Bristol Water
Draft Drought Plan Appendix 2021

bristolwater.co.uk

Document Control Sheet

Report Title:	Draft Drought Plan 2021 Appendix	
Release Date:	31st March 2021	Report Status: Draft
Report Author(s):	Liz Cornwell	
Related Reports:	Bristol Water Draft Drought Plan 2021 Bristol Water: Water Resources Management Plan 2019.	
Distribution List:	**Internal:** Mel Karam, Ricard Price, Iain McGuffog, Patric Bulmer **External:** Defra, Environment Agency, Natural England, Ofwat	

Document History

Version	Authorised	Approved	Date
Draft	 Richard Price Chief Operating Officer	 Patric Bulmer Head of Water Resources & Environment	31st March 2021

Appendix A

Pre-consultation responses

The table below summarises the comments received from organisation responding to the Bristol Water pre-consultation process and where they have been addressed in our draft Drought Plan.

Organisation	Summary of comments	Comments addressed in section
Environment Agency	• Supply agreements: Provide details of how bulk supplies with other companies would operate during a drought and ensure a common understanding across drought plans. This specifically related to the agreement with Wessex Water regarding the Bath export.	Section 4.3.2
	• Supply agreements: Demonstrate the likely effect of both the current and new terms of the agreement with CART relating to your abstraction at Purton during a drought situation.	The new agreement does not change the resilience of the Purton supply
	• Modelling: Re-visit rainfall runoff models of inflow sequences used to see if they are fit for purpose.	Inflows project underway in Jan 2021. Engaging with EA on this
	• Drought scenarios & triggers: Test your drought plan against plausible extreme drought and ensure consistency between your drought plan and WRMP24	Appendix B Section 3.2
	• Drought scenarios & triggers: Explore the representation of all types of sources and identify a mechanism to integrate these into your drought action triggers and throughout your plan.	Section 4
	• Drought Actions: Demand saving actions should be first and prioritise the use of least environmentally damaging supply actions.	Section 4.4
	• Drought Actions: Include information on actions you could implement in an extreme	

Organisation	Summary of comments	Comments addressed in section
	drought, after the level 3 restrictions and before level 4 emergency restrictions. • Drought Actions: Utilise the outcomes of the environmental monitoring you have carried out to support the drought permit options and be clear on how you will integrate any further developments. • Drought Actions: Continue your work to ensure you have a full understanding of how a more extreme drought could impact your abstraction at Purton. This should include the interaction between the River Severn Drought Order and your abstraction. Outline how you will hear that the order has been enacted and what actions you would take as a result. Ensure your plan makes sufficient time allowances for any implementation. • Dry year lessons: Review and incorporate any lessons learnt from operational experiences and the prolonged dry weather in 2018 and 2020 into your drought plan. • Comms and engagement: engage with neighbouring water companies and your regional water resources group when developing your plan. Consider joint communication campaigns and aligned customer restrictions as well as regional supply actions. • Comms and engagement: demonstrate how you will pro-actively scale up your household and retail customer communication campaigns during dry weather. • Comms and engagement: Include details on how you will communicate with the Environment Agency and other regulators during a drought. This should include how you are operating according to your plan and what additional data will be provided to regulators during and following a drought.	Section 5 and Appendix C Section 3.2.3 Table 6 Section 4.2.1 Section 6.7 Section 4.3.1 Section 4.2.1 and Section 6.4 Section 6.8, Table 13 & Section 8.2
Natural England	• Confirmed that the comments provided on the previous review of the Bristol Water drought	

Organisation	Summary of comments	Comments addressed in section
	plan still stand and are relevant to the current review. These are listed below: ▪ Assess vulnerabilities of SSSI interest features to effects of reservoir drawdown (ref: Blagdon Lake) ▪ Any new drought measures should be considered against the appropriate legislative requirements. ▪ Consideration of any in-combination effects with other water company plans on the River Severn if this is being proposed as a drought option within the plan	SEA Report SEA, HRA and WFD reports N/A
CCW	• Reflect the move to regional water resource planning by considering the opportunities to align drought management strategies with neighbouring companies, including: - any lessons learned from lived experience of events, such as the 2020 pandemic, dry Spring and high temperatures, - the approach to communications; and - implementation of temporary use restrictions (TUBs). • Follow the principles set out in the Water UK/UKWIR Code of Practice on Temporary Use Restrictions, demonstrating an understanding of the impact of any measures on different household and non-household customer groups; and how these impacts have informed the company's approach • Reflect customers' priorities and preferences in relation to the company's planned actions, including showing evidence of relevant research and how the company has used the results. • Explain the company's strategy for engaging with household and non-household customers and retailers, in relation to:	Section 6.7 Section 4.2.3 Ref: levels of service research for PR19 and WRMP19 Section 6

Organisation	Summary of comments	Comments addressed in section
	- managing a developing drought situation; and - promoting and supporting water efficiency/demand reduction. • We expect companies to have well considered communication plans that utilise a wide range of methods of communication. They should also keep their communications plans under constant review, especially in the light of any extreme events such as pandemics. • Show evidence of effective engagement and reflect the views of relevant stakeholders, such as Government departments, other water companies, Local NGOs, business sector and the agriculture sector. • Outline what would happen in an emergency drought situation, such as when supplies might be interrupted/subject to rota cuts or standpipes. • Be written clearly and accessible.	Section 6 Section 1.1.3 and Appendix A This is outside the scope of the drought plan. This would be via incident response procedures (see table 7).
Bristol Water Challenge Panel	• Feedback on the Drought Plan non-technical summary • Feedback on the drought plan pre-consultation list • Communications: include an indicator on the Bristol Water website showing the state of current restrictions, providing a quick guide on what is currently allowable in the context of restrictions. • Communications: monitoring of daily water consumption against target consumption and make this information available on the website and how it effects the drought decision making process. • What are the implications of a pandemic lockdown at the same time as a drought? • Format of statement of response for customer comments: Suggest that customer comments are responded to in the same way as was implemented for the WRMP19 statement of response document.	2021 non-technical summary Section 1.1.3 Section 6 and table 11 Section 6 and table 11 Assessment of lockdown effect on demand ongoing so not able to be included yet Will be actioned for SoR

Organisation	Summary of comments	Comments addressed in section
Wessex Water	• Key area to address is the drought plan alignment of assumptions regarding the operation of the bulk transfer from Bristol to Wessex Water in drought conditions. • Need to work together to clarify the availability of the transfer during drought conditions and identify the most efficient use of water resource in the region as a whole.	Section 4.3.2 and scenario modelling in Appendix B
Water2Business	• Feedback that Water2Business are happy with the proposed drought plan and have nothing further to add.	
National Farmers Union	• Ensuring communication with all stakeholders around the likelihood of a drought and its impact – NFU especially concerned with dairy, poultry and livestock farmers who will need to make alternative arrangements for supply. • Ensure that the impact of any drought is noted in terms of environmental and agricultural productivity. Requirements under the Agriculture Bill to monitor food security. Loss of natural capital as a result of drought could have an impact on contracts for natural capital service delivers. • Support farmers to deal with issues of leakage across the network. • Pay for and encourage farmers to develop additional sources of water that can be used. • Support the introduction of increased water efficiency on farms where this will have a benefit for BW, the farmer, the environment, climate change and the wider environment. • Provide additional sources of water to farms where there is a loss of supply and the potential risk to animal welfare and health.	Table 10 Support for non-public water supply failure is addressed in Section 4.3.1 and will be developed for final drought plan.

Appendix B

Testing the drought plan

1 Testing the drought plan against a range of drought scenarios

The latest Environment Agency drought planning guidance (September 2020) requires us to test our drought triggers using selected worked examples to show how we would expect our drought plan to work under a range of droughts. These examples should:

- Demonstrate how our drought triggers would work in different droughts.
- Show what actions we take in different droughts.
- Demonstrate the expected time frames and durations for our actions.
- Show what the effects of a range of droughts such as the worst on record.

The scenarios used should include the same severity of drought used in our baseline planning assumptions for the WRMP and a plausible more extreme drought.

In line with this guidance, we have carried out drought scenario analysis to test our drought triggers. This has been done using our 'design drought' with a 1-in-200 year return period, as presented in our WRMP19, and also a more severe drought from our drought library. The selection of this more severe drought was informed by our drought vulnerability assessment to identify a drought scenario that represents between a 1 in 200 and 1 in 500-year level of severity.

For each drought scenario assessed we modelled 2 demand scenarios capturing both the annual average dry year demand forecast from our WRMP19, and the higher demands experienced during the summer of 2018.

The scenario testing has been carried out using the mass balance model of our water resource zone that reflects the current system set up in terms of reservoir storage and licence constraints. The mode uses river flow records for inflow into the Mendip Reservoirs, to simulate the operation of our current water resource zone if it experienced those river flows again.

The analysis of our modelling assessment has focused on the performance of the water resource zone in the context of the combined storage of the Mendip Reservoirs against the drought management zones defined by the combined reservoir control curves. The storage in the reservoirs is the key variable in the system, and the indicator used to determine the operational response both during a drought, and under normal operation. It is therefore considered appropriate to implement this drought assessment against combined reservoir storage.

1.1 WRMP19 'design drought' assessment

The drought used to determine the WRMP19 deployable output was the 1933/34 drought with a 3% deficit factor, as this equates to a difference between a 1 in 100 and 1 in 200-year drought event as estimated by our extreme value analysis. The response of the Bristol Water

system to this drought under 2 demand scenarios has been assessed. The demand scenarios are set out in table B1.

Table B1: Demand scenarios used to test the drought plan.

Scenario	Distribution Input	Potable and non-potable exports	Target headroom	Outage	RWL TWL & OU	Climate change	Total	Demand modelled
WRMP19 forecast 2020/21	270.22	11.95	17.26	5.12	20.27	4.62	329.44	330 Ml/d
WRMP19 forecast 2024/25	268.55	11.95	18.78	5.12	20.27	5.03	329.7	
2018/19 annual average DI	280.6	11.95	17.26	5.12	20.27	4.62	339.82	340 Ml/d

The 1-in-200-year drought event is based on a slightly more severe 1933/34 drought. This drought consists of a dry winter followed by a dry summer and lasts for 14 months (November 1933 to December 1934). Our analysis of the historical drought record indicates that the rainfall deficit in the 18 months to November 1934 was 66.4% of the long-term average (LTA) (1961-2009), and the winter of 1933/34 from November to February was 37.1% of LTA. Our extreme value analysis (EVA) assessment indicates that the rainfall deficit (%LTA) for an 18-month duration (ending in November) for a 1-in-200 year return period is around 68% LTA.[1]

The graph in figure B1 shows the response of the combined storage of the Mendip Reservoirs to this drought under the two demand scenario set out in table B1 (330Ml/d and 340Ml/d). Tables B2 and B3 set out the timeline for this drought indicating the timings of when the different actions would be implemented under each demand scenario. The estimated additional water available as a result of implementing each of the actions is also provided in the table.

[1] HR Wallingford (Aug 2018): *Bristol Water WRMP19 – Drought Vulnerability Framework and Design Droughts.*

Figure B1: Modelled combined reservoir response for 1-in-200-year drought scenario (Annual average demand at 330Ml/d (DP20_05) and 340Ml/d (DP20_07)).

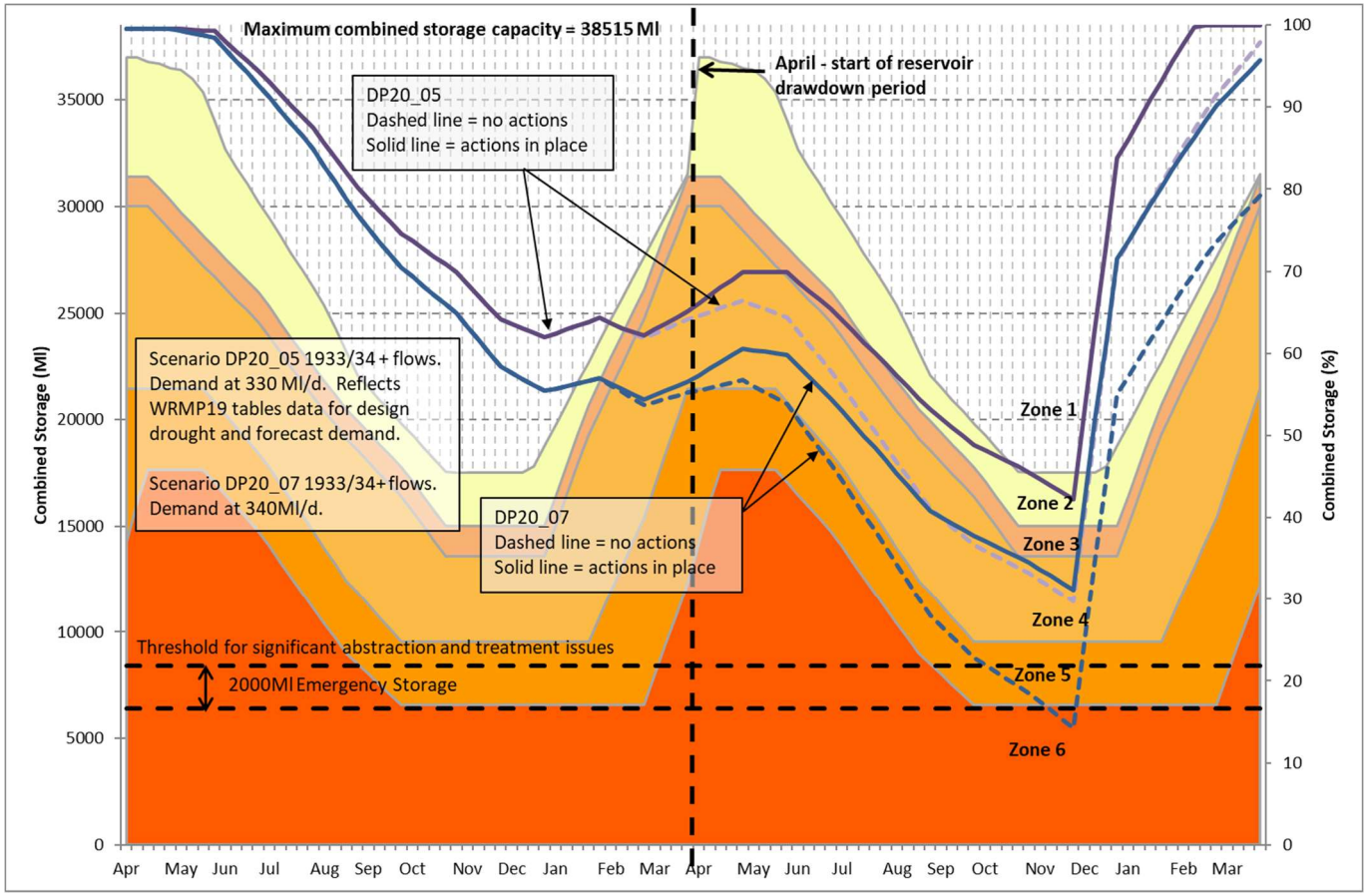


Table B2: Timeline for WRMP19 forecast demand and 1-in-200 year drought scenario (330 Ml/d demand scenario - model ref DP20_05)

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Jan	4	DMZ 1 (Normal)	Normal operation	Normal operation
Jan	5			
Feb	6	DMZ 2 (Dry weather management)	Media campaigns raising awareness and asking for voluntary restraint	Minimise reservoir storage use and maximise use of River Axe and River Severn sources. Maximise groundwater abstractions. Discuss feasibility of reducing transfer to Wessex Water.
Feb	7			
Feb	8	DMZ 3 Level 1	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Reduced transfer to Wessex Water (6.97 Ml/d benefit)
Feb	9	DMZ 4 Level 2	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Ongoing increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Reduced transfer to Wessex Water (6.97 Ml/d benefit) – maintained throughout DMZ 4. Initiate work required to put R24R back into supply (6 month lead time to bring online)
Mar	10		Preparation for TUBS implementation in April. Public consultation week 1. Ongoing increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	
Mar	11		Preparation for TUBS implementation in April. Public consultation week 2. Additional leakage activity working at full capacity (2Ml/d benefit).	

