Any daily/annual estimates of water demand will involve a number of assumptions and come with a large variation.

4.3 Estimates of livestock water demand

Livestock drinking demands (Table 22 to Table 24) have been estimated using livestock numbers from the 2010 DEFRA data and the average drinking demands presented in Table 21; noting the uncertainties around this approach.

Table 22: Cattle numbers (2010) and estimated drinking demands in the West Country

	South West Water	Bristol Water	Wessex Water	Bournemouth Water
Livestock Type	**Dairy cows**			
Number (2010)	368,820	94,792	247,753	8,788
Drinking water demand (Ml/d) based on average demand presented in Table 21	39.5	10.1	26.5	0.9
Livestock Type	**Beef cattle**			
Number (2010)	297,997	53,958	144,538	8,863
Drinking water demand (Ml/d) based on average demand presented in Table 21	12.2	2.2	5.9	0.4
Livestock Type	**Other cattle**			
Number (2010)	267,914	48,967	121,075	5,877
Drinking water demand (Ml/d) based on average demand presented in Table 21	11.0	2.0	5.0	0.2

	South West Water	Bristol Water	Wessex Water	Bournemouth Water
	All cattle			
Total	**934,731**	**197,717**	**513,367**	**23,528**
Total (Ml/d)	**62.7**	**14.4**	**37.4**	**1.5**

Table 23: Sheep numbers (2010) and estimate drinking demands in the West Country

	South West Water	Bristol Water	Wessex Water	Bournemouth Water
Livestock Type	**Rams**			
Number (2010)	21,349	1,864	8,177	199
Drinking water demand (Ml/d) based on average demand presented in Table 21	0.13	0.01	0.05	0.00
Livestock Type	**Lambs**			
Number (2010)	868,406	70,736	338,156	8,593
Drinking water demand (Ml/d) based on average demand presented in Table 21	4.34	0.35	1.69	0.04
Livestock Type	**Ewes**			
Number (2010)	841,384	69,083	326,784	8,096
Drinking water demand (Ml/d) based on average demand presented in Table 21	7.57	0.62	2.94	0.07
Livestock Type	**Other sheep**			
Number (2010)	33,288	6,590	16,244	577
Drinking water demand (Ml/d) based on average demand presented in Table 21	0.20	0.04	0.10	0.00
	All sheep			
Total	**1,764,427**	**148,273**	**689,362**	**17,465**
Total (Ml/d)	**12.2**	**1.0**	**4.8**	**0.1**

Table 24: Pig and poultry numbers (2010) and estimate drinking demands in the West Country

	South West Water	Bristol Water	Wessex Water	Bournemouth Water
Livestock Type	**All pigs**			
Number (2010)	129,478	53,320	164,419	20,854

	South West Water	Bristol Water	Wessex Water	Bournemouth Water
Drinking water demand (Ml/d) based on average demand presented in Table 21	1.04	0.43	1.32	0.17
Livestock Type	**All poultry**			
Number (2010)	7,170,759	2,147,401	6,996,528	491,056
Drinking water demand (Ml/d) based on average demand presented in Table 21	2.15	0.64	2.10	0.15

4.4 Trends in agriculture

The following charts (Figure 11 to Figure 14) present some general trends for livestock numbers across England and have been included purely for illustrative purposes. Given the lack of up-to-date data specific to the West Country it is difficult to draw any firm conclusions at this time; however, when the datasets become available these trends can be revisited.

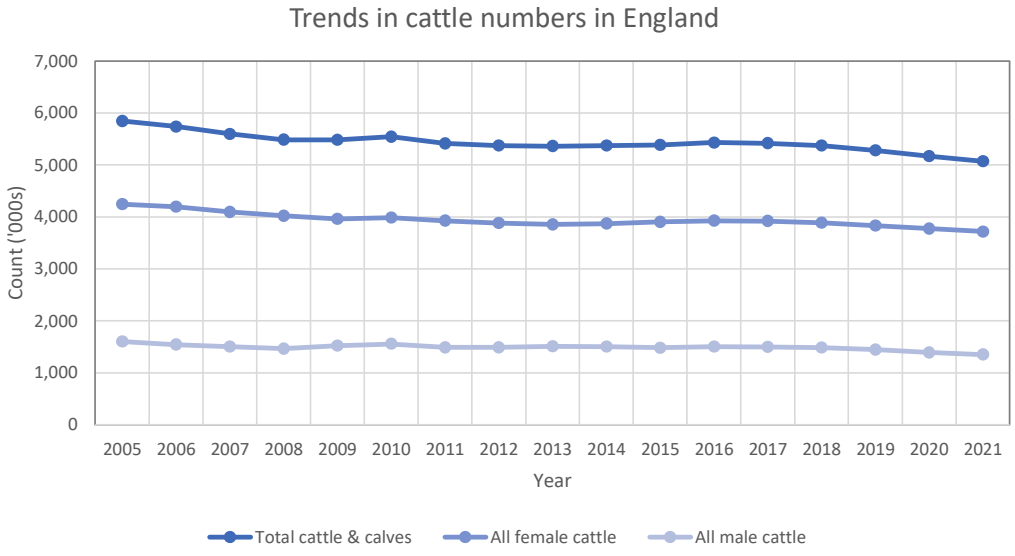

Figure 11: Trends in cattle numbers in England between 2005 and 2021.

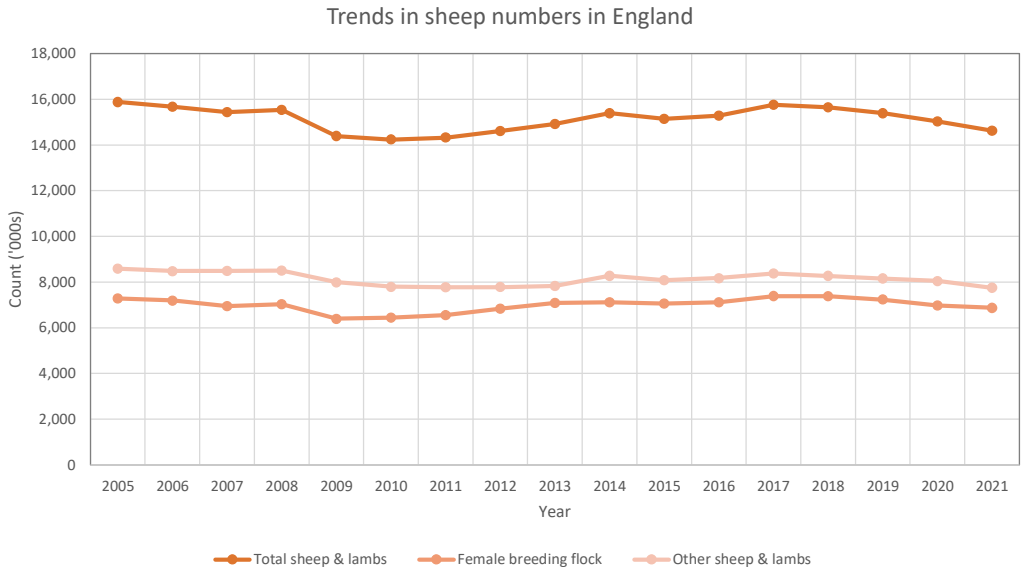

Figure 12: Trends in sheep numbers in England between 2005 and 2021

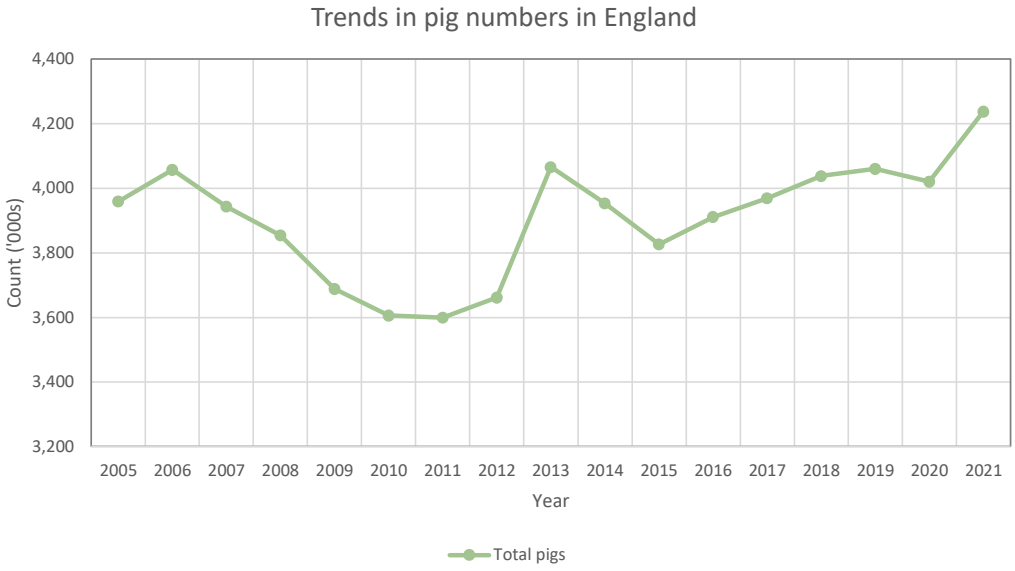

Figure 13: Trends in pig numbers in England between 2005 and 2021

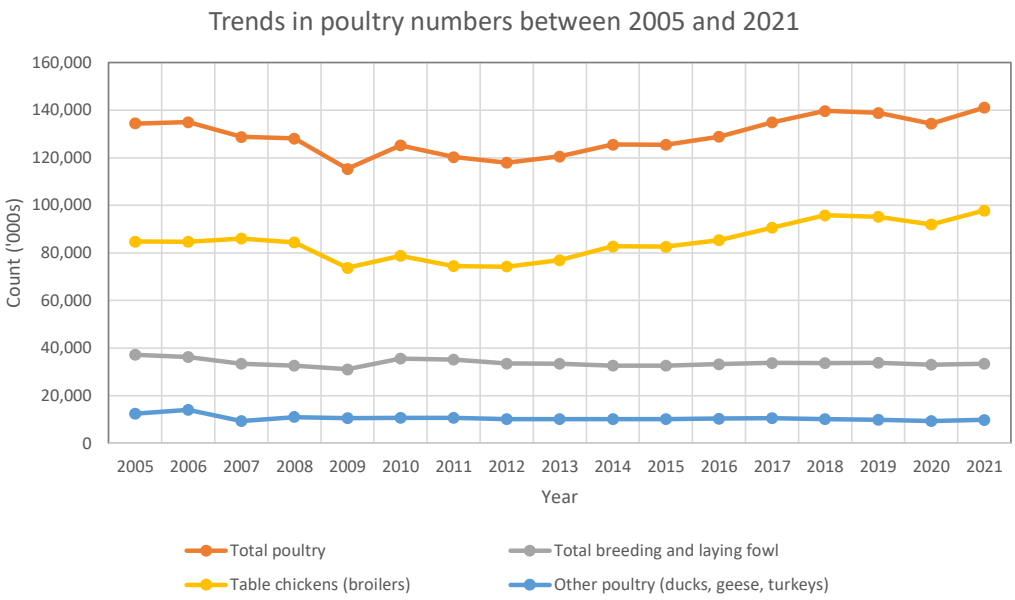

Figure 14: Trends in poultry in England numbers between 2005 and 2021

4.5 Summary of Agriculture Water Demand Estimates

The data presented in Table 25 summarises the estimates of drinking water demand for a selection of livestock types. The estimate of total drinking water demands, based on the assumptions presented in this section, is 142 Ml/d; with over half of this made up from demands from dairy herds.

Table 25: Summary of livestock drinking water demands

	Wimbleball WRZ	***Colliford WRZ***	***Roadford WRZ***	**South West Water (Total)**	**Bristol Water**	**Wessex Water**	**Bournemouth Water**
Dairy Cows Demand (Ml/d)	*9.66*	*12.62*	*17.19*	39.46	10.14	26.51	0.94
Beef Cattle Demand (Ml/d	*1.94*	*4.16*	*6.11*	12.22	2.21	5.93	0.36
All Cattle Demand (Ml/d)	*13.68*	*20.44*	*28.54*	62.67	14.36	37.40	1.54
All Sheep Demand (Ml/d)	*1.93*	*2.78*	*7.53*	12.24	1.03	4.78	0.12
ALL Livestock Demand (Ml/d)	***17.19***	***23.73***	***37.18***	**78.10**	**16.46**	**45.59**	**1.98**

To try and appreciate the sources of supply to meet these drinking water demands Hess *et. al*[23]. cited a reference that private water supplies are particularly important for livestock farms for drinking water which can account for 79% of the total water requirement of dairy cattle and >90% of the water requirement for pigs, sheep and poultry. Given the total demand estimate for dairy cattle is 77 Ml/d, this indicates around 60 Ml/d could be met by a PvWS if this percentage is applied. However to illustrate the uncertainty further, the data from the DEFRA (2017) study (Table 20 above) highlights that in the West Country 49% of the farming water demands is met by mains water which could potentially imply approximately around 39 Ml/d could be met by PvWS,

The following Figure 15 to Figure 17 attempt to spatially represent where these demands are greatest based on the Water Resource Zones (WRZ) for each water company in the West Country. For dairy cattle (Figure 15) demands are highest in Wessex and Roadford (SWW) WRZs.

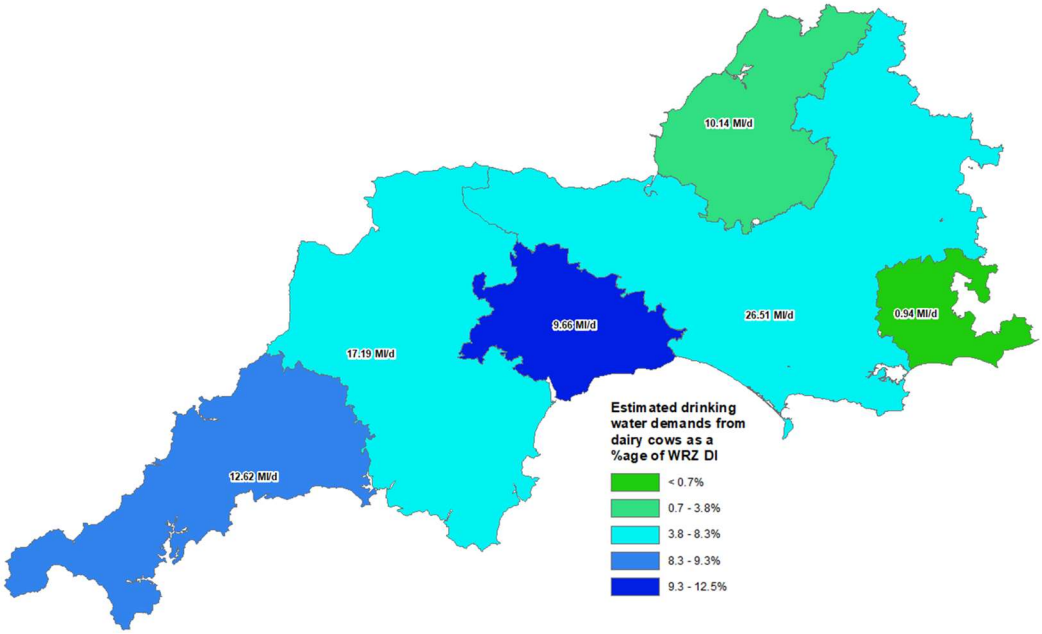

Figure 15: Estimated drinking water demands from dairy herds and as percentage of WRZ Distribution Input (DI)

Figure 16 shows that beef cattle have the highest drinking water demands in the Roadford WRZ (SWW). The Roadford WRZ also has the highest demand from sheep (Figure 17).

[23] Hess, T., Knox, J., Holman, I., Sutcliffe, C. (2020). Water, 12(8), 2155: Resilience of primary food production to a changing climate: on-farm responses to water-related risks

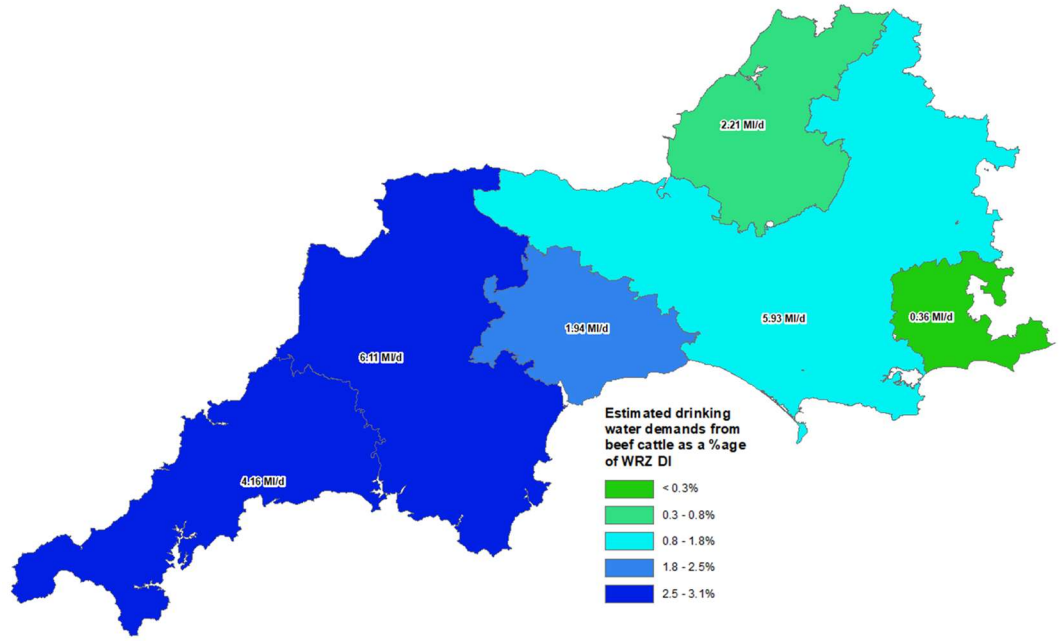

Figure 16: Estimated drinking water demands from beef cattle and as percentage of WRZ Distribution Input (DI)