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Mar	12	DMZ 4 Level 2	Media campaign and messaging about TUBS restrictions that will be in place from April. Leakage activity working at full capacity (2Ml/d benefit)	
Mar	13			
Apr	14		TUBS restriction implemented beginning of April (estimated saving of 9.5% of household demand) Leakage activity working at full capacity (2Ml/d benefit)	Supply forecasting carried out to assess risk of entering DMZ 5 and whether Drought Permits are likely to be required.
Apr	15		TUBS restriction in place (estimated 9.5% saving on household demand) Leakage activity working at full capacity (2Ml/d benefit)	
Apr	16			
Apr	17			
Apr	18			
May	19			
May	20			
May	21			
May	22	DMZ 3 Level 1 (Recovering drought)	TUBS restriction remains in place due to time of year – peak summer demand period. Reservoir demand still falling, and forecasts suggest a risk of moving back to DMZ 4. Leakage activity continues at full capacity (up to 2Ml/d benefit)	Reduced transfer to Wessex Water (6.97 Ml/d benefit) – continued whilst in DMZ 3.
Jun	23			
Jun	24			
Jun	25			
Jun	6			
Jul	27			
Jul	28			
Jul	29			
Jul	30			
Jul	31			
Aug	32	DMZ 2 (Recovering drought)	Reservoir storage still falling and risk of increased summer demand if TUBS restriction lifted, so TUBS remain in place until after August Bank Holiday weekend.	Reduced transfer to Wessex Water (6.97 Ml/d benefit) – continued as long as TUBS in place.
Aug	33			
Aug	34			
Aug	35			Earliest point R24R supply would be available – but now not required as in recovering drought.
Sep	36		TUBS restrictions lifted (after August bank holiday weekend). Strong communications messaging to continue with water efficiency.	Wessex transfer back to full capacity if required.
Sep	37			
Sep	38			

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Sep	39	DMZ 2 (Recovering drought)	Communications campaign maintained throughout recovery period, until normal conditions resume.	Dry weather system management to conserve reservoir storage.
Oct	40			
Oct	41			
Oct	42			
Oct	43			
Oct	44			
Nov	45			
Nov	46			
Nov	47			
Nov	48			Turning point for reservoir storage – recovery starts.
Dec	49	DMZ 1 (Normal)	Post drought actions implemented. Review and lessons learned report produced.	
Dec	50			
Dec	51			
Dec	52			

Table B3: Timeline for WRMP19 forecast demand and 1-in-200 year drought scenario (340Ml/d demand scenario - model ref DP20_07)

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Jan	1	DMZ 1 (Normal)	Normal operation	Normal operation
Jan	2			
Jan	3	DMZ 2 (Dry weather management)	Media campaigns raising awareness and asking for voluntary restraint	Minimise reservoir storage use and maximise use of River Axe and River Severn sources. Maximise groundwater abstractions. Discuss feasibility of reducing transfer to Wessex Water.
Jan	4			
Jan	5			
Feb	6	DMZ 3 Level 1	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Reduced transfer to Wessex Water (6.97 Ml/d benefit)
Feb	7	DMZ 4 Level 2	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Ongoing increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Reduced transfer to Wessex Water (6.97 Ml/d benefit) – maintained throughout DMZ 4. Initiate work required to put R24R back into supply (6 month lead time to bring online)
Feb	8			
Feb	9			

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Mar	10	DMZ 4 Level 2	Preparation for TUBS implementation in April. Public consultation week 1. Leakage activity working at full capacity (2Ml/d benefit)	
Mar	11		Preparation for TUBS implementation in April. Public consultation week 2. Additional leakage activity working at full capacity (2Ml/d benefit).	
Mar	12		Media campaign and messaging about TUBS restrictions that will be in place from April. Leakage activity working at full capacity (2Ml/d benefit)	
Mar	13			
Apr	14		TUBS restriction implemented beginning of April (estimated saving of 9.5% of household demand) Leakage activity working at full capacity (2Ml/d benefit)	Supply forecasting carried out to assess risk of entering DMZ 5 and whether Drought Permits are likely to be required.
Apr	15		TUBS restriction in place (estimated 9.5% saving on household demand) April to September. Ongoing high profile media campaign to maintain awareness of water resource position over the summer months. Advice provided to customers on how to be as water efficient as possible. Leakage activity continuing to work at full capacity (2Ml/d benefit)	Reduced transfer to Wessex Water (6.97 Ml/d benefit) – maintained throughout DMZ 4.
Apr	16			
Apr	17			
Apr	18			
May	19			
May	20			
May	21			
May	22			
Jun	23			
Jun	24			
Jun	25			
Jun	6			
Jul	27			
Jul	28			
Jul	29			
Jul	30			
Jul	31			
Aug	32			
Aug	33			

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Aug	34	DMZ 4 Level 2		
Aug	35			R24R source commissioned and in supply. Estimated dry weather yield of 2.4Ml/d
Sep	36			Reduced transfer to Wessex Water (6.97 Ml/d benefit) – maintained throughout DMZ 4. R24R source available and in supply. 2.4Ml/d estimated dry weather yield
Sep	37			
Sep	38			
Sep	39			
Oct	40		TUBS lifted at end of September due to minimal effect over autumn/winter period.	
Oct	41		High profile media campaign maintained to keep demand down and emphasise that the drought is not yet over. Leakage activity continuing to work at full capacity (2Ml/d benefit)	
Oct	42			
Oct	43			
Oct	44			
Nov	45			
Nov	46			
Nov	47			
Nov	48			
Dec	49			Turning point for reservoir storage – recovery starts.
Dec	50	DMZ 2 (Recovering drought)	Communications campaign maintained during recovery period, until normal conditions resume.	Wessex transfer back to full capacity if required. Dry weather system management to conserve reservoir storage.
Dec	51	DMZ 1 (Normal)	Post drought actions implemented. Review and lessons learned report produced.	
Dec	52			

1.2 WRMP19 1-in-200-year drought scenario - summary

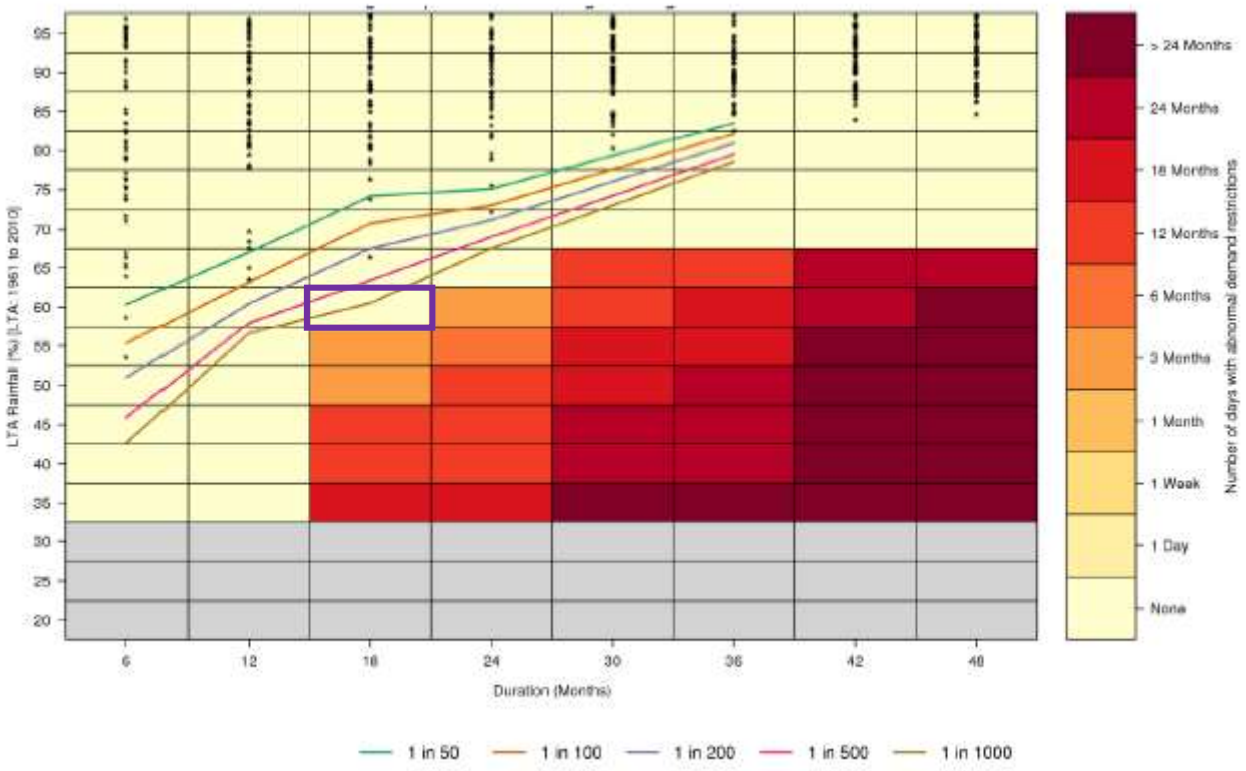
The worked examples presented above, demonstrates that by implementing our demand side actions in line with our drought plan (including leakage actions and TUBS), we prevent the water resource drought situation deteriorating to a Level 3 position, where supply side drought permits would be required. Initial supply side actions are also required to support this position, in terms of reducing the bulk supply to Wessex Water, providing a 6.97Ml/d benefit to the Bristol Water supply system. However, we have still maintained a 4.4Ml/d supply to Wessex Water throughout the drought scenarios assessed. Under both scenarios we implement the work required to bring our R24R source back into supply. Under the higher demand scenario (340Ml/d – DP20_07) this source is also put to use due to the length of time we remain within DMZ 4 (Level 2), further reducing the risk of needing supply side drought permits if the drought had continued into a second dry winter.

1.3 1-in-500-year drought assessment

A drought as severe as a 1-in-500-year drought is not available in our historic record. We therefore have used the information from our drought vulnerability assessment, and our drought library to assess a drought scenario that is estimated to be within this level of severity, or worse.

Figure B2 shows the drought response surface for the Bristol Water resource zone. The drought severity indicator curves plotted on this chart indicate that an 18-month drought with 60% long term average rainfall would be between a 1-in-500 and 1-in-1000 year event (outlined in purple on the chart). We have therefore used this scenario to test our drought plan response under this drought severity.

Figure B2: Drought response surface from WRMP19 drought vulnerability assessment.



The graph in figure B3 shows the response of the combined storage of the Mendip Reservoirs to this drought under the two demand scenario set out in table B1 (330Ml/d and 340Ml/d). Tables B4 and B5 set out the timeline for this drought indicating the timings of when the different actions would be implemented under each demand scenario. The estimated additional water available as a result of implementing each of the actions is also provided in the table.

Figure B3: Modelled combined reservoir response for 1-in-500-year drought scenario (Annual average demand at 330Ml/d (DP20_09) and 340Ml/d (DP20_11)).

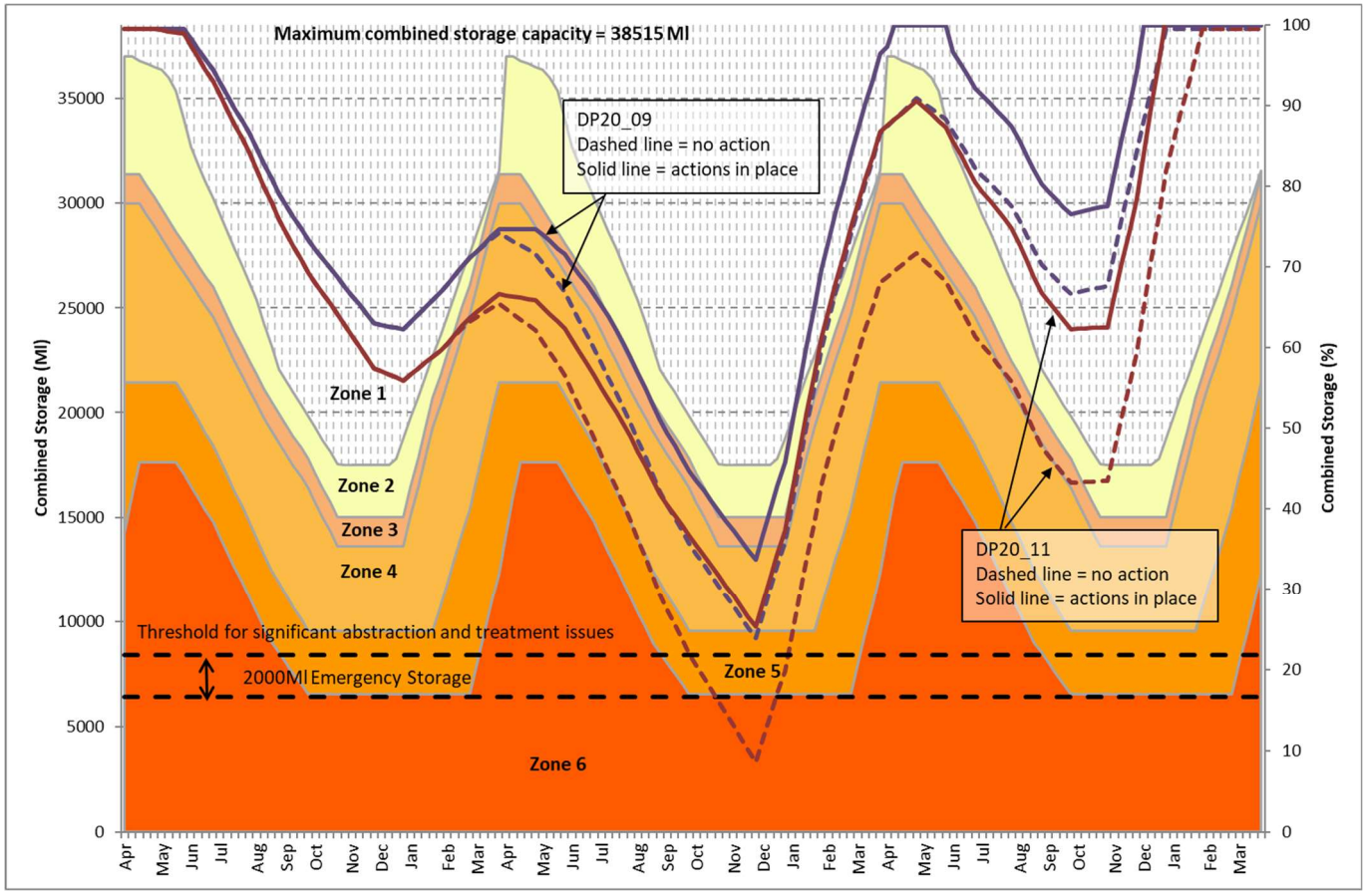


Table B4: Drought library assessment for 18-month drought at 60% long term average rainfall. (average demand 330Ml/d – model reference DP20_09)

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Feb	6	DMZ 1 (Normal)	Normal operation	Normal operation
Feb	7			
Feb	8			
Feb	9	DMZ 2 (Prolonged dry weather)	Media campaigns raising awareness and asking for voluntary restraint	Minimise reservoir storage use and maximise use of River Axe and River Severn sources. Maximise groundwater abstractions. Discuss feasibility of reducing transfer to Wessex Water.
Mar	10			

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Mar	11	DMZ 3 Level 1	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Reduced transfer to Wessex Water (6.97 Ml/d benefit)
Mar	12	DMZ 4 Level 2	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Preparation for TUBS implementation in April. Public consultation week 1. Ongoing increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Reduced transfer to Wessex Water (6.97 Ml/d benefit) – maintained throughout DMZ 4. Initiate work required to put R24R back into supply (6 month lead time to bring online)
Mar	13		Preparation for TUBS implementation in April. Public consultation week 2. Additional leakage activity working at full capacity (2Ml/d benefit).	
Apr	14		TUBS restriction implemented beginning of April (estimated saving of 9.5% of household demand) Leakage activity working at full capacity (2Ml/d benefit)	Supply forecasting carried out to assess risk of entering DMZ 5 and whether Drought Permits are likely to be required.
Apr	15		TUBS restriction in place (estimated 9.5% saving on household demand) April to September. Ongoing high profile media campaign to maintain awareness of water resource position over the summer months. Advice provided to customers on how to be as water efficient as possible. Leakage activity continuing to work at full capacity (2Ml/d benefit)	
Apr	16			
Apr	17			
Apr	18			
May	19			
May	20			
May	21			

Month	Week No	DMZ / Action level	Demand actions	Supply actions
May	22	DMZ 3 Level 1	TUBS restrictions remain in place during summer as still in drought, and reservoir storage falling. This is to prevent the need for drought permits later in the year and any associated environmental effects. Ongoing high profile media campaign to maintain awareness of water resource position over the summer months. Advice provided to customers on how to be as water efficient as possible. Leakage activity continuing to work at full capacity (2Ml/d benefit)	Reduced transfer to Wessex Water (6.97 Ml/d benefit)
Jun	23			
Jun	24			
Jun	25			
Jun	26			
Jul	27			
Jul	28			
Jul	29	DMZ 3 Level 1		
Jul	30			
Jul	31			
Aug	32			
Aug	33			
Aug	34			
Aug	35			
Sep	36	DMZ 3 Level 1	TUBS restrictions lifted (after August bank holiday weekend). Strong communications messaging to continue with water efficiency. Leakage activity continuing to work at full capacity (2Ml/d benefit)	Wessex transfer back to full capacity if required.
Sep	37			
Sep	38			
Sep	39			R24R source commissioned and in supply. Estimated dry weather yield of 2.4Ml/d
Oct	40			
Oct	41			
Oct	42			
Oct	43			
Oct	44			
Nov	45			
Nov	46			
Nov	47			
Nov	48			Turning point for reservoir storage – recovery starts.
Dec	49			
Dec	50			
Dec	51	DMZ 2 (Recovering drought)	Communications campaign maintained during recovery period, until normal conditions resume.	Dry weather system management to conserve reservoir storage.
Dec	52			
Jan	1			
Jan	2			
Jan	3	DMZ 1 (Normal)	Post drought actions implemented. Review and lessons learned report produced.	
Jan	4			
Jan	5			

Table B5: Drought library assessment for 18-month drought at 60% long term average rainfall. (average demand 340Ml/d – model reference DP20_11)