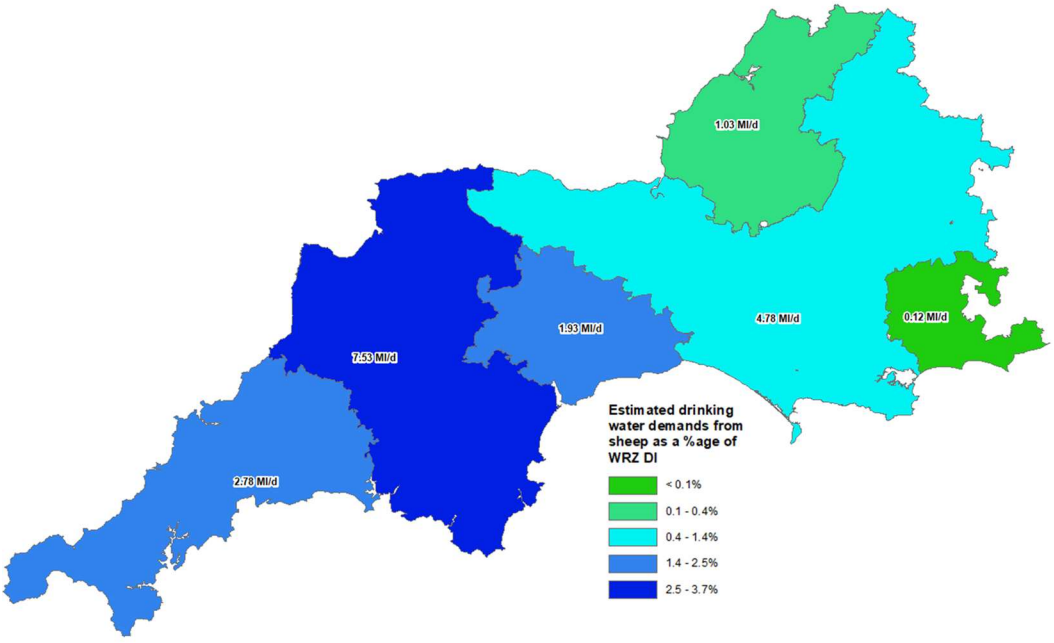

Figure 17: Estimated drinking water demands from sheep and as percentage of WRZ Distribution Input (DI)

5 Minerals and Mining

The minerals sector is a significant water user in the WCWR region. An assessment has been carried out to improve current understanding of water demand from the sector, including total demand, key users within the sectors, key use types, and the spread of demand geographically.

The assessment was based on three key datasets:

- The National Abstraction License Database (NALD), which records information on all regulated licenses, except those previously categorised as exempt activities.
- An extract from the New Authorisations dataset, which records information on licenses put in place following the introduction of new regulations on the 01 January 2018, to bring previously exempt abstractions under regulation.
- An extract from the Deregulated Licence dataset, which records information on water uses for which a license or exemption is not required. These include abstractions of 20 m^3/d or less.

The following sections present results for the assessment for each of the three datasets. These are then brought together in Section 5.5 where consumptiveness of different use types is also considered.

5.1 Geographical spread

Figure 18 illustrates the distribution of licenses across the WCWR region. Note that where licenses have multiple abstraction points associated with them, licences have been attached to the grid reference of the first abstraction point listed in the relevant dataset. It has therefore been assumed that all abstraction points associated with a given license are located within reasonable proximity.

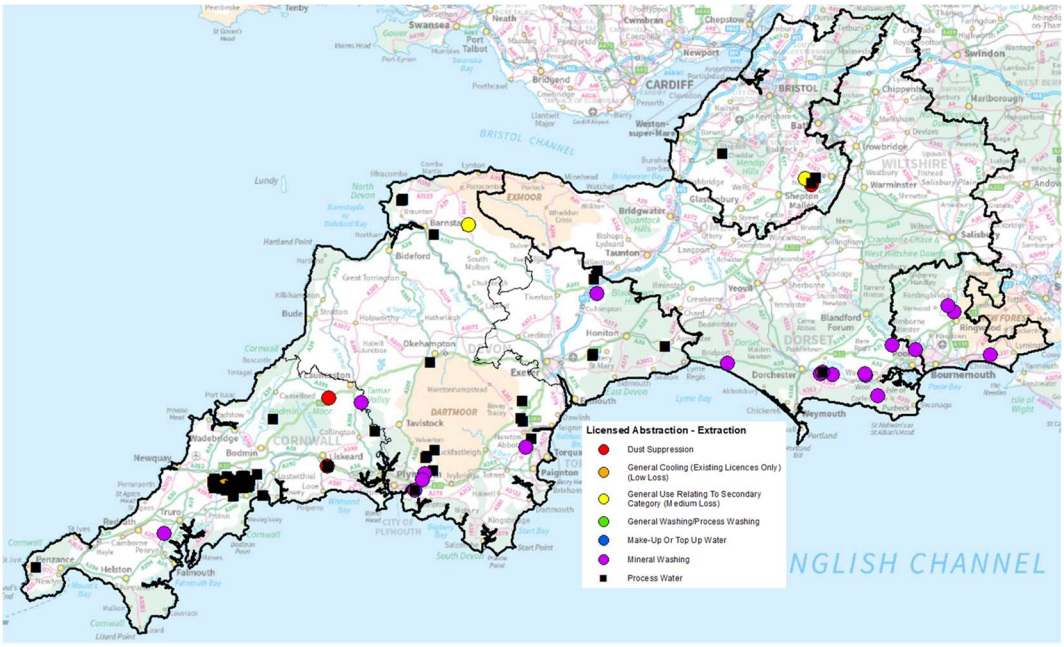

Figure 18: Distribution of licenses in the region

5.2 NALD assessment

The following key steps were undertaken to process the NALD data:

1. The dataset was clipped in a GIS to the WCWR region boundary.
2. The clipped dataset was then filtered to exclude all secondary use descriptions other than Extractive and Mineral Products.
3. Lookup and pivot table functions were then used to filter the results.

Figure 19 sets out authorised water use by company across the region. Note that quantities shown represent maximum authorised annual average day. Key conclusions are as follows:

- There are 64 licenses under the Extractive and Mineral Products categories in the region, spread across 21 users/companies.
- There is a total authorised quantity of 43 Ml/d, 55% of which is attributed to IMERYS Minerals Ltd.

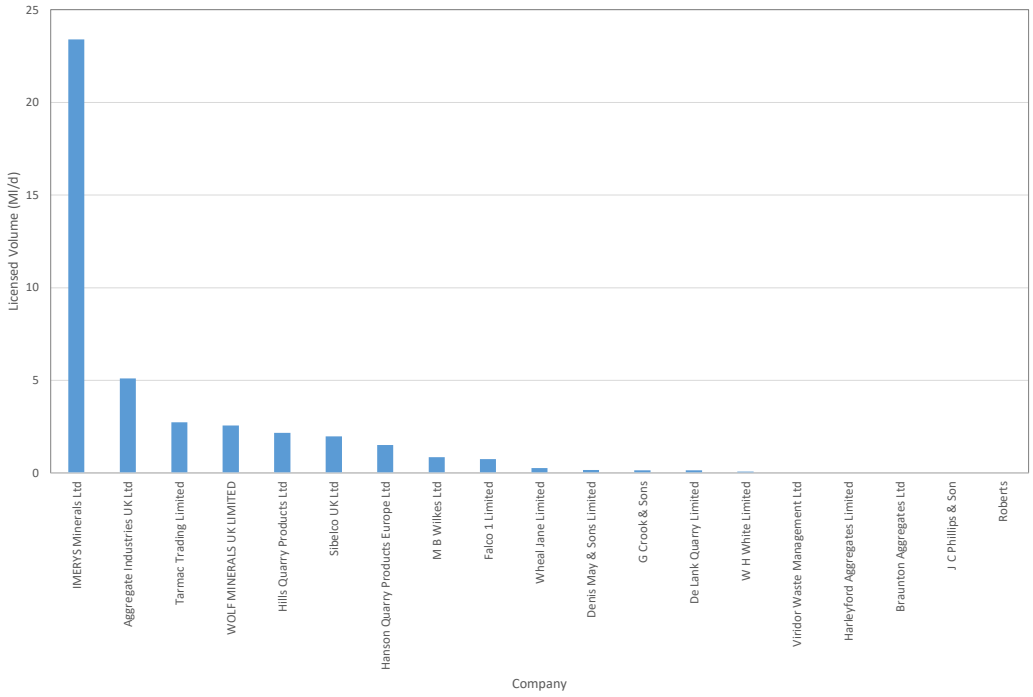

Figure 19: NALD extract, authorised abstraction quantity by user

Figure 20 sets out authorised quantity by use type. Again, note that quantities shown represent maximum authorised daily average.