Month	Week No	DMZ / Action level	Demand actions	Supply actions
Jan	2	DMZ 1 Normal	Normal operation	Normal operation
Jan	3			
Jan	4	DMZ 2 Dry weather management	Media campaign raising awareness and asking for voluntary restraint	Minimise reservoir storage and maximise use of River Axe and River Severn sources. Maximise groundwater abstractions. Discuss feasibility of reducing transfer to Wessex Water.
Jan	5			
Feb	6			
Feb	7	DMZ 3 Level 1	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Reduced transfer to Wessex Water (6.97 Ml/d benefit)
Feb	8			
Feb	9	DMZ 4 Level 2	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Ongoing increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Initiate work required to put R24R back into supply (6 month lead time to bring online) Reduced transfer to Wessex Water (6.97 Ml/d benefit) – maintained throughout DMZ 4.
Mar	10		Preparation for TUBS implementation in April. Public consultation week 1. Leakage activity working at full capacity (2Ml/d benefit)	
Mar	11		Preparation for TUBS implementation in April. Public consultation week 2. Additional leakage activity working at full capacity (2Ml/d benefit).	
Mar	12		Media campaign and messaging about TUBS restrictions that will be in place from April.	
Mar	13			

Month	Week No	DMZ / Action level	Demand actions	Supply actions
		DMZ 4 Level 2	Leakage activity working at full capacity (2Ml/d benefit)	
Apr	14		TUBS restriction implemented beginning of April (estimated saving of 9.5% of household demand) Leakage activity working at full capacity (2Ml/d benefit)	Supply forecasting carried out to assess risk of entering DMZ 5 and whether Drought Permits are likely to be required.
Apr	15		TUBS restriction in place (estimated 9.5% saving on household demand) April to September. Ongoing high profile media campaign to maintain awareness of water resource position over the summer months. Advice provided to customers on how to be as water efficient as possible. Leakage activity continuing to work at full capacity (2Ml/d benefit)	Reduced transfer to Wessex Water (6.97 Ml/d benefit) – maintained throughout DMZ 4.
Apr	16			
Apr	17			
Apr	18			
May	19			
May	20			
May	21			
May	22			
Jun	23			
Jun	24			
Jun	25			
Jun	26			
Jul	27			
Jul	28			
Jul	29			
Jul	30			
Jul	31			
Aug	32			
Aug	33			
Aug	34			
Aug	35			R24R source commissioned and in supply. Estimated dry weather yield of 2.4Ml/d
Sep	36			
Sep	37			
Sep	38			
Sep	39			
Oct	40		TUBS lifted at end of September due to minimal effect over autumn/winter period.	
Oct	41		High profile media campaign maintained to keep demand down and emphasise that the drought is not yet over.	
Oct	42			

Month	Week No	DMZ / Action level	Demand actions	Supply actions
		DMZ 4 Level 2	Leakage activity continuing to work at full capacity (2Ml/d benefit)	
Oct	43		Forecasts indicate that storage could reach DMZ 5 within 6 weeks. Initiate process for Non-essential use ban Drought Order application. Maintain high profile media campaign maintained to keep demand down and emphasise that the drought is not yet over and still risk of further restrictions.	Supply forecasts indicate that storage could reach DMZ 5 within 6 weeks. Initiate process for drought permit applications
Oct	44			
Nov	45			
Nov	46			
Nov	47			
Nov	48			
Dec	49			Turning point for reservoir storage – recovery starts.
Dec	50			
Dec	51			
Dec	52			
Jan	1	DMZ 3 Level 1	Strong communications messaging to continue with water efficiency. Leakage activity continuing to work at full capacity (2Ml/d benefit)	R24R remains in supply throughout the refill period to support reservoir recovery. (2.4Ml/d estimated yield) Reduced transfer to Wessex Water (6.97 Ml/d benefit)
Jan	2			
Jan	3			
Jan	4			
Jan	5	DMZ 2 Recovering drought	Communications campaign maintained throughout recovery period, until normal conditions resume.	Wessex transfer back to full capacity if required. Dry weather system management to conserve reservoir storage.
Feb	6			
Feb	7			
Feb	8			
Feb	9	DMZ 1 Normal	Post drought actions implemented. Review and lessons learned report produced.	
Feb	10			

1.4 Drought library assessment 1-in-500-year drought scenario - summary

The worked examples presented above, demonstrates that by implementing our demand side actions in line with our drought plan (including leakage actions and TUBS), we prevent the water resource drought situation deteriorating to a point where supply side drought permits would be required. In the case of scenario DP20_11 the actions carried out prevent both drought permits and Non-essential use bans being required under Level 3 (DMZ 5) and emergency drought orders being required under Level 4 (DMZ 6). The demand side actions are supported by some initial supply side actions including reducing the bulk supply to Wessex Water providing a 6.97Ml/d benefit to the Bristol Water supply system. However, we have still maintained a 4.4Ml/d supply to Wessex Water throughout the drought scenarios assessed. Under both scenarios we implement the work required to bring our R24R source back into supply, and in both scenarios this resource is commissioned and used to support reservoir refill, due to the length of time the reservoir storage remains in DMZ 4 (Level 2).

Appendix C

Drought options environmental assessment and monitoring tables.

	Supply side action	Reduction of Blagdon Reservoir compensation release
Supply side action information	Trigger/previous action	Drought – Entering drought management zone 5 (Level 3)
	Deployable output of action	4.038Ml/d (15th May to 30th November) Based on a reduction in compensation flow, from 8.638 Ml/d to a daily flow of 4.6Ml/d between May and November.
	Implementation timetable	Drought permit application preparation will be commenced when combined reservoir storage enters zone 4 (i.e. when TUBs are introduced). If supporting up-to–date environmental assessment reports are available we anticipate that the application will be ready for submission and advertising within 2 weeks. We will provide 7 days written notice to organisations likely to be affected by the permit, advising that any objections should be made to the Environment Agency within 7 days of the notice being served. We will advertise the drought permit application in at least one local newspaper and the London Gazette. We assume EA will determine the drought permit application within 12 calendar days of the date of our last advertisement, if no objections are received, or 7 calendar days of the receipt of a hearing report if a hearing takes place. Once the drought permit is received we will advertise the successful application in the London Gazette and the same local newspaper where the application was advertised. The practical implementation of the option could be effective within 7 days.

	Supply side action	Reduction of Blagdon Reservoir compensation release
		This drought options reduces the compensation release between 15th May and 30th November to conserve reservoir storage during a drought and improve the subsequent reservoir winter refill. Drought permits are valid for up to 6 months and can be extended for a further 6 months. We will contact the EA at least 28 days before the existing permit expires if an extension is required.
	Permissions required and constraints	Drought Permit from the Environment Agency
	Risks associated with the option	Drought permit not being issued by the EA
Summary of environmental assessment	Overall environmental impact (minor, moderate, major or uncertain)	The hydrological assessment identified that the zone of influence associated with implementation of the drought permit extends from the Blagdon Reservoir compensation release point to the tidal limit at Woodspring Bay. The environmental assessment has concluded that there are major-moderate impacts on macrophytes and fish, moderate-minor impacts on macroinvertebrates, and minor impacts on Puxton Moor SSSI and Biddle Street Yatton SSSI. The HRA identifies potential for major (but uncertain) adverse effects on eel (designated under Severn Estuary Ramsar site) and potential for major adverse effects on Greater Horseshoe Bats (designated under North Somerset and Mendip Bats SAC). Further work is required to assess whether upstream eel migration will be adversely affected if lower flows due to the drought permit reduces the ability of eel to pass in-stream barriers compared to the baseline conditions without the drought permit in place.

	Supply side action	Reduction of Blagdon Reservoir compensation release
	Level of confidence (H, M, L)	High
	Summary of likely environmental impacts	An Environmental Assessment Report has been produced for this drought permit. The assessment concluded that there is a major-moderate impact on flows in the River Yeo as a result of implementing the drought permit. These hydrological impacts are assessed as leading to major impacts on the physical environment of the river, including water quality. The environmental assessment identified potential environmental impacts (prior to mitigation) within the zone of influence to the following environmental features: • North Somerset and Mendip Bats SAC – Major • Chew Valley Lake SPA – Major • Severn Estuary SAC, Ramsar – Major • Puxton Moor SSSI – Moderate impacts • Biddle Street Yatton SSSI – Minor impacts • Congresbury Yeo, adjacent land and rhynes LWS – Minor impacts • Macrophyte community - Moderate impacts • Macroinvertebrate community - Moderate impacts • Fish community - Moderate impacts • White-clawed crayfish (*Austropotamobius pallipes*) - Moderate impacts • Water crowfoot (*Ranunculus* spp.) - Moderate impacts • Great silver water beetle (*Hydrophilus piceus*) - Moderate impacts • False orb pea mussel (*Pisidium pseudosphaerium*) - Moderate impacts • Variable damselfly (*Coenagrion pulchellum*) - Moderate impacts • Brown/sea trout – Major impacts • Bullhead – Major impacts

	Supply side action	Reduction of Blagdon Reservoir compensation release
		• Brook lamprey – Moderate impacts • River and sea lamprey - Moderate impacts • European eel - Moderate impacts • Otter – Negligible impacts
	Summary of baseline information used	The environmental assessment used previous reports and studies, Environment Agency and Bristol Water routine monitoring data and other bespoke data, as well as data collected during the three year period since publication of the last drought plan (2018, 2019 and 2020). This has included information on reservoir and river flow/levels, water quality monitoring data, macroinvertebrate/macrophyte/fisheries survey data, available data on statutory and non-statutory designated sites, NERC Act Section 41 priority species distributions data, distribution of Invasive and Non-Native Species and recreational resources.
	Summary of additional monitoring required	Monitoring recommendations have been developed as part of the environmental assessment studies through consultation with the Environment Agency. Details of additional baseline monitoring requirements have been specified in the Environmental Assessment Report which lists the features to be monitored and methods used; location, timing and frequency of surveys; and who will undertake the monitoring. Table C1 provides further details.
	Summary of mitigation measures	Monitoring led mitigation measures have been identified as part of the environmental assessment studies through consultation with the Environment Agency and Natural England and are documented in the Environmental Assessment Report. Mitigation measures have been proposed for the following environmental features: • Macrophytes/*Ranunculus* • Macroinvertebrates • White clawed crayfish

	Supply side action	Reduction of Blagdon Reservoir compensation release
		• Fish community The range of proposed measures are included in Table C4.
	Permits/approvals needs for mitigation measures	In order to carry out the mitigation measures set out above, the Environment Agency has advised that we will need to apply for the following permits/approvals: • Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. • Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i.e. Wildlife Trusts, River Trusts) in the context of the specific circumstances as a drought progresses.
	Impact on other activities for example fisheries, industry.	Wider environmental features have been considered in determining the potential impacts of drought permit implementation, including: • Mendip Hills AONB • Cheddar Valley Railway Walk (LNR) • Angling Low river levels and flows may affect the aesthetics of the area and reduce the aquatic habitats and associated species. However any impacts are not considered significant as any impacts would be temporary and river levels will be low during baseline conditions prior to drought permit implementation.

Table C1: Environmental monitoring plan - Reduction of Blagdon Reservoir compensation release.

Supply side action	**Reduction of Blagdon Reservoir compensation release**				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
Macrophytes	Blagdon Reservoir compensation release point to the tidal limit at Woodspring Bay	Walkover (where survey site identification is required) and river macrophyte survey at one site in each of the impacted freshwater reaches. Carry out water quality sampling at same time including samples for soluble reactive phosphorous.	Monitoring to be carried out annually during June-September, to identify any key point sources of nutrient loading.	Bristol Water are responsible for survey to be undertaken and macrophytes identified (if drought permit likely to be implemented in plant growing season). Walkover survey to identify any key sources of nutrient loading. Carry out water quality sampling at the baseline sites including samples for soluble reactive phosphorous.	Bristol Water are responsible for carrying out post-drought permit implementation surveys at the baseline monitoring sites for 2 consecutive summers after the last summer of a drought (one survey each year) to understand the extent of recovery from any adverse impacts. Water quality sampling is to be undertaken at the baseline sites including samples for soluble reactive phosphorous.
Ranunculus spp.	Blagdon Reservoir compensation release point to the tidal limit at Woodspring Bay	Seasonal walkover and carry out *Ranunculus* surveys at the baseline survey sites (if during plant growing season) Carry out water quality sampling at same time, including soluble reactive phosphorous	Bristol Water to carry out summer *Ranunculus* surveys – one site in each of the freshwater impacted reaches (Reaches 1 to 3). Surveys to identify any key point sources of nutrient loading. Water quality sampling to be conducted at the	At the onset of drought Bristol water to conduct seasonal walkover and carry out *Ranunculus* surveys at the baseline survey sites (if during plant growing season), along with water quality sampling at same time, including soluble reactive phosphorous. At drought start, surveys to be undertaken and *Ranunculus*	Bristol Water to carry out post-drought order implementation surveys at the baseline monitoring sites for 2 consecutive summers after the last summer of a drought (one survey each year) to understand the extent of recovery from any adverse impacts.

Supply side action	Reduction of Blagdon Reservoir compensation release				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
			same time, including soluble reactive phosphorous. Repeat surveys annually	identified (if drought order implemented in plant growing season). Walkover survey to identify any key sources of nutrient loading. Carry out water quality sampling at same time, including SRP	
Macroinvertebrates	Blagdon Reservoir compensation release point to the tidal limit at Woodspring Bay	Seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time.	Bristol Water to carry out seasonal (spring and autumn) macroinvertebrate surveys. One site in each of the impacted reaches (Reaches 1 to 3) (ideally complementing the existing EA monitoring, in discussion with the EA). Surveys to be repeated in spring and autumn for a minimum of three years, ideally annually, including a 'dry' year. Identify to species level.	Bristol water to conduct seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time. Seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time. Operation of key flow control structures to maintain water levels in vulnerable	Bristol water to conduct seasonal monitoring of macroinvertebrates at the baseline survey sites. No action required outside of baseline seasonal monitoring programmes

Supply side action	Reduction of Blagdon Reservoir compensation release				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
			Carry out water quality surveys at the same time.	reaches/water bodies where applicable.	
White-clawed crayfish *Austropotamobius pallipes*	Blagdon Reservoir compensation release point to the tidal limit at Woodspring Bay	A walkover survey was conducted in 2018 followed by white-clawed crayfish presence absence survey (manual search and/or sweep net method). Suitable crayfish habitat was identified however no crayfish were identified as present. No further baseline surveys are proposed at the current time.	No further baseline surveys are proposed at the current time.	Bristol Water to conduct full suite of surveys carried out July-October, exclusive of sensitive breeding period for in stream survey techniques. Walkover surveys targeted to habitat sensitive to low flows (as identified in baseline survey).	Full suite of surveys carried out July-October the following, exclusive of sensitive breeding period for in stream survey techniques.
Fish community	Blagdon Reservoir compensation release point to the tidal limit at Woodspring Bay	Fish populations are not well understood as a result of lack of recent survey data. One survey round every three years at same sites, coordinating with EA monitoring schedule.	Electric-fishing surveys were carried out in 2018 to monitor fish populations at one site in each of the impacted reaches of the River Yeo: Reach 1 - Site 'Emley Lane d/s'; Reach 2- Site 'Beam Bridge (Se-	Utilise information gathered from the Environment Agency or public regarding incidents of fish in distress or fish kills to inform need for investigative walkovers and resultant mitigation measures. Additional walkover surveys if situation is expected to deteriorate in river sections	Bristol water to undertake post-drought fish surveys at the baseline monitoring sites to substantiate the level of impact in the year following drought order implementation, Three consecutive years post drought order monitoring at baseline monitoring site to determine relative health of year classes which may be

Supply side action	Reduction of Blagdon Reservoir compensation release				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
		Carry out water quality sampling at the same time for: dissolved oxygen, pH, turbidity, suspended sediment, conductivity, temperature, ammonia and SRP.	05)'; Reach 3 – Site 'East Hewish'. Collate any further information from local knowledge and EA local staff, plus local biological records.	known to contain high fish densities. If barriers to eel migration due to low flows caused by the permit, monitor upstream eel migration to direct any identified mitigation measures.	influenced by the drought order/permit. Including fish scale analysis.

	Supply side action	Reduction of Chew Reservoir compensation release
Supply side action information	Trigger/previous action	Drought – Entering drought management zone 5 (Level 3).
	Deployable output of action	7.32Ml/d (1st May to 30th Nov) based on a reduction in compensation flow from 14.32Ml/d to 7 Ml/d between May and Nov. 3.419 Ml/d (1st Dec to 30th April) based on a reduction in compensation flow from 6.819Ml/d to 3.4Ml/d between December and April.
	Implementation timetable	Drought permit application preparation will be commenced when combined reservoir storage enters zone 4 (i.e. when TUBs are introduced). If supporting up-to–date environmental assessment reports are available we anticipate that the application will be ready for submission and advertising within 2 weeks. We will provide 7 days written notice to organisations likely to be affected by the permit, advising that any objections should be made to the Environment Agency within 7 days of the notice being served. We will advertise the drought permit application in at least one local newspaper and the London Gazette. We assume EA will determine the drought permit application within 12 calendar days of the date of our last advertisement, if no objections are received, or 7 calendar days of the receipt of a hearing report if a hearing takes place. Once the drought permit is received we will advertise the successful application in the London Gazette and the same local newspaper where the application was advertised.

	Supply side action	Reduction of Chew Reservoir compensation release
		The practical implementation of the option could be effective within 7 days. This drought options reduces the compensation release between 1st May and 30th Nov, and again between 1st December and the 30th April, to conserve reservoir storage during a drought and improve the subsequent reservoir winter refill. Drought permits are valid for up to 6 months and can be extended for a further 6 months. We will contact the EA at least 28 days before the existing permit expires if an extension is required.
	Permissions required and constraints	Drought Permit from the Environment Agency In order to carry out the mitigation measures set out below, the Environment Agency has advised that we will need to apply for the following permits/approvals: • Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. • Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i.e. Wildlife Trusts) in the context of the specific circumstances as a drought progresses.
	Risks associated with the option	Drought permit not being issued by the EA.

	Supply side action	Reduction of Chew Reservoir compensation release
Summary of environmental assessment	Overall environmental impact (minor, moderate, major or uncertain)	The hydrological assessment identified that the zone of influence associated with implementation of the drought permit extends from the downstream of the Chew Reservoir outflow, to the confluence with the River Avon. The assessment has concluded that there are major-moderate impacts on macrophytes (including *Ranunculus* spp) and fish, and moderate impacts on macroinvertebrates, white-clawed crayfish, eel and river lamprey. The HRA identifies potential for major (but uncertain) adverse effects on eel (designated under Severn Estuary Ramsar site). Further work is required to assess whether upstream eel migration will be adversely affected if lower flows due to the drought permit reduces the ability of eel to pass in-stream barriers compared to the baseline conditions without the drought permit in place.
	Level of confidence (H, M, L)	High
	Summary of likely environmental impacts	An Environmental Assessment Report has been produced for this drought permit. The assessment has concluded that there is a major-moderate impact on flows in the River Chew as a result of implementing the drought permit. These hydrological impacts are assessed as leading to major impacts on the physical environment of the river, including water quality. The environmental assessment identified potential environmental impacts (prior to mitigation) within the zone of influence to the following environmental features: • Severn Estuary SAC and Ramsar Site – Major • River Chew and adjacent land LWS – Minor • Macrophyte community - Medium impacts

	Supply side action	Reduction of Chew Reservoir compensation release
		• Macroinvertebrate community - Medium impacts • Freshwater Fish – Medium impact • Celery-leaved crowfoot (*Ranunculus sceleratus*) – Negligible impacts • Water crowfoot (*Ranunculus* (Batrachian) spp.) - Minor impacts • Riffle beetle (*Riolus subviolaceus*) - Minor Impacts • Least water snipefly (*Atrichops crassipes*) – Minor Impacts • Brown/sea trout – Moderate impacts • Atlantic Salmon – Major impacts • Grayling – Moderate impacts • Bullhead – Moderate impacts • Brook lamprey – Moderate impacts • River and sea lamprey - Moderate impacts • European eel - Moderate impacts • Otter – Negligible impacts
	Summary of baseline information used	The environmental assessment used previous reports and studies, Environment Agency and Bristol Water routine monitoring data and other bespoke data. This has included information on reservoir and river flow/levels, water quality monitoring data, macroinvertebrate/macrophyte/fisheries survey data, available data on statutory and non-statutory designated sites, NERC Act Section 41 priority species distributions data, distribution of Invasive and Non-Native Species and recreational resources.
	Summary of additional monitoring required	Monitoring recommendations have been developed as part of the environmental assessment studies through consultation with the Environment Agency. Details of additional baseline monitoring requirements have been specified in the Environmental Assessment Report which lists the features to be monitored and methods used; location, timing and frequency of surveys; and who will undertake the monitoring. Table C2 provides further details.

	Supply side action	Reduction of Chew Reservoir compensation release
	Summary of mitigation measures	Monitoring led mitigation measures have been identified as part of the environmental assessment studies through consultation with the Environment Agency and Natural England and are documented in the Environmental Assessment Report. Mitigation measures have been proposed for the following environmental features: • Macrophytes/*Ranunculus* • Macroinvertebrates • White clawed crayfish • Fish community The range of proposed measures are included in Table C4.
	Permits/approvals needs for mitigation measures	In order to carry out the mitigation measures set out above, the Environment Agency has advised that we will need to apply for the following permits/approvals: • Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. • Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i e. Wildlife Trusts) in the context of the specific circumstances as a drought progresses.
	Impact on other activities for example fisheries, industry.	Wider environmental features have been considered in determining the potential impacts of drought permit implementation, including: • Mendip Hills AONB • Angling Low river levels and flows may affect the aesthetics of the area and reduce the aquatic habitats and associated species. However any impacts are not considered significant as any

	Supply side action	Reduction of Chew Reservoir compensation release
		impacts would be temporary and river levels will be low during baseline conditions prior to drought permit implementation.

Table C2: Environmental monitoring plan - Reduction of Chew Reservoir compensation release

Supply side action	**Reduction of Chew Reservoir compensation release**				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
Macrophytes	Downstream of the Chew Reservoir outflow, to the confluence with the River Avon	Walkover (where survey site identification is required) and river macrophyte survey at one site in each of the impacted freshwater reaches. Carry out water quality sampling at same time including samples for soluble reactive phosphorous.	Monitoring to be carried out annually during June-September, to identify any key point sources of nutrient loading.	Bristol Water are responsible for survey to be undertaken and macrophytes identified (if drought permit likely to be implemented in plant growing season). Walkover survey to identify any key sources of nutrient loading. Carry out water quality sampling at the baseline sites including samples for soluble reactive phosphorous.	Bristol Water is responsible for carrying out post-drought permit implementation surveys at the baseline monitoring sites for 2 consecutive summers after the last summer of a drought (one survey each year) to understand the extent of recovery from any adverse impacts. Water quality sampling is to be undertaken at the baseline sites including samples for soluble reactive phosphorous.
Ranunculus spp.	Downstream of the Chew Reservoir outflow, to the confluence with the River Avon	Seasonal walkover and carry out *Ranunculus* surveys at the baseline survey sites (if during plant growing season) Carry out water quality sampling at same time, including soluble reactive phosphorous	Bristol Water to carry out summer *Ranunculus* surveys – one site in each of the freshwater impacted reaches (Reaches 1 to 3). Surveys to identify any key point sources of nutrient loading. Water quality sampling to be conducted at the same time, including	At the onset of drought Bristol water to conduct seasonal walkover and carry out *Ranunculus* surveys at the baseline survey sites (if during plant growing season), along with water quality sampling at same time, including soluble reactive phosphorous. At drought start, surveys to be undertaken and	Bristol Water to carry out post-drought order implementation surveys at the baseline monitoring sites for 2 consecutive summers after the last summer of a drought (one survey each year) to understand the extent of recovery from any adverse impacts.

Supply side action	Reduction of Chew Reservoir compensation release				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
			soluble reactive phosphorous. Repeat surveys annually	*Ranunculus* identified (if drought order implemented in plant growing season). Walkover survey to identify any key sources of nutrient loading. Carry out water quality sampling at same time, including SRP	
Macroinvertebrates	Downstream of the Chew Reservoir outflow, to the confluence with the River Avon	Seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time.	Bristol Water to carry out seasonal (spring and autumn) macroinvertebrate surveys. One site in each of the impacted reaches (Reaches 1 to 3) (ideally complementing the existing EA monitoring, in discussion with the EA). Surveys to be repeated in spring and autumn for a minimum of three years, ideally annually, including a 'dry' year. Identify to species level.	Bristol water to conduct seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time. Seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time. Operation of key flow control structures to maintain water levels in vulnerable	Bristol water to conduct seasonal monitoring of macroinvertebrates at the baseline survey sites. No action required outside of baseline seasonal monitoring programmes

Supply side action	Reduction of Chew Reservoir compensation release				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
			Carry out water quality surveys at the same time.	reaches/water bodies where applicable.	
White-clawed crayfish *Austropotamobius pallipes*	Downstream of the Chew Reservoir outflow, to the confluence with the River Avon	A walkover survey was conducted in 2018 followed by white-clawed crayfish presence absence survey (manual search and/or sweep net method). Suitable crayfish habitat was identified however no crayfish were identified as present. No further baseline surveys are proposed at the current time.	No further baseline surveys are proposed at the current time.	Bristol Water to conduct full suite of surveys carried out July-October, exclusive of sensitive breeding period for in stream survey techniques. Walkover surveys targeted to habitat sensitive to low flows (as identified in baseline survey).	Full suite of surveys carried out July-October the following, exclusive of sensitive breeding period for in stream survey techniques.
Fish community	Downstream of the Chew Reservoir outflow, to the confluence with the River Avon	Fish populations are not well understood as a result of lack of recent survey data. One survey round every three years at same sites, coordinating with EA monitoring schedule. Carry out water quality sampling at the same time for: dissolved oxygen, pH, turbidity,	Electric-fishing surveys were carried out in 2018 to monitor fish populations at one site in each of the impacted reaches of the River Chew: (.: Reach 1 - Site 'Chew Magna'; Reach 2- Site 'Pensford (Te)'; Reach 3 – Compton Danto (Te).	Utilise information gathered from the Environment Agency or public regarding incidents of fish in distress or fish kills to inform need for investigative walkovers and resultant mitigation measures. Additional walkover surveys if situation is expected to deteriorate in river sections known to contain high fish densities.	Bristol water to undertake post-drought fish surveys at the baseline monitoring sites to substantiate the level of impact in the year following drought order implementation, Three consecutive years post drought order monitoring at baseline monitoring site to determine relative health of year classes which may be influenced by the drought

Supply side action	Reduction of Chew Reservoir compensation release				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
		suspended sediment, conductivity, temperature, ammonia and SRP.	Collate any further information from local knowledge and EA local staff, plus local biological records.		order/permit. Including fish scale analysis.

	Supply side action	Reduction of Cheddar Ponds compensation release to Cheddar Yeo.
Supply side action information	Trigger/previous action	Drought – Entering drought management zone 5 (Level 3).
	Deployable output of action	3.4 Ml/d (1st December to 14th May) based on a reduction in compensation flow from 6.8Ml/d to 3.4Ml/d Dec to May.
	Implementation timetable	Drought permit application preparation will be commenced when combined reservoir storage enters zone 4 (i.e. when TUBs are introduced). If supporting up-to–date environmental assessment reports are available we anticipate that the application will be ready for submission and advertising within 2 weeks. We will provide 7 days written notice to organisations likely to be affected by the permit, advising that any objections should be made to the Environment Agency within 7 days of the notice being served. We will advertise the drought permit application in at least one local newspaper and the London Gazette. We assume EA will determine the drought permit application within 12 calendar days of the date of our last advertisement, if no objections are received, or 7 calendar days of the receipt of a hearing report if a hearing takes place. Once the drought permit is received we will advertise the successful application in the London Gazette and the same local newspaper where the application was advertised. The practical implementation of the option could be effective within 7 days.

	Supply side action	Reduction of Cheddar Ponds compensation release to Cheddar Yeo.
		This drought options reduces the compensation release between 1st December and 14th May, to conserve reservoir storage during a drought and improve the reservoir winter refill. Drought permits are valid for up to 6 months and can be extended for a further 6 months. We will contact the EA at least 28 days before the existing permit expires if an extension is required.
	Permissions required and constraints	Drought Permit from the Environment Agency In order to carry out the mitigation measures, the Environment Agency has advised that we will need to apply for the following permits/approvals: ▪ Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. ▪ Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i.e. Wildlife Trusts) in the context of the specific circumstances as a drought progresses.
	Risks associated with the option	Drought permit not being issued by the EA.
Summary	Overall environmental impact (minor, moderate, major or uncertain)	The hydrological assessment identified that the zone of influence associated with implementation of the drought permit extends from the Cheddar Ponds intake to the confluence with the River Axe.

	Supply side action	Reduction of Cheddar Ponds compensation release to Cheddar Yeo.
		The assessment has concluded that in the absence of mitigation there are major-moderate impacts on macrophytes, macroinvertebrates and fish within the stated reaches of the River Yeo. The HRA identifies potential for major (but uncertain) adverse effects on eel (designated under Severn Estuary Ramsar site). Further work is required to assess whether upstream eel migration will be adversely affected if lower flows due to the drought permit reduces the ability of eel to pass in-stream barriers compared to the baseline conditions without the drought permit in place.
	Level of confidence (H, M, L)	High
	Summary of likely environmental impacts	An Environmental Assessment Report has been produced for this drought permit. The assessment has concluded that there is a major-moderate impact on flows in the River Yeo as a result of implementing the drought permit. These hydrological impacts are assessed as leading to impacts on the physical environment of the river, including medium risks to water quality. The environmental assessment identified potential environmental impacts (prior to mitigation) within the zone of influence to the following environmental features: ▪ Severn Estuary Ramsar - Major ▪ River Cheddar Yeo LWS – Minor ▪ Macrophyte community - Medium impacts ▪ Macroinvertebrate community - Medium impacts ▪ Freshwater Fish – Medium impact ▪ Celery-leaved crowfoot (*Ranunculus sceleratus*) – Negligible impacts

	Supply side action	Reduction of Cheddar Ponds compensation release to Cheddar Yeo.
		▪ Water crowfoot (*Ranunculus* spp.) – Moderate impacts ▪ *Myriophyllum verticillatum* – Minor ▪ Riffle beetle (*Riolus subviolaceus*) – Moderate Impacts ▪ Caddis Fly (*Tinodes unicolor*) – Moderate Impacts ▪ Atlantic Salmon – Major impacts ▪ Brown/sea trout – Major impacts ▪ Bullhead – Moderate impacts ▪ European eel – Minor impacts ▪ Otter – Negligible impacts
	Summary of baseline information used	The environmental assessment used previous reports and studies, Environment Agency and Bristol Water routine monitoring data and other bespoke data. This has included information on reservoir and river flow/levels, water quality monitoring data, macroinvertebrate/macrophyte/fisheries survey data, available data on statutory and non-statutory designated sites, NERC Act Section 41 priority species distributions data, distribution of Invasive and Non-Native Species and recreational resources.
	Summary of additional monitoring required	Monitoring recommendations have been developed as part of the environmental assessment studies through consultation with the Environment Agency. Details of additional baseline monitoring requirements have been specified in the Environmental Assessment Report which lists the features to be monitored and methods used; location, timing and frequency of surveys; and who will undertake the monitoring. Table C3 provides further details.
	Summary of mitigation measures	Monitoring led mitigation measures have been identified as part of the environmental assessment studies through consultation with the Environment Agency and Natural England and are documented in the Environmental Assessment Report. Mitigation measures have been proposed for the following environmental features: • Macrophytes/*Ranunculus*

	Supply side action	Reduction of Cheddar Ponds compensation release to Cheddar Yeo.
		• Macroinvertebrates • Fish community The range of proposed measures are included in Table C4.
	Permits/approvals needs for mitigation measures	In order to carry out the mitigation measures set out above, the Environment Agency has advised that we will need to apply for the following permits/approvals: • Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. • Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i.e. Wildlife Trusts) in the context of the specific circumstances as a drought progresses.
	Impact on other activities for example fisheries, industry.	Wider environmental features have been considered in determining the potential impacts of drought permit implementation, including: • Mendip Hills AONB • Rodney Stoke National Nature Reserve (NNR) • Sladers Leigh Local Nature Reserve (LNR) • Berrow Dunes Local Nature Reserve (LNR) • Uphill Local Nature Reserve (LNR) Low river levels and flows may affect the aesthetics of the area and reduce the aquatic habitats and associated species. However, any impacts are not considered significant as any impacts would be temporary and river levels will be low during baseline conditions prior to drought permit implementation

Table C3: Environmental monitoring plan - Reduction of Cheddar Ponds compensation release to Cheddar Yeo.

Supply side action	**Reduction of Cheddar Ponds compensation release to Cheddar Yeo**				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
Macrophytes	Cheddar Ponds intake to the confluence with the River Axe	Walkover (where survey site identification is required) and river macrophyte survey at one site in each of the impacted freshwater reaches. Carry out water quality sampling at same time including samples for soluble reactive phosphorous.	Monitoring to be carried out annually during June-September, to identify any key point sources of nutrient loading.	Bristol Water are responsible for survey to be undertaken and macrophytes identified (if drought permit likely to be implemented in plant growing season). Walkover survey to identify any key sources of nutrient loading. Carry out water quality sampling at the baseline sites including samples for soluble reactive phosphorous.	Bristol Water are responsible for carrying out post-drought permit implementation surveys at the baseline monitoring sites for 2 consecutive summers after the last summer of a drought (one survey each year) to understand the extent of recovery from any adverse impacts. Water quality sampling is to be undertaken at the baseline sites including samples for soluble reactive phosphorous.
Ranunculus spp.	Cheddar Ponds intake to the confluence with the River Axe	Seasonal walkover and carry out *Ranunculus* surveys at the baseline survey sites (if during plant growing season) Carry out water quality sampling at same time, including soluble reactive phosphorous	Bristol Water to carry out summer *Ranunculus* surveys – one site in each of the freshwater impacted reaches (Reaches 1 to 3). Surveys to identify any key point sources of nutrient loading. Water quality sampling to be conducted at the same time, including soluble reactive phosphorous.	At the onset of drought Bristol water to conduct seasonal walkover and carry out *Ranunculus* surveys at the baseline survey sites (if during plant growing season), along with water quality sampling at same time, including soluble reactive phosphorous. At drought start, surveys to be undertaken and *Ranunculus* identified (if drought order implemented in plant growing	Bristol Water to carry out post-drought order implementation surveys at the baseline monitoring sites for 2 consecutive summers after the last summer of a drought (one survey each year) to understand the extent of recovery from any adverse impacts.