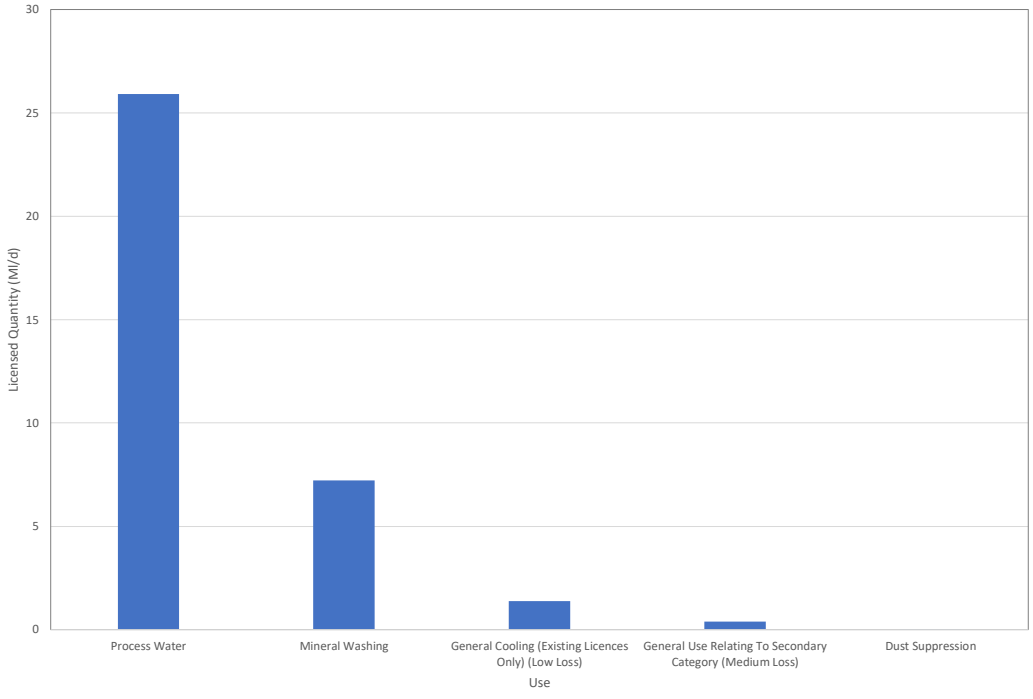

Figure 20: NALD extraction, authorised quantity by use type

For the assessment of demand by use type, it should be noted that the dataset tags licenses against the following designations:

- Multiple Points / Multiple Purposes;

- Multiple Points / Single Purpose;
- Single Point / Multiple Purposes; and
- Single Point / Single Purpose..

Of the 43 Ml/d total demand depicted in Figure 19, 8 Ml/d is recorded in the dataset as having multiple purposes. Figure 20 shows the remaining 35 Ml/d by single use type. Key conclusions are as follows:

- Water demand in the minerals sector is predominantly for process water applications (26 Ml/d) and, to a lesser extent, mineral washing (7 Ml/d).
- 85% of the 26 Ml/d used for process water applications is attributed to IMERYS Minerals Ltd. (22 Ml/d).

In addition to the assessment of demand from Extractive and Mineral Products secondary use descriptions, a manual filter was carried out through entries in the dataset under the use description Other Industrial/Commercial/Public Services. This was to determine whether there were any licenses that could reasonably be considered to contribute to demand from the minerals sector, but which may have been inappropriately categorised.

As a result of this manual filter, it is proposed that the following license entries are recategorized for inclusion in the mineral sector demand estimate:

Table 26: Proposed licenses for re-categorisation

License No.	License Description	Licensed Volume (Ml/d)
15/49/026/S/059	Blue Hills Tin Streams, St Agnes, Cornwall	6.5
17/53/012/S/066	Moons Hill Quarry, Radstock, Somerset	0.14
16/52/002/G/319	Tout Quarry, Somerton, Somerset	0.025
11/42/4/2	HH & DE Drew Ltd, New Milton, Hampshire	0.055
17/53/012/S/010	Hanson Quarry Products Europe Ltd	0.033
	Total	**6.716**

Note that license 15/49/026/S/059 is for the Blue Hills Tin Streams in St Agnes, Cornwall.

5.3 New Authorisations assessment

The following key steps were undertaken to process the New Authorisations dataset:

1. Conversion of grid references to Eastings and Northings.
2. Clipping of the dataset in a GIS to the WCWR region boundary.
3. Manual review of all entries to identify mining activities.

4. Use of pivot table to filter the results.

The New Authorisations dataset tags license entries as either abstraction or transfer licenses. Figure 21 sets out authorised water use by company for both abstraction and transfer licenses. Figure 22 sets out water use for abstraction licenses only. Note that quantities represent maximum annual average day. Key conclusions are as follows:

- There are 47 licenses in total: 18 abstraction licenses and 29 transfer licenses. These are spread across 14 users/companies.
- There is a total authorised quantity of 171 Ml/d for both abstraction and transfer licences. Of this, 60% is attributed to the top three water users and 97% is attributed to the top ten users.
- There is a total authorised quantity of 17 Ml/d when considering abstraction licenses only. This is predominantly attributed to Aggregate Industries UK Ltd (7 Ml/d) and Sibelco UK Ltd (6 Ml/d).

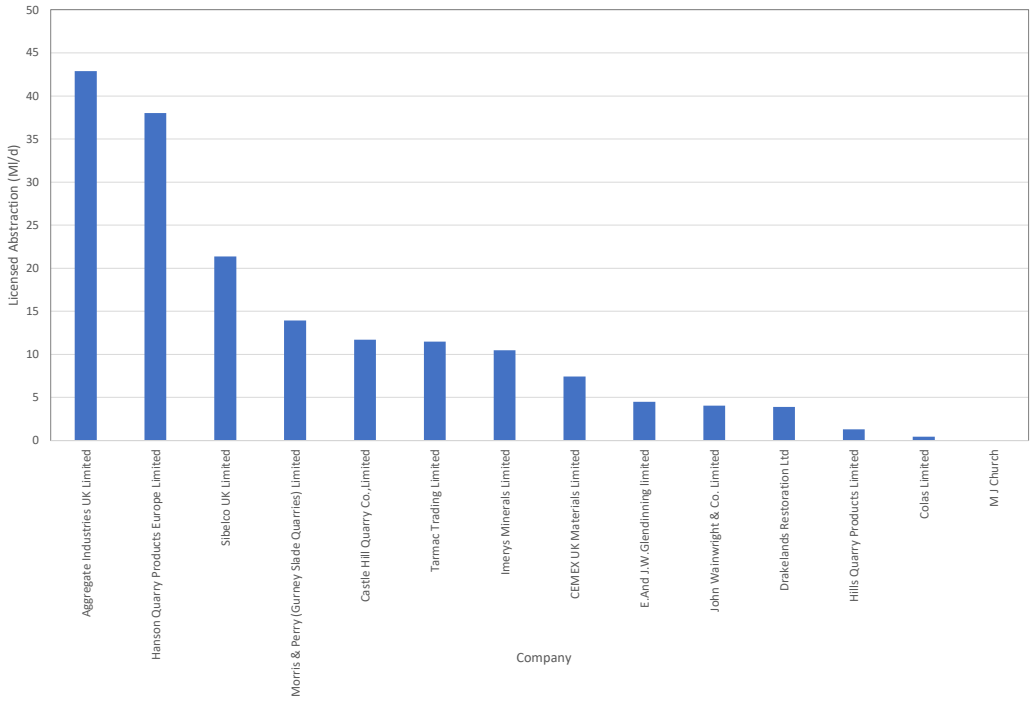

Figure 21: New Authorisations, authorised quantity by user

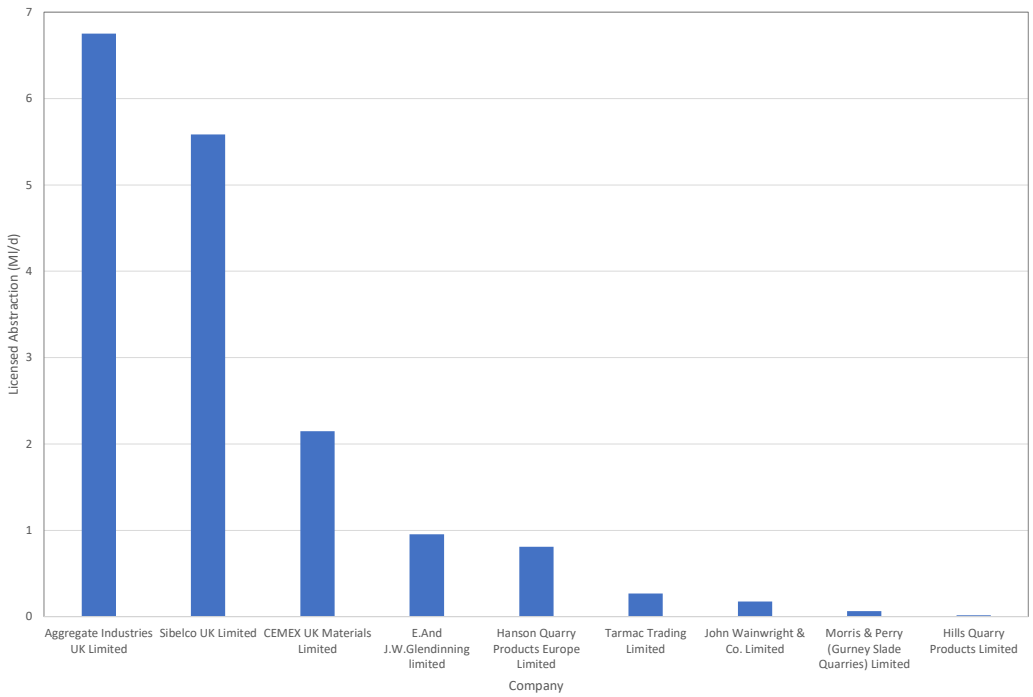

Figure 22: New Authorisations, quantity by company (abstraction licenses only)