Supply side action	Reduction of Cheddar Ponds compensation release to Cheddar Yeo				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
			Repeat surveys annually	season). Walkover survey to identify any key sources of nutrient loading. Carry out water quality sampling at same time, including SRP	
Macroinvertebrates	Cheddar Ponds intake to the confluence with the River Axe	Seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time.	Bristol Water to carry out seasonal (spring and autumn) macroinvertebrate surveys. One site in each of the impacted reaches (Reaches 1 to 3) (ideally complementing the existing EA monitoring, in discussion with the EA). Surveys to be repeated in spring and autumn for a minimum of three years, ideally annually, including a 'dry' year. Identify to species level. Carry out water quality surveys at the same time.	Bristol water to conduct seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time. Seasonal monitoring of macroinvertebrates at the baseline survey sites. Samples to be collected and identified to species level. Carry out water quality surveys at same time. Operation of key flow control structures to maintain water levels in vulnerable reaches/water bodies where applicable.	Bristol water to conduct seasonal monitoring of macroinvertebrates at the baseline survey sites. No action required outside of baseline seasonal monitoring programmes

Supply side action	Reduction of Cheddar Ponds compensation release to Cheddar Yeo				
Feature of interest	**Location**	**Method**	**Baseline (frequency, timing, responsibility**	**In-drought (frequency, timing, responsibility)**	**Post-drought (recovery) (frequency, timing, responsibility)**
Fish community	Cheddar Ponds intake to the confluence with the River Axe	Fish populations are not well understood as a result of lack of recent survey data. One survey round every three years at same sites, coordinating with EA monitoring schedule. Carry out water quality sampling at the same time for: dissolved oxygen, pH, turbidity, suspended sediment, conductivity, temperature, ammonia and SRP.	Electric-fishing surveys were carried out in 2018 to monitor fish populations at one site in each of the impacted reaches of the River Yeo: Reach 1 - Site 'Emley Lane d/s'; Reach 2- Site 'Beam Bridge (Se-05)'; Reach 3 – Site 'East Hewish'. Collate any further information from local knowledge and EA local staff, plus local biological records.	Utilise information gathered from the Environment Agency or public regarding incidents of fish in distress or fish kills to inform need for investigative walkovers and resultant mitigation measures. Additional walkover surveys if situation is expected to deteriorate in river sections known to contain high fish densities.	Bristol water to undertake post-drought fish surveys at the baseline monitoring sites to substantiate the level of impact in the year following drought order implementation, Three consecutive years post drought order monitoring at baseline monitoring site to determine relative health of year classes which may be influenced by the drought order/permit. Including fish scale analysis.

	Supply side action	River Axe licence variation
Supply side action information	Trigger/previous action	Drought – Entering drought management zone 5 (Level 3).
	Deployable output of action	Additional yield of between 1.5Ml/d and 6.5Ml/d depending on the severity of the drought and flow availability in the river. This is based on an extension of the period of abstraction by 2 months to include May and October (period of abstraction extended from November – April, to October to May) and an increase in the annual abstraction volume from 4750Ml/year to 7145Ml/year (increase of 2395Ml/year)
	Implementation timetable	Drought permit application preparation will be commenced when combined reservoir storage enters zone 4 (i.e. when TUBs are introduced). If supporting up-to–date environmental assessment reports are available we anticipate that the application will be ready for submission and advertising within 2 weeks. We will provide 7 days written notice to organisations likely to be affected by the permit, advising that any objections should be made to the Environment Agency within 7 days of the notice being served. We will advertise the drought permit application in at least one local newspaper and the London Gazette. We assume EA will determine the drought permit application within 12 calendar days of the date of our last advertisement, if no objections are received, or 7 calendar days of the receipt of a hearing report if a hearing takes place. Once the drought permit is received we will advertise the successful application in the London Gazette and the same local newspaper where the application was advertised.

	Supply side action	River Axe licence variation
		The practical implementation of the option could be effective within 7 days. This drought options enables more water to be abstracted from the River Axe over the winter period to improve Cheddar reservoir winter refill. Drought permits are valid for up to 6 months and can be extended for a further 6 months. We would contact the EA at least 28 days before the existing permit expires if an extension is required.
	Permissions required and constraints	Drought Permit from the Environment Agency
	Risks associated with the option	Drought permit not being issued by the EA.
Summary of environmental assessment	Overall environmental impact (minor, moderate, major or uncertain)	As this option relates to a river abstraction only, the study area is the River Axe waterbody from the abstraction location (ST423527) to the sluice at Brean Cross. The overall environmental impact is assessed as major due to the potential (but uncertain) for major adverse effects on eel (designated under Severn Estuary Ramsar site). The HRA also identified the potential for major adverse effects on populations of Greater and Lesser Horseshoe Bats (designated under the North Somerset and Mendip Bats SAC and the Mendip Limestone Grassland SAC).
	Level of confidence (H, M, L)	Low

	Supply side action	River Axe licence variation
	Summary of likely 'environmental impacts	There is no construction associated with this option. The operation of the River Axe licence variation is likely to lower water level and flow between the Axbridge abstraction location and the Brean Cross Sluice for two extra months compared to the baseline conditions. This will result in potentially a major (but uncertain) impact on eel, moderate impact on other fish species and aquatic macroinvertebrates and a minor impact to macrophytes during the duration of the permit. However, impact would not be long lasting, and is restricted by the minimum flow requirements in the licence which will minimise the magnitude of effects, including for foraging horseshoe bats. There would be no impact to water quality. The HRA identifies potential for impacts on interest features of the: ▪ Severn Estuary SAC and Ramsar - Major ▪ North Somerset and Mendip Bats SAC - Major ▪ Mendip Limestone Grassland SAC - Major Further work is required to assess whether upstream eel migration will be adversely affected during the months of October and May if lower flows in these two months reduces the ability of eel to pass in-stream barriers compared to the baseline conditions without the drought permit in place.
	Summary of baseline information used	The Environment Agency's Catchment Data Explorer, DEFRA Data Services Platform, Henley Gauge Flows, Aerial Imagery.
	Summary of additional monitoring required	A programme of monitoring to assess the effects of the drought permit and the recovery of the environment after the drought will be required, likely to include biological, hydrology and water quality monitoring. A one-off review of data on in-river barriers to upstream eel migration will also be required to address the uncertainty about the effects of the drought permit on eel.

	Supply side action	River Axe licence variation
	Summary of mitigation measures	Mitigation actions would be agreed with the Environment Agency and Natural England prior to the implementation of this option. If barriers to eel migration are identified due to low flows caused by the permit, monitoring may be required of upstream eel migration during drought permit implementation to direct any identified mitigation measures. The range of likely measures are included in Table C4.
	Permits/approvals needs for mitigation measures	In order to carry out the mitigation measures likely to be required, the Environment Agency has advised that we will need to apply for the following permits/approvals: • Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. • Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i.e. Wildlife Trusts, Rivers Trusts) in the context of the specific circumstances as a drought progresses.
	Impact on other activities for example fisheries, industry.	Low river levels and flows may affect the aesthetics of the area and reduce the aquatic habitats and associated species. However any impacts are not likely to be significant as any impacts would be temporary and river levels will be low during baseline conditions prior to drought permit implementation.

<table>
<tr><th></th><th>Supply side action</th><th>P08R licence variation</th></tr>
<tr><td rowspan="3">Supply side action information</td><td>Trigger/previous action</td><td>Drought – Entering drought management zone 5 (Level 3).</td></tr>
<tr><td>Deployable output of action</td><td>Estimated yield of c. 2Ml/d. This is based on a change to the authorised quantities of water to be abstracted at P08R when flow in the Ozleworth Brook is less than 13 Ml/d. Under the permit abstraction of up to 4.25Ml/d would be permitted when flows drop below 13Ml/d. The proposed changes to the licence are set out in the table below:

<table>
<tr><th>Gross flow of the Ozleworth Brook</th><th>Licenced maximum quantity authorised to be abstracted in any day (Ml/d)</th><th>Proposed permit condition for maximum quantity authorised to be abstracted in any day (Ml/d)</th></tr>
<tr><td>Less than 10</td><td>2.25</td><td>4.25</td></tr>
<tr><td>10</td><td>2.75</td><td>4.25</td></tr>
<tr><td>11</td><td>3.25</td><td>4.25</td></tr>
<tr><td>12</td><td>3.75</td><td>4.25</td></tr>
<tr><td>13</td><td>4.25</td><td>4.25</td></tr>
<tr><td>14</td><td>4.50</td><td>4.50</td></tr>
<tr><td>15</td><td>4.75</td><td>4.75</td></tr>
<tr><td>16</td><td>5.00</td><td>5.00</td></tr>
<tr><td>17</td><td>5.50</td><td>5.50</td></tr>
<tr><td>18</td><td>6.00</td><td>6.00</td></tr>
<tr><td>19</td><td>6.50</td><td>6.50</td></tr>
<tr><td>20</td><td>7.00</td><td>7.00</td></tr>
</table>

A drought permit could be applied for any time of year but is considered most likely in summer</td></tr>
<tr><td>Implementation timetable</td><td>Drought permit application preparation will be commenced when combined reservoir storage enters zone 4 (i.e. when TUBs are introduced).</td></tr>
</table>

	Supply side action	P08R licence variation
		If supporting up-to–date environmental assessment reports are available we anticipate that the application will be ready for submission and advertising within 2 weeks. We will provide 7 days written notice to organisations likely to be affected by the permit, advising that any objections should be made to the Environment Agency within 7 days of the notice being served. We will advertise the drought permit application in at least one local newspaper and the London Gazette. We assume EA will determine the drought permit application within 12 calendar days of the date of our last advertisement, if no objections are received, or 7 calendar days of the receipt of a hearing report if a hearing takes place. Once the drought permit is received we will advertise the successful application in the London Gazette and the same local newspaper where the application was advertised. The practical implementation of the option could be effective within 7 days. Drought permits are valid for up to 6 months and can be extended for a further 6 months. We will contact the EA at least 28 days before the existing permit expires if an extension is required.
	Permissions required and constraints	Drought Permit from the Environment Agency
	Risks associated with the option	Drought permit not being issued by the EA.

	Supply side action	P08R licence variation
Summary of environmental assessment	Overall environmental impact (minor, moderate, major or uncertain)	The overall environmental impact is assessed as major due to the potential major (but uncertain) effects on spawning of European designated river lamprey, European eel and sea trout.
	Level of confidence (H, M, L)	Low
	Summary of likely 'environmental impacts	There is no construction associated with this option. The operation of the P08R option is likely to lower water level and flow within the Ozleworth Brook from source until the confluence the Little Avon, and within the Little Avon to the tidal sluice due to a reduction in groundwater contribution from abstraction location and the headwaters. The likely seasonality of the drought option would require further investigation. Depending on season (most likely summer), operation may result in a major (but uncertain) impact on spawning river lamprey (European designated species), moderate impact to resident fish, invertebrates and minor impact to macrophytes within the Ozleworth Brook and Little Avon during the operation of the drought option and during subsequent recovery. There would not be impact to water quality. There would be a moderate impact to the dependant surface water body status. There would be a minor (temporary and local) impact to water balance within the Wells groundwater, not significant in the context the WFD waterbody.
	Summary of baseline information used	The Environment Agency's Catchment Data Explorer, DEFRA Data Services Platform, Gross Flow of the Ozleworth Brook Flows, Aerial Imagery.
	Summary of additional monitoring required	A programme of monitoring to assess the effects of the drought permit and the recovery of the environment after the drought will be required, likely to include biological, hydrology and water quality monitoring. Monitoring is required to assess the spawning habitat for river

	Supply side action	P08R licence variation
		lamprey to reduce the current uncertainty about the effects of the drought permit on river lamprey spawning.
	Summary of mitigation measures	Mitigation actions will be agreed with the Environment Agency and Natural England prior to the implementation of this option. The mitigation will be informed by our understanding gained from the baseline environmental monitoring data and information. The range of likely measures are included in Table C4..
	Permits/approvals needs for mitigation measures	In order to carry out the mitigation measures likely to be required, the Environment Agency has advised that we will need to apply for the following permits/approvals: • Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. • Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i.e. Wildlife Trusts, River Trusts) in the context of the specific circumstances as a drought progresses.
	Impact on other activities for example fisheries, industry.	Low river levels and flows may affect the aesthetics of the area and reduce the aquatic habitats and associated species. However any impacts are not likely to be significant as any impacts would be temporary and river levels will be low during baseline conditions prior to drought permit implementation.

	Supply side action	P05R licence variation (TBC)
Supply side action information	Trigger/previous action	Drought – Entering drought management zone 5 (Level 3).
	Deployable output of action	Estimated yield of 2.2Ml/d. This is based on a change to the minimum flow level that has to be maintained at the Kenn gauge for abstraction to continue. Under the licence conditions a flow of 4.41Ml/d at the Kenn gauge must be maintained. Under the permit conditions the minimum flow requirement at the Kenn gauge would be reduced to 2.21Ml/d.
	Implementation timetable	Drought permit application preparation will be commenced when combined reservoir storage enters zone 4 (i.e. when TUBs are introduced). If supporting up-to–date environmental assessment reports are available we anticipate that the application will be ready for submission and advertising within 2 weeks. We will provide 7 days written notice to organisations likely to be affected by the permit, advising that any objections should be made to the Environment Agency within 7 days of the notice being served. We will advertise the drought permit application in at least one local newspaper and the London Gazette. We assume EA will determine the drought permit application within 12 calendar days of the date of our last advertisement, if no objections are received, or 7 calendar days of the receipt of a hearing report if a hearing takes place. Once the drought permit is received we will advertise the successful application in the London Gazette and the same local newspaper where the application was advertised. The practical implementation of the option could be effective within 7 days.

	Supply side action	P05R licence variation (TBC)
		This drought option enables water to be abstracted at P05R Well for a longer period during dry conditions. Drought permits are valid for up to 6 months and can be extended for a further 6 months. We will contact the EA at least 28 days before the existing permit expires if an extension is required.
	Permissions required and constraints	Drought Permit from the Environment Agency
	Risks associated with the option	Drought permit not being issued by the EA.
Summary of environmental assessment	Overall environmental impact (minor, moderate, major or uncertain)	The overall impact is assessed as moderate.
	Level of confidence (H, M, L)	Low
	Summary of likely environmental impacts	There is no construction associated with this option. The operation of the P05R drought option is likely to reduce flows within the River Kenn from close to the source to the tidal sluice at North End due to a reduction in groundwater contribution to river flow. Levels within the Bristol Triassic would also be drawn down. Any flow reduction is likely to impact on river velocities due to the management of water level by

	Supply side action	P05R licence variation (TBC)
		weirs and other structures in the study area. These velocity effects could result in a moderate impact to fish and invertebrates within the River Kenn from source to Kenn Moor SSSI WFD water body, and a minor impact to macrophytes. Downstream there would continue to be a moderate impact to invertebrates within the Kenn SSSI WFD water body during the operation of the drought option and during subsequent recovery due to reduced flows. There would be water quality changes arising from a change in the proportional groundwater flow contribution and subsequent reduced dilution of surface water inputs. The impact to fish would be lower (minor) in the Kenn Moor SSSI WFD water body than upstream noting fish are already poor WFD status probably due to fish stocking. The flow impacts are temporary and do not extend over multiple years, and therefore will not result in adverse effects for foraging horseshoe bats. The abstraction is at the centre of a Source Protection Zone (SPZ) covering some of the Bristol Triassic WFD groundwater water body and Bristol Airport Carboniferous Limestone WFD groundwater water body. Review of WFD groundwater tests in these water bodies identified the potential for minor (temporary and local) impacts on the water balance; and negligible effects on saline intrusion or groundwater dependant terrestrial ecosystems. The overall environmental impact is assessed as major due to the potential major (but uncertain) effects on spawning of European designated river lamprey, European eel and sea trout. There are also potential major effects on greater and lesser horseshoe bats designated under North Somerset and Mendip Bats SAC.
	Summary of baseline information used	The Environment Agency's Catchment Data Explorer, DEFRA Data Services Platform, Aerial Imagery, Bristol Water AMP7 WINEP Abstraction Investigations Phase 1 Desk Study: P05R Well Desk Study.

	Supply side action	P05R licence variation (TBC)
	Summary of additional monitoring required	A programme of monitoring to assess the effects of the drought permit and the recovery of the environment after the drought will be required, likely to include biological, hydrology and water quality monitoring.
	Summary of mitigation measures	Mitigation actions will be agreed with the Environment Agency and Natural England prior to the implementation of this option. The mitigation will be informed by our understanding gained from the baseline environmental monitoring data and information. The range of likely measures are included in Table C4.
	Permits/approvals needs for mitigation measures	In order to carry out the mitigation measures likely to be required, the Environment Agency has advised that we will need to apply for the following permits/approvals: • Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. • Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i.e. Wildlife Trusts, River Trusts) in the context of the specific circumstances as a drought progresses.
	Impact on other activities for example fisheries, industry.	Low river levels and flows may affect the aesthetics of the area and reduce the aquatic habitats and associated species. However any impacts are not likely to be significant as any impacts would be temporary and river levels will be low during baseline conditions prior to drought permit implementation

	Supply side action	R24R Well
Supply side action information	Trigger/previous action	Drought – Entering drought management zone 4 (Level 2)
	Deployable output of action	2.4 Ml/d dry year annual average yield
	Implementation timetable	Up to 6 months including laying a new pipeline from the source to Cheddar. Some pre-planning feasibility work already carried out.
	Permissions required and constraints	The source is licensed for 4.11Ml/d annual average but has not been used for c. 20 years and we will have to give regard to the 'no deterioration' principle set out in the Water Framework Directive when considering changing the operation of the sources.
	Risks associated with the option	Water quality issues Timing of getting the source into supply in response to a drought situation
Summary of environmental assessment	Overall environmental impact (minor, moderate, major or uncertain)	The study area has been defined as the Axe catchment, from the source to Brean Cross Sluice; a tidal sluice gate, and the underlying Wells WFD waterbody. Also included is the Mendips WFD groundwater waterbody, in case of any hydraulic connectivity with the Wells groundwater waterbody. Additionally, the area surrounding the pipeline to Cheddar may be impacted and has been included for study. The HRA identifies potential for impacts on interest features of the North Somerset and Mendip Bats Special Area of Conservation (SAC) (Lesser horseshoe bat and Greater horseshoe bat) from construction of the pipeline. Unmitigated, the pipeline has potential to result in short-term, temporary habitat loss, habitat degradation and disturbance. Construction could also result in short term, localised effects on water quality in a number of rhynes that the pipeline would have to cross, which cannot be avoided but could be mitigated. Lower flows during operation of the source may also result in adverse effects on foraging habitat for these bat species.

	Supply side action	R24R Well
		The HRA identifies potential for adverse effects (But uncertain) on protected fish species of the (designated under Severn Estuary Ramsar site), including European eel, Atlantic salmon and sea trout. The HRA also identifies the potential for adverse effects upon waterbird assemblages within Somerset Levels and Moors SPA, including Bewick's swan (Non-breeding), Eurasian teal (Non-breeding), European golden plover (Non-breeding), Northern lapwing (Non-breeding) as well as shoveler, teal, wigeon, snipe, pintail, gadwall and whimbrel. The overall impact has been assessed as major due to the potential for major (but uncertain) impacts on the European designated horseshoe bats, both in relation to construction and operational effects on river flows which could impact on foraging habitat for the designated bat species.
	Level of confidence (H, M, L)	Low
	Summary of likely environmental impacts	A pipeline will be constructed from the source to Cheddar. Following best practice construction methods and mitigation. Abstraction from the source is likely to cause moderate impacts to fish and invertebrates, and minor impact on macrophytes within the River Axe downstream of the Stoke Brook confluence due to flow reduction caused by the abstractions. Any flow reduction is likely to impact on river velocities, rather than level, due to the management of water level by weirs and other structures in the River Axe. The HRA screening identified likely significant effects from the operation of the abstraction on European eel, Atlantic Salmon and sea trout.

	Supply side action	R24R Well
		There is potential for minor impacts to water quality (lead and its compounds) and supporting physicochemical quality elements (phosphate) within the River Axe due to reduced dilution capacity resulting from a reduced contribution to river flows from ground water input. The operation of the abstraction has the potential to cause a major impact to fish, invertebrates and macrophytes, localised to the Stoke Brook, due to derogated flows, completely removed flows or delayed flows depending on the seasonality of the drought option implementation however this is uncertain due to limited ecological records within the Stoke Brook. The HRA Screening identified likely significant effects from construction activity for the pipeline route and during operation of the source within a Bat Conservation Zone for the North Somerset and Mendip Bat SAC. Continued, multi-year abstraction from the source in a severe drought extending beyond 12 months could have an adverse effect on bat foraging habitat and a mitigation mechanism would be required in this situation. Construction could also impact on the foraging habitat and mitigation measures are required to avoid adverse effects on designated horseshoe bat species. Review of WFD groundwater tests in the Wells groundwater body identified the potential for minor (temporary and local) impacts on the water balance (and negligible effects on saline intrusion or groundwater dependant terrestrial ecosystems) if abstraction from R24R Well exceeds the natural overflow rate of the spring, depending on seasonality of the abstraction, noting that the spring stops flowing during dry periods. There would be no impact to the groundwater from the operation of the Wellhead spring abstraction.

	Supply side action	R24R Well
	Summary of baseline information used	The Environment Agency's Catchment Data Explorer, DEFRA Data Services Platform, Aerial Imagery, Bristol Water AMP7 WINEP Abstraction Investigations Phase 1 Desk Study: R24Ra Group Desk Study.
	Summary of additional monitoring required	A programme of monitoring to assess the effects of the drought permit and the recovery of the environment after the drought will be required, likely to include biological, hydrology and water quality monitoring.
	Summary of mitigation measures	Specific construction-related mitigation measures with respect to the North Somerset and Mendip Bats Special Area of Conservation (SAC) would be developed to avoid adverse effects on designated bat species in consultation with Natural England and the local planning authority. Owing to the nature of the works, bespoke mitigation is highly unlikely to be required. Mitigation measures may include: minor alterations to the pipeline alignment; trees with potential roosts would be avoided; hedgerows and linear features, such as rhynes are avoided through directional drilling; working in short sections to minimise the duration of temporary grassland loss; and habitat replacement (grassland) and maintenance. With these measures in place, it is considered that the adverse effects on the designated bat populations can be avoided but there is currently some uncertainty about this conclusion pending consultation with Natural England. Mitigation actions would be agreed with the Environment Agency, Natural England and the local planning authority (as applicable) prior to the implementation of this action. The mitigation would be informed by our understanding gained from the baseline environmental monitoring data and information. The range of likely measures are included in Table C4.
	Permits/approvals needs for mitigation measures	In order to carry out the mitigation measures likely to be required, the Environment Agency has advised that we will need to apply for the following permits/approvals:

	Supply side action	R24R Well
		• Environment Agency Section 27 authorisation under the Salmon and Freshwater Fisheries Act 1975. • Application to the Environment Agency for a Site Permit under the Keeping and Introduction of Fish Regulations 2015. The list of required permits/ approvals is indicative based on the anticipated mitigation measures, and not exhaustive. It will be reviewed in close liaison with EA, Natural England, the Local Authorities, landowners and relevant environmental groups (i.e. Wildlife Trusts, Rivers Trusts) in the context of the specific circumstances as a drought progresses.
	Impact on other activities for example fisheries, industry.	Low river levels and flows may affect the aesthetics of the area and reduce the aquatic habitats and associated species. However any impacts are not likely to be significant as any impacts would be temporary and river levels will be low during baseline conditions prior to drought permit implementation

Table C4 – Proposed mitigation measures for the environmental features identified in the environmental assessment.

Environmental Feature	Possible Mitigation Actions
All features	▪ Temporary reduction or cessation of the terms of the drought permit ▪ Protection of 'spate flows' (temporary increases in river flows following periods of rain can be important to flush sediment/pollutants from the system or promote fish passage). Where possible, the supply-side action could be temporarily reduced/suspended so that these spate flows are preferentially allowed to pass through the system)
Macrophyte community	▪ Consider measures to address identified point sources of nutrient loading. ▪ Operation of key flow control structures to maintain water levels in vulnerable reaches/water bodies where applicable. ▪ Consider possible in-stream measures or adjustments to improve habitat conditions

Environmental Feature	Possible Mitigation Actions
Rannunculus spp.	▪ Consider measures to address identified point sources of nutrient loading. ▪ Operation of key flow control structures to maintain water levels in key reaches/water bodies where applicable. ▪ Consider possible in-stream measures or adjustments to improve habitat conditions
Macroinvertebrate community	▪ Operation of key flow control structures to maintain water levels in vulnerable reaches/water bodies where applicable. ▪ Consider possible in-stream measures or adjustments to improve habitat conditions
White-clawed crayfish	▪ Consider crayfish rescue and relocation to pre identified location, ideally in same watercourse in an area not sensitive to further low flow pressure
Fish community	▪ Consider deployment of aeration equipment in key reaches/water bodies with critically low oxygen levels. Where this is not feasible (due to depth), other mitigation measures may be required such as fish-rescue, in-stream measures or consideration of increased flow utilising other sources. ▪ Consider provision of bird scarers to deter piscivorous birds at significant locations, if appropriate taking account of the balance between bird food supply and fish requirements ▪ Operation of key flow control structures to maintain water levels in vulnerable reaches/water bodies where applicable ▪ Consider possible in-stream measures or adjustments to improve habitat conditions ▪ Consider temporary or permanent measures to address any adverse effects on upstream eel migration at identified in-river barriers to eel migration ▪ In extreme cases, consider capture/rescue surveys for fish. Where fish are rescued, they would be released to more suitable areas of the catchment, but locations would need to be discussed with the Environment Agency to ensure compliance with the Keeping and Introduction of Fish Regulations 2015.

Appendix D

Draft drought permit application exercise documentation

Document included in this appendix:

1. Form WR80: Application for a drought permit
2. Draft drought permit application for Chew Reservoir – supporting information

Form WR80: Application for a drought permit

Application for a drought permit

Environment Agency

This application is made under section 79A Water Resources Act 1991 as amended by the Environment Act 1995.

Please read through this form and the drought permit guidelines before you fill the form in. Please write clearly in the answer spaces.

You should check joint guidelines from Defra, the Welsh Assembly Government and the Environment Agency on applications for drought permits **before** preparing the documents we ask you for and sending in your application. The guidance explains which documents we need with your application.

You can get guidance from https://www.gov.uk/guidance/apply-for-a-drought-permit

Contents

1 Company details

Company name
Bristol Water PLC

Registered office (address and postcode)
Bridgwater Road
Bristol

Postcode BS13 7AT

Contact address (if different from above)

Postcode

Contact name
Title (Mr, Mrs, Miss and so on) Mrs
First name Liz
Last name Cornwell

Position
Water Resources Manager

Contact numbers, please include the area code
Phone
Fax
Mobile 07766441519
Email liz.cornwell@bristolwater.co.uk

The above water company is a water undertaker and is applying for a drought permit with the terms set out in the attached draft drought permit.

2 Accompanying information

Please tick Yes to confirm which documents are included with this application, or tick N/A for any which don't apply.

1	A description of the proposal	Yes ☑	N/A ☐
2	A draft drought permit	Yes ☑	N/A ☐
3	A statement of reasons why you've applied	Yes ☑	N/A ☐
4	A location map	Yes ☑	N/A ☐
5	The navigation authority's permission	Yes ☐	N/A ☑
6	Notice(s) sent to local councils	Yes ☑	N/A ☐
7	Notice(s) sent to protected persons	Yes ☑	N/A ☐
8	Notice(s) sent to other water companies	Yes ☑	N/A ☐
9	Notice(s) sent to navigation authorities	Yes ☐	N/A ☑
10	Notice(s) on internal drainage boards	Yes ☐	N/A ☑
11	An advertisement you have put in a local newspaper (send the actual page which includes the advertisement or, if yet to be advertised, the date we can expect to recieve this)	Yes ☑	N/A ☐
12	An advertisement in the London Gazette (the date when the notice was or is to be advertised)	Yes ☑	N/A ☐
13	A description of arrangements for public inspection of application (where and when this took place)	Yes ☑	N/A ☐
14	A current abstraction licence	Yes ☑	N/A ☐
15	A statutory instrument (government order) or local Act of Parliament	Yes ☑	N/A ☐
16	A water-shortage strategy	Yes ☑	N/A ☐
17	An environmental report	Yes ☑	N/A ☐
18	Water quality information, (if we suggest using water from a new source for a public supply)	Yes ☐	N/A ☑
19	Comments you have received from anyone you have consulted about the application	Yes ☑	N/A ☐
20	Any objections you have received or details of anything you have agreed with objectors	Yes ☑	N/A ☐

Form WR80: Application for a drought permit

3 The Data Protection Act 1998

We, the Environment Agency, will process the information you provide so that we can:

- deal with your application;
- make sure you keep to the conditions of the licence, permit or registration; and
- process renewals.

We may also process or release the information to:

- offer you documents or services relating to environmental matters;
- consult the public, public organisations and other organisations (for example, the Health and Safety Executive, local councils, the emergency services, the Department for Environment, Food and Rural Affairs) on environmental issues;
- carry out research and development work on environmental issues;
- prevent anyone from breaking environmental law, investigate cases where environmental law may have been broken, and take any action that is needed;
- assess whether customers are satisfied with our service, and to improve our service; and
- respond to requests for information under the Freedom of Information Act 2000 and the Environmental Information Regulations 2004 (if the Data Protection Act allows).

We may pass the information on to our agents or representatives to do these things for us.

4 Freedom of information

Please note that the information you supply to us is potentially disclosable under the Freedom of Information Act 2000 and/or Environmental Information Regulations 2004.

5 Declaration

If you make a statement that is false or misleading, you may be committing an offence under Section 206 Water Resources Act 1991.

I declare that as far as I know and believe, the information in this application is true. I understand that this application may be refused, or approval withdrawn, if I give false or incomplete information.

Tick this box to confirm that you understand and agree with the declaration above. ☑

Name

Title (Mr, Mrs, Miss and so on) Mr

First name Mel

Last name Karam

Position

CEO

Today's date (DD/MM/YYYY)

12/02/2021

6 How to contact us

If you need help filling in this form, please contact the person who sent it to you or contact us as shown below.

General enquiries: 03708 506 506 (Monday to Friday, 8am to 6pm)

Minicom service (for the hard of hearing): 03702 422 549 (Monday to Friday, 8am to 6pm)

E-mail: enquiries@environment-agency.gov.uk

Website: https://www.gov.uk/government/organisations/environment-agency

If you are happy with our service, please tell us. It helps us to identify good practice and encourages our staff. If you're not happy with our service, please tell us how we can improve it.

Please tell us if you need information in a different language or format (for example, in large print) so we can keep in touch with you more easily.

Crystal Mark 18853
Clarity approved by Plain English Campaign

For Environment Agency use only

Date received (DD/MM/YYYY)

Our reference number

WR80 Version 2, June 2017 page 2 of 2

HR Wallingford
Working with water

Hydro-Logic Services

Draft Drought Permit Application for Chew Reservoir

Supporting Information

FWM8785-RT001-R02-00

March 2021

Document information

Document permissions	Confidential - client
Project number	FWM8785
Project name	Draft Drought Permit Application for Chew Reservoir
Report title	Supporting Information
Report number	RT001
Release number	R02-00
Report date	March 2021
Client	Bristol Water Plc
Client representative	Liz Cornwell
Project manager	Claire Robertson
Project director	Andrew Ball

Document authorisation

Prepared	Approved	Authorised

Document history

Date	Release	Prepared	Approved	Authorised	Notes
26 Mar 2021	02-00	CLR	ABL	ABL	Addressing Environment Agency comments on mock exercise.
12 Feb 2021	01-00	CLR	ABL	ABL	

Background to the mock drought permit application

This document is a mock application for a Drought Permit prepared by Bristol Water, following liaison with the Environment Agency as part of consultation for Drought Plan 2022. The application is intended to demonstrate that Bristol Water is 'permit ready', should a situation arise where a drought application would be necessary. The mock drought permit application is made in connection to Bristol Water's Chew Reservoir abstraction licence, and seeks to vary the requirement for compensation flow releases to the River Chew, which form part of the licence conditions. The permit would be required to secure Public Water Supplies in the Bristol Water supply area if an extreme shortage of rainfall and associated risk to supply would be affecting its supply area.

This document sets out the case of need for the permit, including meeting the requirement that there has been an exceptional shortage of rain (ESoR) and there is a threat to supplies. The document should only be used for the purpose for which it was intended, which is to prepare a mock drought permit application for inclusion in Bristol Water's next drought plan.

The supporting information contained in this document follows the structure suggested in Appendix E of the Drought Orders and Permits Guidelines issued by the Environment Agency in 2020. As such, it includes a draft of the Notice for the Chew Reservoir Drought Permit Application, as well as a completed drought permit application form (WR80)[2]. Bristol Water maintains shelf copies of the Environmental Assessment Report (EAR), including a Monitoring and Mitigation Plan for this Drought Permit, which would be updated and submitted in a real drought; however the mock application does not include a copy of this EAR, a placeholder for this document has been created as Appendix D.

The document's narrative is constructed to represent a real scenario, however, whilst some of the data within this document is correct, some of it, especially the rainfall sequences have been generated to present a drought situation. Throughout the document there are placeholders for text and graphical inputs which would be required in a real application, for some of these it was not possible to recreate with fictitious data for this exercise. Text placeholders are in grey text boxes, while placeholders for graphs and charts are displayed by a white figure box. Where values are not available but included in text, red bold font has been used to highlight a necessary change. Footnotes have also been included for clarity surrounding some of the data, particularly during the ESoR.

An annotated operational control curve has been included as Figure S.1. This highlights when Bristol Water would intend to contact stakeholders and submit the drought permit application under this mock exercise drought scenario. This can be used as guidance to follow the procedure followed in this document.

The document is structured as follows:

- The Intended Drought Permit and a description of the proposals are presented in Section 3.
- The Statement of Need and supporting analysis to demonstrate a threat to customer supplies arising from an ESoR is presented in Section 4.

[2] Exercise Note: This form has been submitted separately for this exercise. The form has been completed as if it were a real application but would be included as an appendix in a real application.