Figure 23 sets out authorised quantity by use type for both abstraction and transfer licenses. Figure 24 sets out quantity by use type for abstraction licenses only. Again, note that quantities represent maximum annual average day. Key conclusions are as follows:

- Of the 171 Ml/d total quantity, 157 Ml/d (92%) is attributed to dewatering.

- Considering abstraction licenses, authorised quantities are primarily attributed to dewatering (6 Ml/d), process water (5 Ml/d), mineral washing (4 Ml/d), and dust suppression (3 Ml/d) activities.

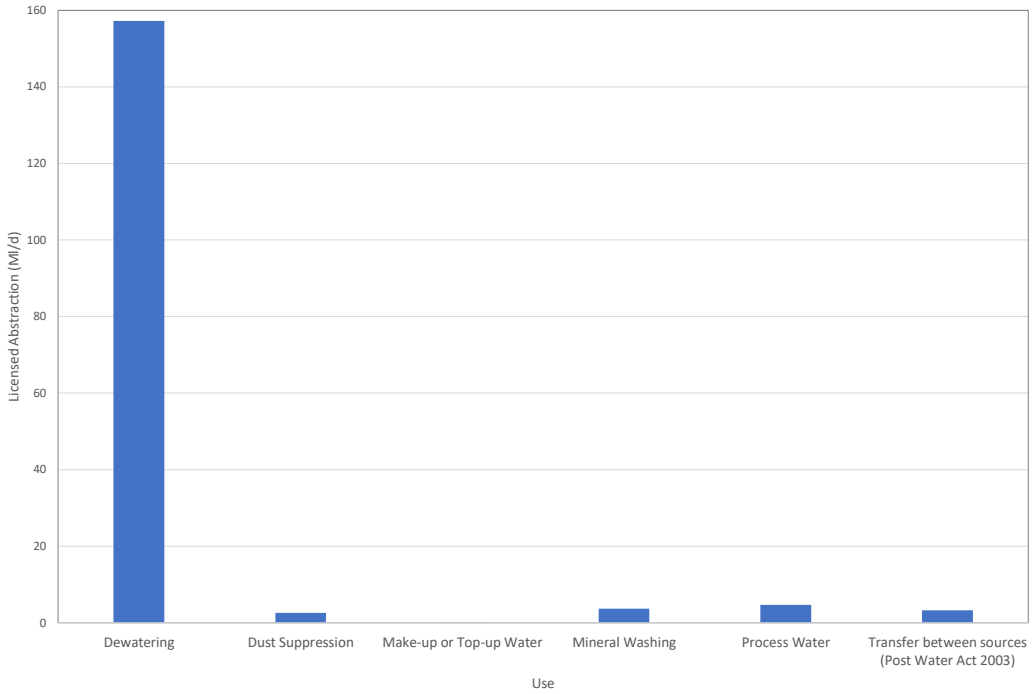

Figure 23: New Authorisations, quantity by use type

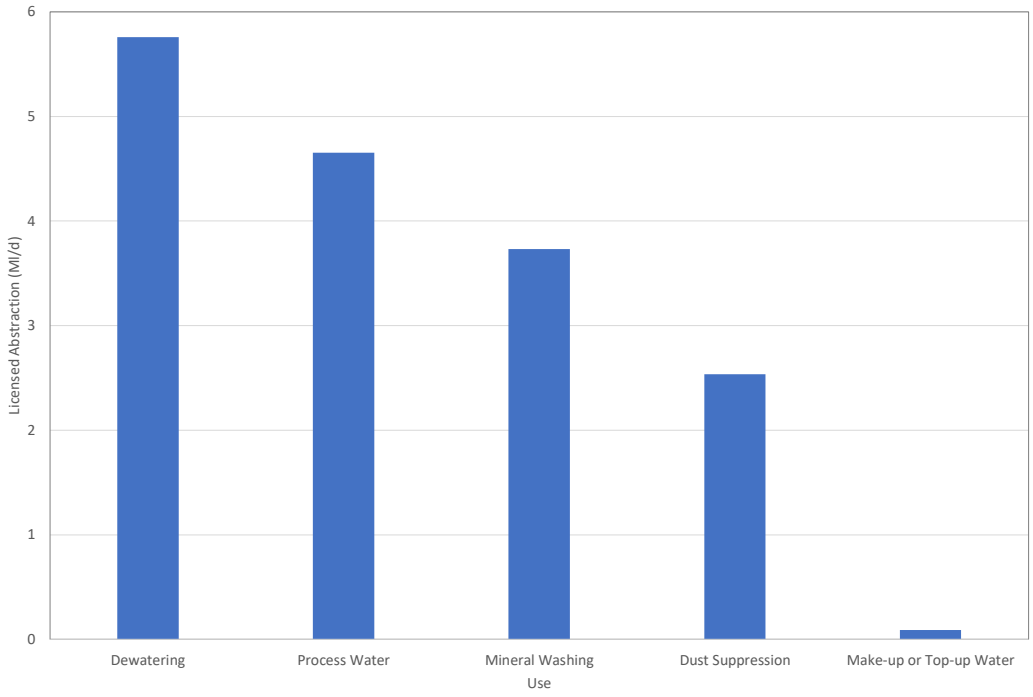

Figure 24: New Authorisations, quantity by use type (abstraction licenses only)

5.4 Deregulated license dataset assessment

The following key steps were undertaken to process the deregulated license dataset:

1. The dataset was clipped in a GIS to the WCWR region boundary
2. The clipped dataset was then filtered to exclude all secondary use descriptions other than Extractive and Mineral Products.
3. Lookup and pivot table functions were then used to filter the results.

Figure 25 sets out authorised quantity by use type. There is a total quantity of 0.07 Ml/d, spread across 17 licenses in the region. None of these licensed abstractions amount to more than 0.014 Ml/d. Authorised quantities are primarily attributed to process water (0.03 Ml/d). As with the NALD extract, the deregulated license dataset records licenses under single- or multiple-purpose designations. Multiple purpose licenses have been grouped under the Multiple Use heading in Figure 25.

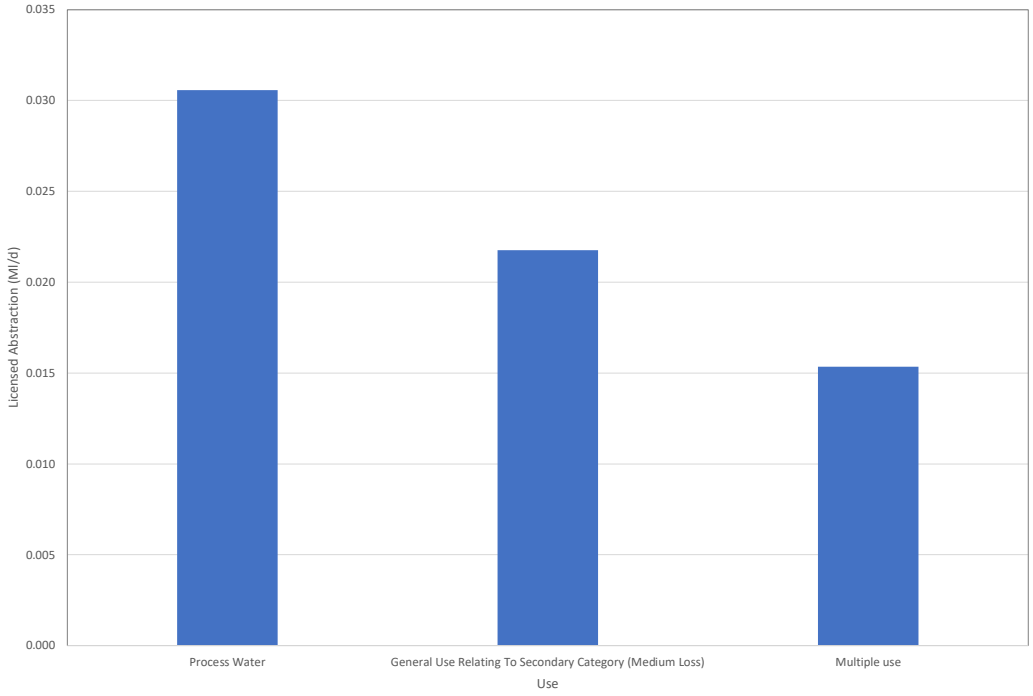

Figure 25: Deregulated abstractions, quantity by use type

5.5 Summary of demand estimates for Minerals and Mining sector

5.5.1 Total licensed quantity

Figure 26 summarises quantities for the three datasets set out in the previous sections of the chapter. For the purposes of this summary, transfer licenses (primarily dewatering) have been excluded. Note that the quantities shown for the

NALD extract include the five licenses proposed for recategorisation in Table 26. Key conclusions are as follows:

- There is a total licensed abstraction quantity in the region (excluding transfer licenses) of 67 Ml/d.
- This quantity is primarily recorded in the NALD extract and is predominantly attributed to process water and mineral washing.