- The evidence that Bristol Water has followed its Drought Plan, and the measures taken to reduce demand and conserve supplies is presented in Section 5.
- A copy of the Drought Permit Application Notice along with a list of the parties upon which this notice would be served is included in Appendix 7.1.1.1.1.
- Analysis supporting the ESoR case is included in Appendix 7.1.1.1.2.
- The drought permit application notice published in the London Gazette is in Appendix 7.1.1.1.3.
- The Environmental Assessment Report is in Appendix 7.1.1.1.4.
- The information on the utilisation of the company's abstraction licences for the past **[X]** years is presented in Appendix 7.1.1.1.5.
- Information on demand profiling is presented in Appendix 7.1.1.1.6.

Placeholder

List to be supplemented with additional appendices at the time of application, as required

Placeholder

This application will need updating at the time of a real application, based on the scenario experienced and the WRMP and DP in force at the time. The structure and text existing in this mock exercise can be used as a guide for similar formats but not every section will be relevant to a real application.

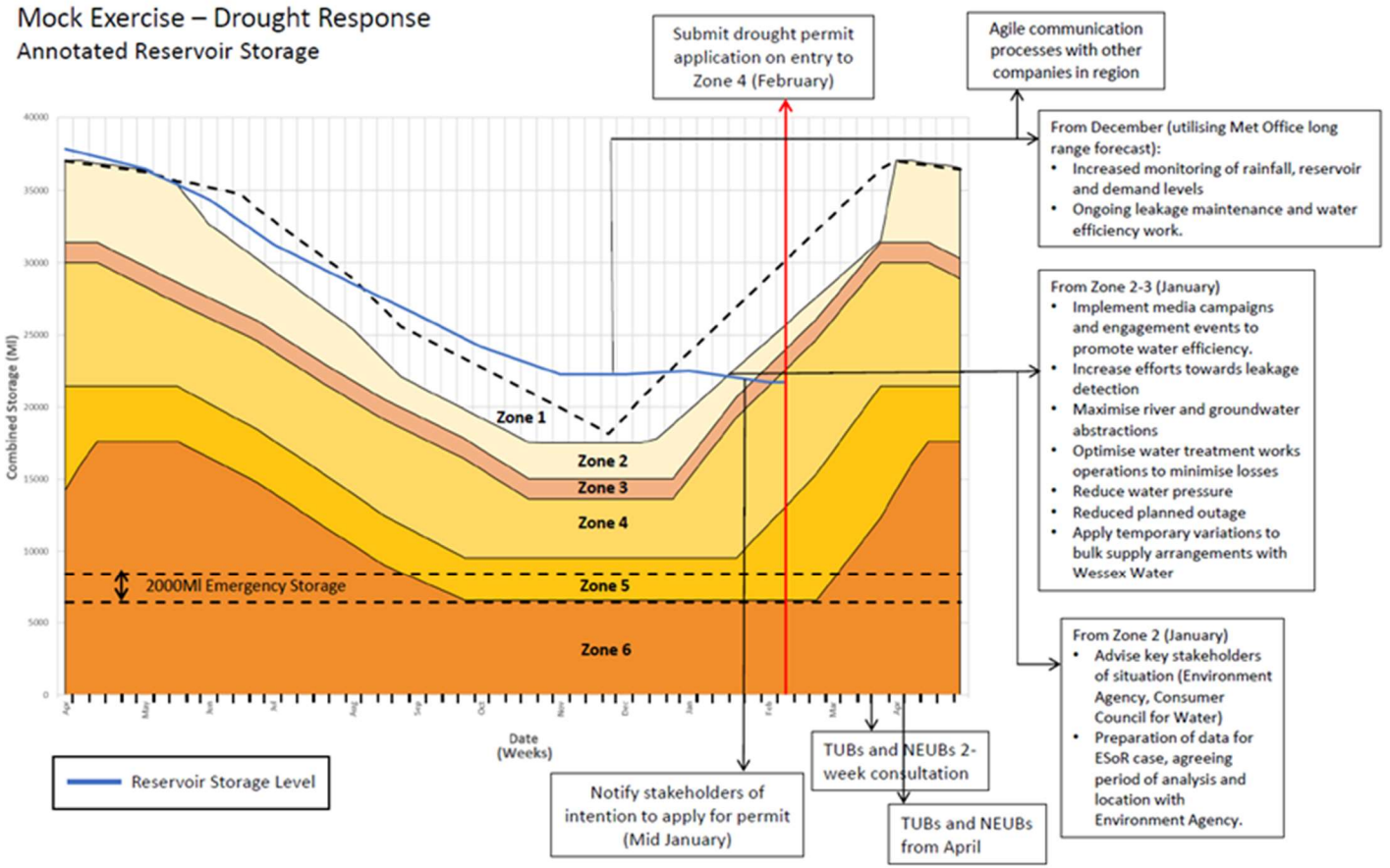


Figure S.1: Annotated Operational Control Curves – Reservoir levels specific to the drought simulated for this mock exercise

Contents

Figures

Tables

2 Overview of Bristol Water's supply area

Bristol Water's supply area covers 2,400 square kilometres (1,000 square miles) and includes a population of almost 1.23 million people. Bristol Water's supply area ranges from Thornbury and Tetbury in the north to Street and Glastonbury in the south, and from Weston-Super-Mare in the west to Frome in the east. Water resource planning is undertaken at water resource zone (WRZ) level. A WRZ is defined as the largest possible area in which all resources, including external transfers, can be shared and hence the zone is which all customers experience the same risk of supply failure from a resource shortfall. Due to the integrated nature of Bristol Water's sources, the company plans on the basis of operating the company area as a single WRZ. This means that all water resources within the company area are capable of being shared within the zone. Bristol Water uses the same WRZ for operational management, water resource planning and drought planning.

2.1 Sources of supply from within Bristol Water's supply area

Only around half of the water supplied by Bristol Water is sourced from within the company's supply area, with the rest being transferred into the zone from outside the area. The intrinsic water resources within the WRZ include Bristol Water's Mendip Reservoirs and associated surface water abstractions, which account for approximately 42% of the available licensed resource. The remaining water sourced from within the supply area is derived from groundwater and accounts for approximately 12% of the available licensed resource. These sources are operated at their optimum output to meet the base-load demand for water.

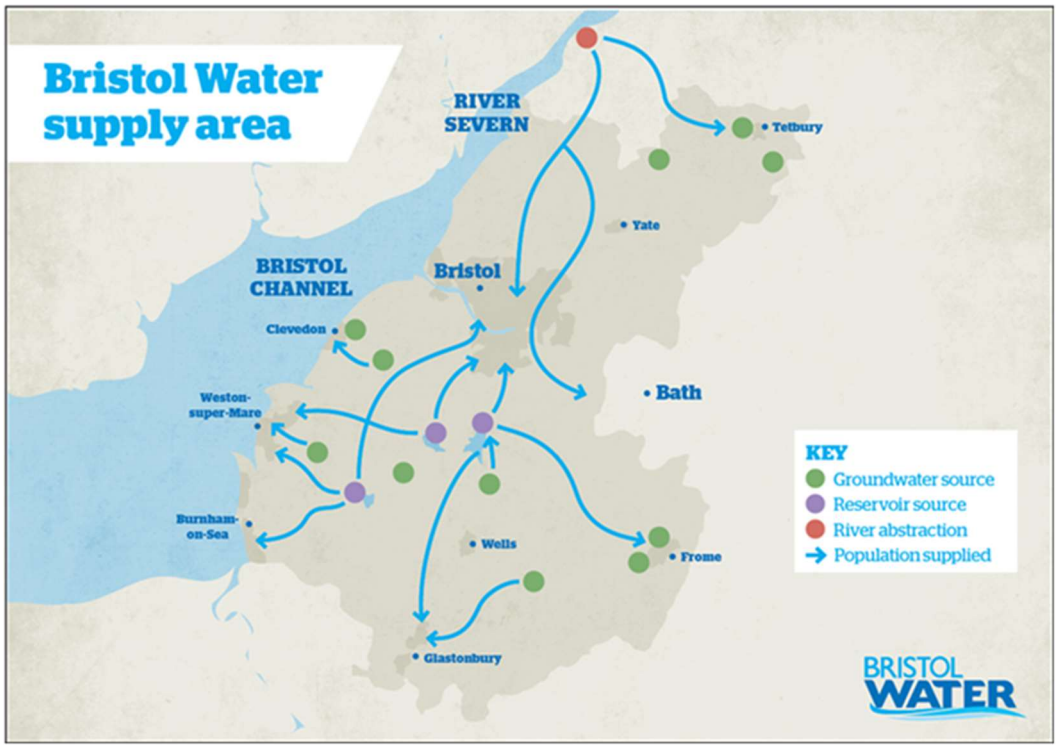


Figure 2.1: Bristol Water supply area

1.1. External sources of supply

Approximately 46% of Bristol Water's water supply is sourced from the Gloucester & Sharpness Canal to supply its largest northern treatment works. The Gloucester & Sharpness Canal is owned and operated by the Canal & River Trust and is supplied by the River Severn and other local rivers (the Cam and the Frome). In dry periods, use of this source is maximised to conserve the water stored in the reservoirs; this is an action Bristol Water has already undertaken when it entered Zone 2, as part of optimising the use of its resources.

1.2. Bulk exports to other Water Companies

Bristol Water has a supply agreement with Wessex Water to provide up to 11.37Ml/d of water via a treated water pipeline to the city of Bath. In the company's WRMP2014 and WRMP2019, it included an option to reduce this supply to 4.40Ml/d in a developing drought (Zone 3). It has already reduced this bulk export to Wessex Water, thus retaining an additional available resource of 6.97Ml/d. Given that is has now entered Zone 4 (drought), we are further considering the feasibility of reducing the supply further and is in liaison with Wessex Water and the Environment Agency to ensure the most efficient use of water within the region. Any agreed reduction would be maintained throughout Zone 5 (drought).

3 Draft Drought Permit

3.1 Bristol Water's abstraction licence

Bristol Water has a licence (number 17/53/14/S/016) to abstract water under the Water Resources Act 1991 at Chew Reservoir. The licence also authorises two stream capture systems which permit the transfer of stream flows into Chew Reservoir from outside the reservoir's natural catchment area. These are Chew Stoke Stream and Winford Brook (impounded at Chew Magna Reservoir), both tributaries of the River Chew.

Abstraction for public water supply is made directly from Chew Reservoir and piped by gravity to Chew Stoke Pumping Station. From there water is pumped into storage at Barrow or direct to Bristol Water's treatment works at Stowey. When the reservoir is full and overflowing, the excess water flows into the River Chew immediately downstream of the reservoir.

The abstraction licence from Chew Reservoir includes the following conditions:

- A daily maximum abstraction of 113.65Ml/d (million litres per day).
- An annual limit of 22,000Ml (1 April to 31 March).

For the River Chew, the licence requires a compensation release downstream of the Chew Reservoir impoundment (see Figure 3.1, NGR ST570616) of:

- 14.32Ml/d during the period 1 May to 30 November.

and

- 6.819Ml/d between 1 December to 30 April.

At Chew Magna Reservoir, the licence requires the continuous, uniform release of compensation water to the Winford Brook downstream of the Chew Magna Reservoir impoundment of:

- 3.41Ml/d during the period 1 May to 31 September.

and

- 2.273Ml/d at other times.

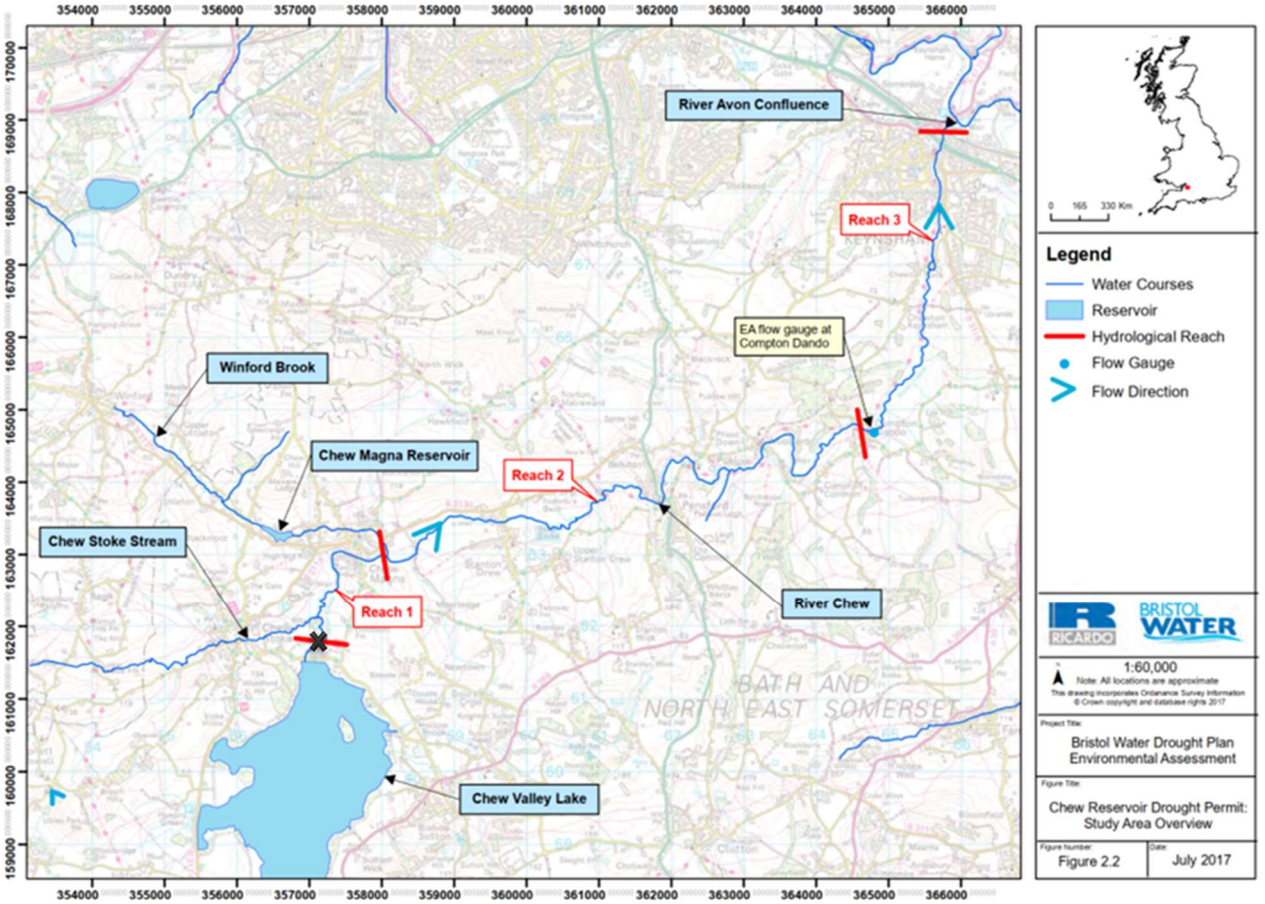


Figure 3.1: Location of compensation flow releases to River Chew (represented by a black 'x' sign) and the river reaches affected by the implementation of the permit (WMRP19 Submission)

3.2 Current monitoring requirements

In line with the recommendations of the Monitoring and Mitigation Plans developed for the three drought permit sites included in Bristol Water's Drought Plan 2018 submission, Bristol Water has been conducting baseline environmental monitoring to fill data gaps identified during the environmental assessment process and to ensure a robust baseline data set exists to enable assessment of impacts arising from the implementation of its drought permit options.

For Chew Reservoir, the permanent baseline monitoring commenced in 2018 and has progressed further in 2019 and 2020, detailing the baseline environmental conditions (hydrology, water quality and ecology indicators) for the River Chew. Monitoring in May and November 2020 were completed, but July was missed partly due to a change in contractors and COVID restrictions. In 2021 the invertebrates will be monitored and the EAR will be amended accordingly. The Drought Permit EAR undertaken for Chew Reservoir has therefore been updated to account for the newly gathered baseline data. A copy of the EAR (including the updated Monitoring and Mitigation Plan) is included with this submission.

In addition to the baseline monitoring data, Bristol Water has an AMP6 National Environment Programme commitment (reference 6BW10002) to gather environmental data and assess the impacts of Chew Valley Reservoir (the impoundments and their operation) on ecology in the downstream Water Framework Directive (WFD) Heavily Modified Water Body (HMWB), the River Chew. Depending on the assessed impacts, Bristol Water must also undertake options appraisal and adaptive management trials of mitigation measures to reduce impacts. These adaptive management trials include changes to the compensation flows from the reservoir. Bristol Water has already started implementing the compensation flow trials in December 2018 and these are likely to lead to improvements in ecological quality. However, any amendments to the current uniform compensation flow regime (outlined in the previous section) will not be legally binding until included in a revised abstraction licence or management agreement for Chew Reservoir. Therefore, this drought permit application is made against the current licence conditions, which will remain in place until any changes to the abstraction licence or a management agreement is agreed with the Environment Agency.

3.3 The intended permit

Bristol Water published its latest Drought Plan on 21st June 2018. This drought plan contains several supply-side options, including the Chew Reservoir drought permit. The Chew Reservoir drought permit will not be implemented until reservoir storage enters drought action Zone 5. In line with the Drought Plan, in the period up to when the drought permit is required, Bristol Water will implement demand side and supply side drought actions in an attempt to decrease water demand, preserve reservoir stocks and delay the application for a drought permit and the length of time the permit is required.