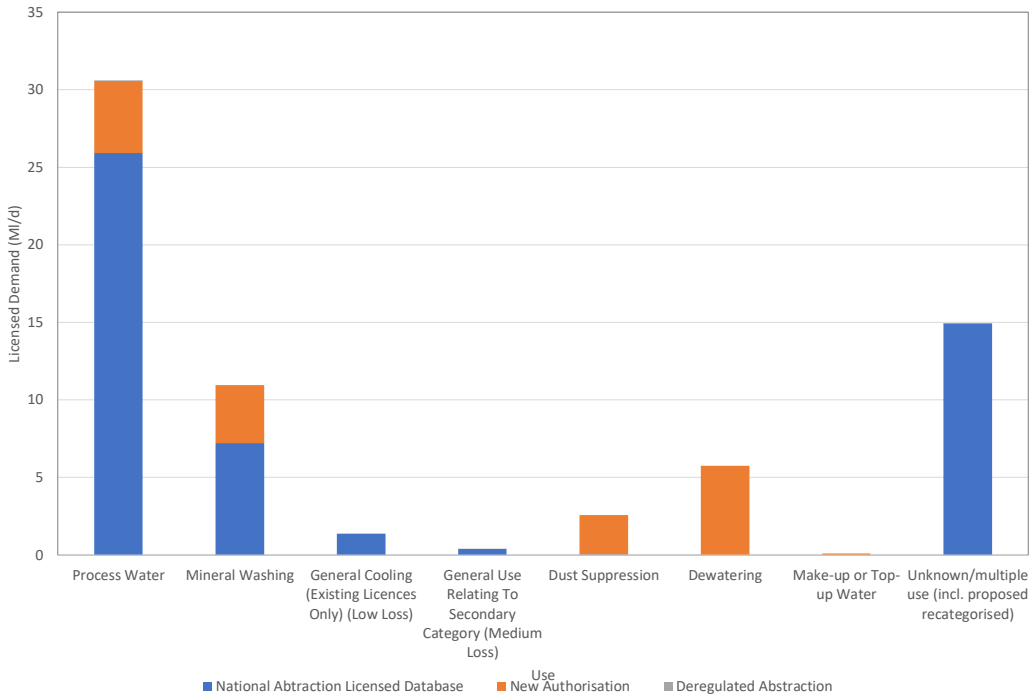

Figure 26: Summary of demand, quantity by use (abstraction licenses only)

5.5.2 Consumptive demand

Having summarised total demand from the minerals sector across the region, an attempt has been made to reflect the level of consumption associated with different use types. Some applications, such as dewatering, will return a significant proportion of water used to the environment and it is valuable to consider demand from the sector on this basis.

A table of loss factors was provided by the Environment Agency, relating to various use types. Loss factors were selected from the table that provided the closest match to the use types that have been assessed in the three license datasets. These have been summarised in Table 27.

Table 27: Summary of Environment Agency loss factors

Use	EA code	EA level of loss (consumption)	EA loss (consumption) factor
Dewatering	660	Very low	0
Mineral washing	300	Low	0.03

Use	EA code	EA level of loss (consumption)	EA loss (consumption) factor
Process water	300	Low	0.03
Dust suppression	60	High	1.0
Transfer between sources	650	Very low	0.0
Make up or top up water	280	High	1.0
General cooling (Existing licenses only) (low loss)	130	Low	0.03
General use relating to secondary category (medium loss)	160	Medium	0.6
Unknown/Multiple use	*Unknown*	*Variable*	*0.08*[*]
[*] Value based on weighted average across uses			

Total demand across the region, with loss factors applied to reflect levels of consumption associated with different use types, is summarised in Figure 27. Key conclusions are as follows:

- With loss factors applied as per Table 27, there is a total water demand from the sector in the region of 19 Ml/d.
- It is challenging to provide a more accurate reflection of consumption given that actual losses are highly site-specific. For example, for water stored in on-site lagoons for various applications, the extent of loss/consumption is dependent on the use of lagoon lining.
- It is important to note that the quantities set out in Figure 27 represent a somewhat coarse and extreme picture. On a real-time or instantaneous basis, water demand is likely to be significantly greater, even for applications such as dewatering where flows will, over time, return to the environment. It is also worth noting that, in these cases, flows may not be returned to the same water body from which they were abstracted.

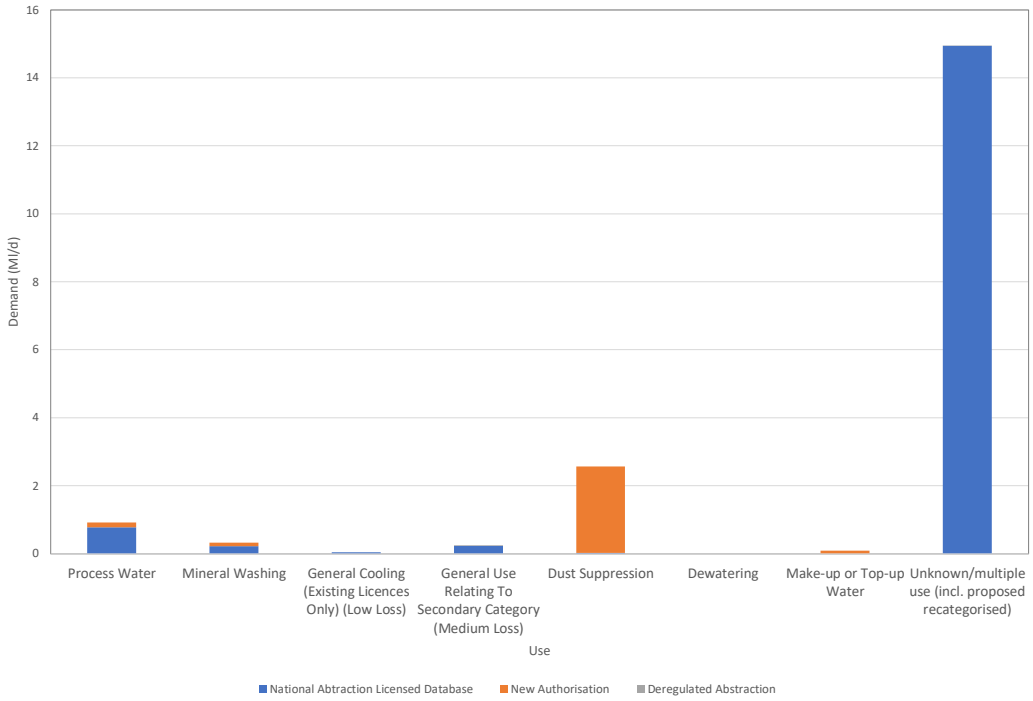

Figure 27: Summary of demand, quantity by use with EA loss factors applied

6 Spatial Hot Spots (WRZ level)

This section provides a summary of the spatial variation in the demand estimates in the three sectors at a WRZ level for PvWS (Figure 28) and agriculture (Figure 29); mining and extraction abstraction license demands are presented in Figure 18. Due to the uncertainties in these estimates we have not attempted to 'map' this information against key parameters such as resource availability and also we are aware of ongoing work to assess resource availability in the context of environmental improvement for the regional plan. If this 'mapping' would be of value we can include in the final report to visually illustrate where the potential pressures may arise from changes in resources position at a catchment scale compared to the spatial estimates of demand.

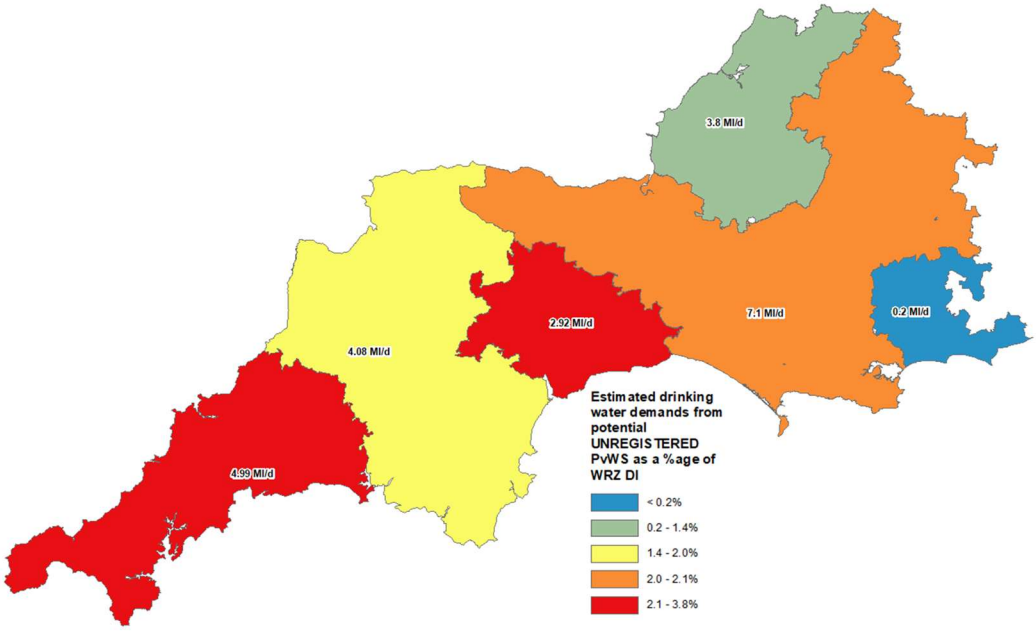

Figure 28: Estimated unregistered PvWS (Domestic) demands and as percentage of WRZ Distribution Input (DI), based on Average Household PCC values (Table 3)

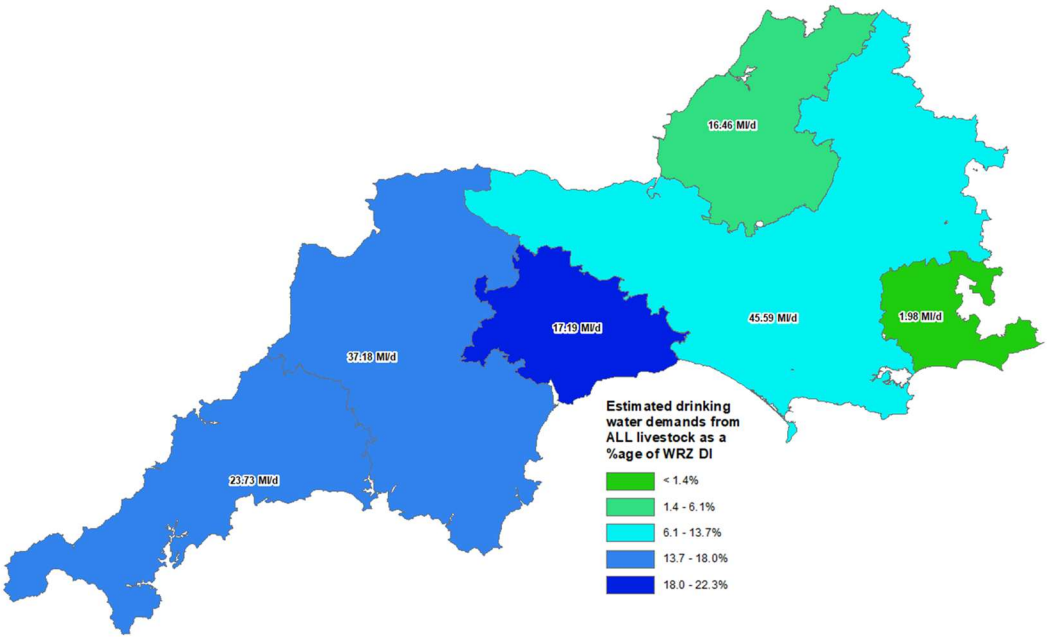

Figure 29: Estimated total livestock drinking water demands and as percentage of WRZ Distribution Input (DI)

7 Future Resilience and Challenges

This section provides examples and a discussion of the challenges considered to be fundamental to understand the future resilience and long-term water resources planning in the sectors considered in this report. We have limited our observations to what are considered to be some of the key themes in the three sectors being assessed.

7.1 3rd Climate Change Risk Assessment (CCRA3)

The potential effects of climate change on the West Country are explained in the draft Regional Plan but some mention of the key gaps in relation to the sub-sectors being considered in this report is merited to help shape future research and improve understanding for future plans.

Agriculture is a vital sector in the West Country, underpinning the economy in many areas but climate change has the potential to affect water availability for farming and lead to increase frequency of droughts leading to a risk of water shortages for livestock production.

However the sector vulnerability to a changing climate has largely focused on the arable component of the Agriculture sector whereas livestock has had comparatively little research[24]. The paper by Wreford and Topp (2020) and cited in the CCRA3 discusses this issue further including impacts to livestock both direct and indirect. Direct impacts relating to animal health, welfare, growth and reproduction and the indirect relating to productivity of pastures, forage crops and feeds. The impacts will all have knock on consequences for water demand. The paper also goes on to discuss potential adaptation measures to limit the impacts from climate change.

The CCRA3 report makes reference to many risks for the Agriculture sector with water scarcity as a key theme but it also recognises that important knowledge gaps remain which necessitate continuing research on adaptation strategies (e.g., grassland and livestock systems).

The primary adaption options considered in relation to water demand is related to drought management[24]. The key consideration in agriculture is water used for irrigation, however, if this water is used to irrigate fodder crops it directly impacts on livestock. Should these demands increase then it puts additional pressure on the already water resource stressed catchments and supply network. This is where further demand management and water efficiency measures need to be considered on the farm, including the prioritisation of water use for certain activities and, improved efficiency and making more use of on-farm storage and water reuse. Wastewater reuse has been the focus of a study completed by Lahlou *et. al.* (2021).[25]

[24] Wreford, A. & Topp, C. (2020). Impacts of climate change on livestock and possible adaptations: A case study of the United Kingdom. Agricultural Systems 178 (2020) 102737
[25] Lahlou, F. *et. al.* (2021) Wastewater reuse for livestock feed irrigation as a sustainable practice: A socio-environmental-economic review. Journal of Cleaner Production 294 (20210 126331

An important recommendation for future regional plans is therefore to undertake specific research into the effect of climate change and extreme drought on the agriculture sector in terms of water availability and resilience to severe drought using the vast experience, guidance and methods developed by the water industry for the assessment of climate change on public water supplies and water resources for example. This could be undertaken in the WCWR in the focus catchments using available planning methods and tools and include an assessment of potential socio-economic scenarios in addition to the direct impacts of changes in rainfall and temperature. Of equal importance is the need to promote the need for adaptation and drought risk management which is considered in more detail in section 7.3 below.

7.2 Private Water Supply

The main pressures on private water supply are similar in many cases to those challenges faced by the public water utilities namely climate change, leakage management, drought resilience and population change.

Socio-economic changes including a preference for the 'security of supply' afforded by connection to the water supply grid is a particular challenge and given the close alignment with private water supply and the agriculture sector, the changes in the latter sector will be a major influence on the future connection of private water users to water company grids.

This 'behaviour' change is not only a long-term knowledge gap but even in the shorter term in dry periods and droughts, the 'switching' of users between private springs and mains supplies where available, is of considerable uncertainty.

7.3 Agriculture (Livestock)

The pressures likely to cause changes in water demand in the West Country relate mainly to changes in the farm subsidy regime likely to be the consequence of the UK leaving the EU and social change as the farming population ages and succession becomes an issue where the next generation is unwilling to take up farming tenancies or takeover the family farm.

Changes in the subsidy regime due to Brexit will probably be driven by a need to maintain and enhance natural capital on a national basis and for land to deliver ecosystems services related to water supply, flood control and leisure access. As an example, one scenario could see a reduction in the numbers of livestock grazing upland pastures and moorland, achieved through reductions in direct subsidy and a movement towards limiting stocking rates with a view to improving water quality and reducing flood flows by maintaining and improving vegetation cover, and retaining soil structure.

In water demand terms, any reduction in stocking numbers, primarily in the uplands could result in a reduction in direct demand for drinking water from rivers and streams and indirect demand from unidentified private water supplies which may serve both housed livestock and domestic needs in areas beyond the extent of the public water supply.

A possible consolidation and expansion of dairy farms could result in a change in the distribution of demand, which will become more focussed and, where the public water supply is not confirmed or planned, likely to look for alternative private supplies from groundwater where available.

The vulnerabilities associated with these changes are limited to the areas undergoing expansion and consolidation, where the existing PWS cannot satisfy demand on the existing network and, despite the perception of farmers, the supply from surface and ground water supplies is neither certain nor sustainable in the light of potential climate change scenarios.

The research by Hess *et. al.*, 2020 is of particular value to understanding the challenges facing water supply and demand for livestock and is also referenced in Climate Change Risk Assessment (CCRA3). Some of the key findings from this paper are summarised below:

- The authors state that over half of the water used on farms (in England and Wales) is used for drinking water for livestock (41%), general farm activities (such as wash-down) (13%), agrochemical spraying (4%) and non-agricultural farm uses (18%).
- Although most of farms have access to public water supply, a large volume of water is still abstracted for non-irrigation uses. Many of these are small water supplies from streams, ponds and shallow groundwater that withdraw less than the de minimis 20 m^3/d and do not require an abstraction licence. Moreover, they are also not subject to abstraction restrictions during drought events.
- Private water supplies are particularly important for livestock farms for drinking water which accounts for 79% of the total water requirement of dairy cattle and >90% of the water requirement for pigs, sheep and poultry.
- Although water demand for livestock production is concentrated in the wetter, more upland catchments in the UK, and in water company areas that are not seriously stressed, small water supplies are subject to increasing risk of 'drying up' due to climate change and there is no obligation on water companies to then supply water.
- It is difficult for livestock farmers to respond to the short-term failure of small water supplies. Potentially requesting tanker supplies from water companies to meet demands. In an extreme situation, livestock farmers would need to reduce herd size by either slaughtering or sale of stock. To build resilience to increasing drought risk, livestock farmers also seek ways to increase the efficiency of water use (i.e., water use per head) on the farm. There is little scope for reducing livestock drinking water demand apart from changing the animal's diet or the ambient temperature of animal housing.
- However, modifying practices, changing water infrastructure and fixing leaks can significantly reduce water withdrawals. Using water from alternative sources can reduce vulnerability to water shortages. Rainwater harvested from roofs of farm buildings, or water recycled after it has been

used for another process, can be used for uses that do not require high quality water, such as yard and equipment washing, or to top up a farm reservoir. However, such sources may not be of suitable quality for livestock drinking water.

- Providing advance warning of water-related risks can also help farmers to take pre-emptive action to minimise the financial impact (e.g., moving stock from land that will flood or changing the choice of crop or variety in advance of a drought). Although warning times may be effective for quick onset events (like floods) providing sufficient, reliable advance warning of droughts is notoriously difficult. As a consequence, farmers are reluctant to make changes that they know will lead to reduced returns, and the uncertainty over future extreme weather affects farmers' decision-making. The development of widespread participation in water abstractor groups in areas prone to water shortages permits farmers to cooperatively determine voluntary abstraction reductions at a catchment scale when water shortages are forecast.
- The actions that farmers can take to increase resilience to these risks can be categorised as reducing the probability of the risk, increasing robustness, facilitating recovery and adaptation, and re-orienting or even transforming the production system. Predominantly, the water-related risks reviewed cause an irreversible loss of production potential. Consequently, if measures to reduce the probability of the event are prohibitively expensive, farmers are primarily concerned with strategies to build robustness or to reduce the impact of the shock reduced through facilitated recovery. Most decisions about actions or investments to increase resilience to water-related risks are taken at the farm level and are influenced by perceived costs and benefits of change, in the context of current and future climate perceptions. This leads to enhanced specified resilience but can result in declining general resilience to larger scale, more uncertain water risks. Fostering collaborative partnerships or 'working together', whether among farmers, between farmers and the regulator, or between farmers and the supply chain, allows for more optimal allocation of a resource during times of scarcity to increase headroom, e.g., by trading of water licences, or to facilitate recovery.
- Policy support to enhance capacities in agriculture to build general resilience by enhancing cross-scale interactions, learning opportunities and catchment-scale autonomy will be key to ensuring the agricultural system can build adaptive and transformational capacity in preparation for the more extreme water-related risks to which it will be subject in the coming decades.

7.4 Minerals and Mining

A workshop was held on the 28 April 2021 with the Mineral Products Association, as well as a representative from each of the aggregates and mineral products sides of the sector. The workshop was primarily used to sense check the application of loss factors as set out in Table 27, as well as to understand the

challenges associated with developing a more accurate picture of consumptive demand.

The workshop was also used for a general discussion of macro trends in the sector that may affect water demand in future. Issues raised during the discussion include:

- The increasing level of attention on climate change resilience across all sectors and national-level carbon reduction commitments;
- The growing focus from regulators on catchment-based approaches to water management;
- The implications of Brexit on import/export of mineral products;
- The changing demand for mineral products from sectors such as the construction industry;
- The potential for increased demand for lithium brines and the impact of this on groundwater flows;
- Possible increased focus from regulators on current license usage and headroom;
- The potential for greater collaboration between the minerals sector and other sectors, including through creation/utilisation of storage facilities;
- The use of latex materials in place of water for dust suppression activities, and the potential issues associated with this in terms of increased additives in groundwater; and
- Potential changes to abstraction license costs.

8 Recommendations for Final Regional Plan

8.1 Uncertainties in Demand Estimates

Some of the key generic challenges and barriers encountered in this research and longer-term key recommendations are:

- There are likely to be significant uncertainties in the inter dependencies between the use of private water supplies (in particular the 'unregistered estimates') for domestic use in properties and in the case of farms, in the use of water for livestock demand. For example it is possible that a significant proportion of the PvWS demand estimate for domestic properties may actually be used to supply livestock;
- Evidence for the level (magnitude) of demand remains a key information gap and currently can only be based on 'best estimates'. This remains an area for more detailed survey and potentially trialling water consumption at specific property level scale;
- Confirmation of the sources of private water supply and a better understanding of behaviours and how PvWS users 'switch' where possible between private sources and the mains water grid in dry summers remains a key uncertainty;
- Understanding the sources of water to the PvWS sector remains a key challenge and this will also inform not just the level of demand but also the vulnerability of demands and possible adaptation options. An improved process of registration of PvWS to include specific information on water sources (borehole, springs, river etc.) and demand is fundamental to improving the evidence base and assessment of resilience in this sector;
- Seasonality is a key factor in the understanding the PvWS demands. Temporary registered abstractions and sectors such as Agriculture, Camping & Caravanning and Holiday & Tourism are likely to see their peak demands during the summer months; critically when resources tend to be under most stress.

8.2 Recommendations for improving uncertainty for future regional planning

This section proposes some specific actions considered to be beneficial for improving the uncertainty in the demand estimates for future WCWR regional plans. The proposals are limited to those considered achievable subject to WCWR agreement and do not include the longer-term analysis and research for future plans.

8.2.1 Private Water Supply Demand

1. Many water companies (Wessex Water included) have a supply point file which indicates all properties which they supply water too, and conversely

those they don't. This then also allows the identification of all properties which do not have a mains connection. The assumption that properties greater than 150m from mains network were not connected could be validated. Stakeholder discussions stated some farms have connections greater than 1.5km in length; the supply point data would eliminate the need to use these assumptions in the analysis.

2. Ground truthing of a sample of the 'unregistered' PvWS to validate connection to the grid or not would have been invaluable but the limitations on field work due to Covid-19 have curtailed this objective at present. When possible this should be undertaken at a sample of locations to 'test' the assumptions with buffer distances used in this research. Advances in digital applications such as earth observations could support more traditional 'walkover' methods but this ground truthing exercise is fundamental to the confidence of the demand estimates provided in this research.

3. Liaison with Dave Sexton at West Devon Borough Council and other local authorities to gather their local knowledge of the private water supply status and trends; an initial discussion is proposed between the completion of this draft and final report when the WCWR group have reviewed the above methods and estimates.

4. Encourage an improved registration record and estimate of individual PvWS demands (currently 200 l/h/d) to reduce the uncertainty around this longer term.

5. Include any specific knowledge and experiences from dry weather events in 2018 and the high demand in early 2020 from the Covid situation.

8.2.2 Agriculture Demand

1. Update the above assessment using new livestock numbers from 2020-21 DEFRA data to provide a sensitivity check on the level of the demand estimates reported above in this sector.

2. Focused investigation with farm surveys in selected pilot areas, identifying individual farms, livestock types and numbers and water supply to better understand water demands and patterns of usage.

3. Review water company demand forecast to better understand supply of water to farms from the grid.

8.2.3 Minerals and Mining Demand

A key area of uncertainty in the estimate of demand from the mineral products sector in the region is the extent to which different use types are considered to be consumptive. As set out in Section 5.4, this study has estimated a total licensed abstraction quantity in the region (excluding transfer licenses) of 67 Ml/d. Generic loss factors have been provided by the Environment Agency and applied to

relevant use types to give an initial, coarse estimate of total consumptive demand. It is challenging to provide a more accurate reflection of consumption, primarily given that actual losses are highly site-specific. Given this, the following actions are proposed for further work:

1. Specific engagement with key users, in particular Imerys Minerals Ltd, Aggregate Industries UK Ltd and Sibelco UK Limited. Demand from these users constitutes two thirds of the estimated total licensed abstraction quantity in the region. Demand from Imerys Minerals Ltd comprises over one third of this total alone.

2. Focus on understanding patterns of consumption by key users for process water and mineral washing applications. These use types constitute over 60% of the estimated total licensed abstraction quantity in the region. This study has applied Environment Agency loss factors for both use types of 0.03 (i.e., almost none of the abstracted water is consumed). On a short-term basis, losses for these use types are likely to be significantly higher than this, even if flows are ultimately returned to the environment.