The proposed drought permit involves an amendment to the abstraction licence to temporarily reduce the compensation flow requirement for the River Chew. The implementation of the drought permit would therefore entail:

- A reduction in summer compensation flows of 7.32 Ml/d (51%) between May and November, resulting in a residual compensation flow of 7 Ml/d to the River Chew, for this period.
- A reduction in winter compensation flows of 3.419 Ml/d (50%) between December and April, resulting in a residual compensation flow of 3.4 Ml/d to the River Chew, for this period.

The proposed drought permit is intended to apply for a period of six months from the date of determination (anticipated mid-March 2021). Therefore, the permit is expected to cease by mid-September 2021. However, if hydrological conditions are favourable and reservoir stocks can increase to a level where Bristol Water supplies are no longer threatened before this date, the company would return to the usual compensation flow release regime stated in the abstraction licence. On the other hand, if conditions do not improve, Bristol Water would consult with the Environment Agency with a view to seek an extension to this drought permit.

Placeholder

At the time of writing this draft application, Bristol Water is undertaking adaptive trials for compensation releases at Chew Reservoir. Should the new compensation regime become legally binding before a real drought permit application is lodged, the drought permit will need to be revised in light of the new compensation requirement.

The statutory compensation requirements as well as the actual compensation made by Bristol Water to the River Chew are shown in Table 3.1.

Placeholder

Text needed here to include comparative analysis of statutory and actual releases to ascertain whether Bristol Water have released less or more than the statutory requirement over the past 12 months. The table may need amendments to include a longer period

A list of drought actions implemented to date, along with the actions to be implemented in the coming weeks and months (if the drought situation progresses) is provided in Section 5.

Table 3.1: Placeholder table

Compensation	Mar xxxx	Apr xxxx	May xxxx	Jun xxxx	Jul xxxx	Aug xxxx	Sep xxxx	Oct xxxx	Nov xxxx	Dec xxxx	Jan xxxx	Feb xxxx
Statutory requirement (Ml/d)	6.819	6.819	14.32	14.32	14.32	14.32	14.32	14.32	14.32	6.819	6.819	6.819
Actual amount released (Ml/d)	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx

3.4 Summary of drought permit impacts

Placeholder

This section will need to be updated for a real application in light of the assessments that would be made based on additional baseline monitoring data acquired since 2018. The narrative here is based on the EAR completed for DP18.

Bristol Water completed EARs for all drought permit options included in its Drought Plan 2018, including Chew Reservoir. In accordance with the Environment Agency's drought plan guidance, it conducted:

- An assessment of the hydrological or hydrogeological effects of the proposed action.
- An assessment of the environmental sensitivity of the affected areas.
- The identification of mitigation or compensation measures for impacted features.
- The development of an environmental monitoring plan.

Bristol Water developed its environmental monitoring plan and mitigation measures in consultation with the Environment Agency and Natural England. These monitoring plans set out the proposed baseline, in-drought and post-drought monitoring requirements and the proposed mitigation measures to be undertaken to reduce any adverse impacts resulting from the implementation of these drought permit options.

The following sections summarise the assessment of impacts likely to arise from the implementation of this drought permit. Details of the monitoring and mitigation measures to be implemented during the duration of the drought permit are detailed in the EAR.

In summary, it has been concluded that the environmental effects on river flows and ecology of implementing a drought permit at Chew Reservoir, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions with the onset of a natural drought, would be major. No cumulative effects of implementing the drought permit with existing licences, consents and plans are currently anticipated.

3.4.1 Hydrological and physical environmental impacts

The detailed hydrological and physical environmental assessment can be found in the EAR. The only waterbody affected by the implementation is the River Chew, which, for the purpose of the environmental assessment, has been divided in three reaches (see Figure 3.1). The potential effects of the drought permit implementation have been assessed considering the reduction in compensation flows during both winter and summer, as follows:

Reach 1 – Chew Valley Reservoir to Winford Brook Confluence

- Major impact on river flows in this reach during both summer and winter.

Reach 2 – Winford Brook Confluence to Chew at Compton Dando

- Major impact on river flows during summer and minor impact during winter.

Reach 3 – Chew at Compton Dando to River Avon

- Major impact on river flows in summer and minor impacts in winter.

With reference to the same river reaches outlined above, the impact on river geomorphology and habitat availability has been assessed as moderate for Reach 1 and Reach 2 and minor for Reach 3, during both summer and winter.

3.4.2 Water quality impact

The EAR identified the likely water quality impacts of this drought permit option (both individually and in-combination) based around the risk of deterioration in Water Framework Directive (WFD) waterbody status classification for several water quality indicators. The potential effects on river water quality are detailed in the EAR and can be summarised as follows:

Reach 1 – Chew Valley Reservoir to Winford Brook Confluence:

- Low risk for dissolved oxygen, medium risk for ammonia and high risk to soluble reactive phosphorus concentrations during summer.
- Negligible risk for dissolved oxygen, low risk for ammonia and medium risk to soluble reactive phosphorus concentrations during winter.

Reach 2 – Winford Brook Confluence to Chew at Compton Dando:

- Low risk for dissolved oxygen and ammonia and medium risk for soluble reactive phosphorus concentrations during summer.
- Negligible risk for dissolved oxygen, negligible risk for ammonia and low risk to soluble reactive phosphorus concentrations during winter.

Reach 3 – Chew at Compton Dando to River Avon:

- Low risk for dissolved oxygen and ammonia and medium risk for soluble reactive phosphorus concentration during summer.
- Negligible risk for dissolved oxygen, negligible risk for ammonia and low risk to soluble reactive phosphorus concentration during winter.

3.4.3 Impacts on sensitive features

Screening of environmental features has been carried out to identify sensitive features likely to be subject to a major or moderate impact, or a minor impact for designated features, due to implementation
of the Chew Reservoir drought permit. These features, together with “uncertain” findings from the screening exercise, were subject to a more detailed assessment. Detailed assessment is neither required
nor included for features where the screening has identified a minor (undesignated) or negligible impact.
Most designated sites within the drought permit’s zone of influence are Sites of Special Scientific Interest (SSSI) & Local Wildlife Sites (LWS) that were assessed as not having the potential to be

significantly impacted by the drought permit implementation, except for the River Chew and adjacent land LWS. Potential impacts have been highlighted on the ecological community (fish, macroinvertebrates and macrophytes) as well as some NERC Section 41 Species and Notable Species. Details surrounding the magnitude and significance of impacts on these features are presented in Appendix D of the EAR.
The potential effects of the drought permit on designated sites are detailed in the EAR and can be summarised as follows:

River Chew and adjacent land LWS:

- Impacts of minor significance related to the reduction in wetted area and velocities as well as changes in habitat quality and extent due to decreased water levels.

The potential effects of the drought permit on NERC Section 41 Species, Notable Species and Species of Principal Importance are detailed in the EAR and can be summarised as follows.

NERC Section 41 Species and Notable Species

- Impacts of minor (winter) - moderate (summer) significance on water crowfoot.
- Impacts of minor significance on macroinvertebrates (riffle beetle and least water snipefly).
- Impacts of minor significance on brown/sea trout, Atlantic salmon and brook lamprey.
- Impacts of moderate significance on river lamprey and European eel.

NERC Section 41 Species of Principal Importance:

- Impacts of moderate (Reach 1) and minor significance (reach 2) on white clawed crayfish.

3.4.4 Risk of deterioration to WFD ecological status

The potential impacts arising from the implementation of the Chew Reservoir drought permit on the macrophyte community, freshwater fish and macroinvertebrates are detailed in the EAR and summarised as follows:

Macrophytes:

- low risk of WFD status deterioration in winter and medium risk in summer.

Macroinvertebrates:

- medium risk of WFD status deterioration in winter for Reach 1 and low for Reach 2 and reach 3; medium risk of WFD status deterioration for all reaches during summer.

Freshwater fish:

- medium risk of WFD status deterioration in winter for Reach 1 and low for Reach 2 and reach 3; medium risk of WFD status deterioration for all reaches during summer.

4 Statement of Need for a Drought Permit

This drought permit application is necessary due to an exceptional shortage of rain threatening a serious deficiency of supplies of water in the area supplied by Bristol Water. A summary of the ESoR findings is provided in Section 4.4, with the full analysis contained in Appendix 7.1.1.1.2.

4.1 Why Bristol Water needs a drought permit

Placeholder

This section will need to be updated according to the situation experienced at the time of the application. The text in this section is based on a fictitious scenario which instigated a drought permit application in February 2021.

In preparing the Water Resource Management Plan 2019 (WRMP19), Bristol Water undertook a drought vulnerability assessment, to assess the resilience of the supply area to a range of drought events.

Bristol Water's single WRZ is highly interconnected and the Mendip Reservoirs are managed as a single unit. Analysis has shown Bristol Water's supply system is particularly resilient to single year drought events for the base year, coping with 12-month events of 35% of LTA rainfall without effect, well beyond the historic record and the 1 in 1000 likelihood contour. However, the supply system is more sensitive to the 18- and 24-month duration droughts. This reflects the fact that, under such conditions, reservoir refill is limited in the winter months and not fully recovering before the drawdown in the following summer.

Since November 2019, rainfall totals in the Mendip Reservoir catchments have been 47% of the long-term average (LTA). This means that the reservoirs did not refill as expected over the winter of 2020 and stocks have depleted rapidly during the summer of 2020, when Bristol Water experienced high customer demand due to a period of dry weather and high temperatures (see Figure 4.1).

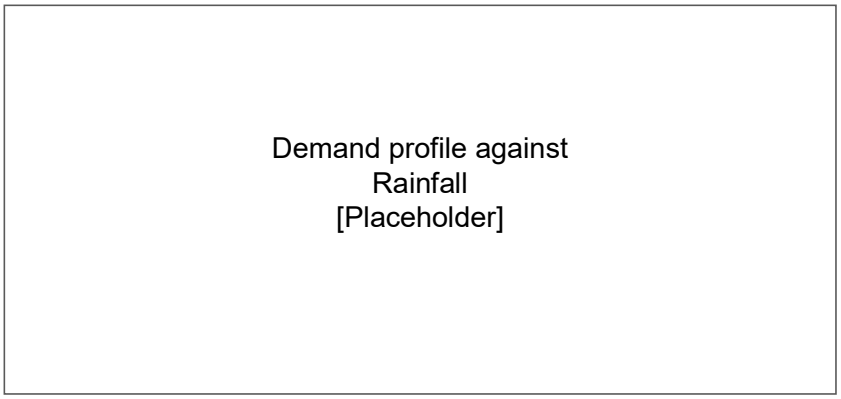


Figure 4.1: Demand profile plotted against rainfall (November 2019-January 2021)

Reservoir storage levels crossed into 'Zone 2' on Bristol Water's operational control curves in early January 2020 as the rainfall deficit continued to persist (see Section 4.6). This triggered additional activity to manage water resources (see Section 5 for details) such as reducing reservoir storage use and maximising the use of the River Axe and River Severn sources, along with the groundwater abstractions. Concomitantly, Bristol Water have deployed media campaigns as part of its Agile communication strategy, to raise awareness and appeal for voluntary restraint. At this time, Bristol Water has also instigated discussions with Wessex Water to assess the feasibility of reducing the transfer to Wessex Water.

By mid-January the drought had crossed into 'Zone 3' and Bristol Water deployed a full-scale publicity and media campaign which is expected to result in a reduction in household demand of 1%. Bristol Water also increased its efforts to detect and fix leaks (see details in Section 5.3), which are anticipated to result in a benefit of 2 Ml/d once complete. In agreement with Wessex Water, Bristol Water has reduced the transfer to 4.4 Ml/d, achieving a benefit to supply of 6.97 Ml/d.

The drought has now entered 'Zone 4' and the company is continuing all the demand side and supply side activities implemented in 'Zone 3'. In addition to this, it has now initiated the work required to put R24R back into supply (see details in Section 4.7.2), although the benefits derived from this source are not expected to have an impact on the resource position for another 6 months. The Company is also starting to prepare for TUBs implementation in April, with a view to hold public consultation in mid-March (see details in Section 5.6.).

Given that the dry weather and insufficient rainfall amounts continue to affect the supply area, the reservoir stocks continue to deplete and forecasts anticipate that there will be limited rainfall in the coming months. This means that the recharge period will be over and there will not have been sufficient rainfall for the reservoirs to recover before the drawdown period. The drought conditions being experienced now are more severe than any recorded historic event and it is forecast that by early March, the drought will enter Zone 5.

The threat to supplies can be viewed in the context of the supply - demand balance scenarios considered in the water resources management plan. The main supply demand components and resultant balance are summarised in Section 4.5.

The current situation presents a threat to supplies and therefore, Bristol Water are lodging this application for a drought permit at Chew Reservoir.

4.2 The benefits of the permit

Bristol Water's supply area covers 2,400 square kilometres (1,000 square miles) and includes a population of almost 1.23 million people. Due to the integrated nature of Bristol Water's sources, the company plans on the basis of operating the company area as a single WRZ. Within this WRZ all customers experience the same risk of supply failure from a resource shortfall.

Having this permit in place would allow the company to rebalance reservoir stocks to ensure that it can continue to supply customers in the coming weeks and months before it is able to further reduce demand by implementing TUBs and NEUBs. Long range forecasts suggest a continued rainfall deficit approaching the summer and reservoir levels will be unable to recover until the next winter recharge period. This permit would allow the company to put an additional 3.42 Ml/d

into supply between mid-March and the end of April and an additional 7.32 Ml/d between May and September.

Placeholder
Text needed here to elaborate on the benefits achieved in light of demand graph above (Figure 4.1)]

4.3 Drought indicators

Bristol Water monitor the water resource situation throughout the year across its operating area as part of the day-to-day operations. As well as providing the resource information required to manage its operations, this monitoring also ensures that it is aware of the onset of drought and has the opportunity for timely action. The indicators that Bristol Water use to identify and measure the onset of drought in its operating area are described in the sections below with supporting headline analysis for the existing scenario.

Placeholder
Further information would be entered in each section to show what analysis has been completed for a real application.

4.3.1 Rainfall

Rainfall is monitored at six locations across the supply area, including a site close to the Chew Reservoir (Chew Stoke PS), which is the location of the drought permit. Rainfall is monitored on a weekly basis, but in times of a drought, like the company are currently experiencing, this rainfall is being more closely monitored.
In addition to this, Bristol Water has access to other rainfall datasets (daily and monthly rainfall totals) from the Environment Agency which help contextualise and better analyse the position and provides evidence used in the ESoR. In order to support the drought monitoring, this data is requested more frequently during a drought and since entering Zone 2, Bristol Water have requested this data at weekly intervals.
Both storage gauges and tipping bucket gauges are used to collect data. Table 4.1 summarises the record at each of the seven sites. A full analysis comparing recent rainfall compared to LTA is presented in Section 4.4.

Table 4.1: Bristol Water rain gauges

Rain gauge location	Period of Record	
	Storage Gauge	Tipping bucket gauge
Chew Stoke PS	1984-2020	1996-2021
Barrow	1960-2020	2014-2021
Litton	1909-2020	2014-2021
Pucklechurch	2007-2020	2002-2021

Rain gauge location	Period of Record	
Purton	1996-2020	2014-2021
Shipton Moyne	1985-2020	2014-2021

4.3.2 River Flows

The Environment Agency monitors river flows across England via a network of river gauging stations and reports monthly data in their 'Monthly Water Situation Reports'. As well as monthly mean flow, data is also presented as a percentage of LTA for the reporting month and given a classification on a scale from Exceptionally Low to Exceptionally High. Reviewing this data enables the company to quickly identify if river flows are receding in response to low rainfall and the onset of potential drought conditions.

Given the rainfall shortages in the supply area since November 2019, the rivers that sustain supplies and particularly those used to refill the company's reservoirs, have been reported as 'below normal' and more recently, 'notably low'. In response to this, Bristol Water has requested provision of data on a weekly basis from the Environment Agency since entering Zone 2, in order to monitor the ongoing conditions within the catchment.

Table 4.2 lists the gauging stations that are used to monitor the response of the river catchments.

Table 4.2: River gauging stations used by Bristol Water

Gauging station name	Gaugin station number	River	Associated Bristol Water Source	Period of record
Bewdley	54001	Severn	Gloucester & Sharpness canal at Purton	1921 to present day
Deerhurst	54110	Severn	Gloucester & Sharpness canal at Purton	1995 to present day
Iwood	52017	Congresbury Yeo	Blagdon Reservoir	1973 to present day
Compton Dando	53004	Chew	Chew Valley Lake	1958 to present day
Wookey	52001	Axe	River Axe & Cheddar Reservoir	1958 to present day

Placeholder

River Flows headline analysis. This section requires some discussion about the river flows of relevant rivers. As part of this exercise a hydrograph has been included to compare the LTA Chew Inflows, against the current flows. In a real application, only hydrographs of rivers with gauged data can be measured.

Figure 4.2 highlights the flows for the River Chew are significantly lower than the long-term average (LTA) for this river. The flows noticeably reduce towards the end of 2019 and remain low until present-day. The flow duration curves included in Figure 4.3 also demonstrates the low flows that have been experienced over the past 15 months.

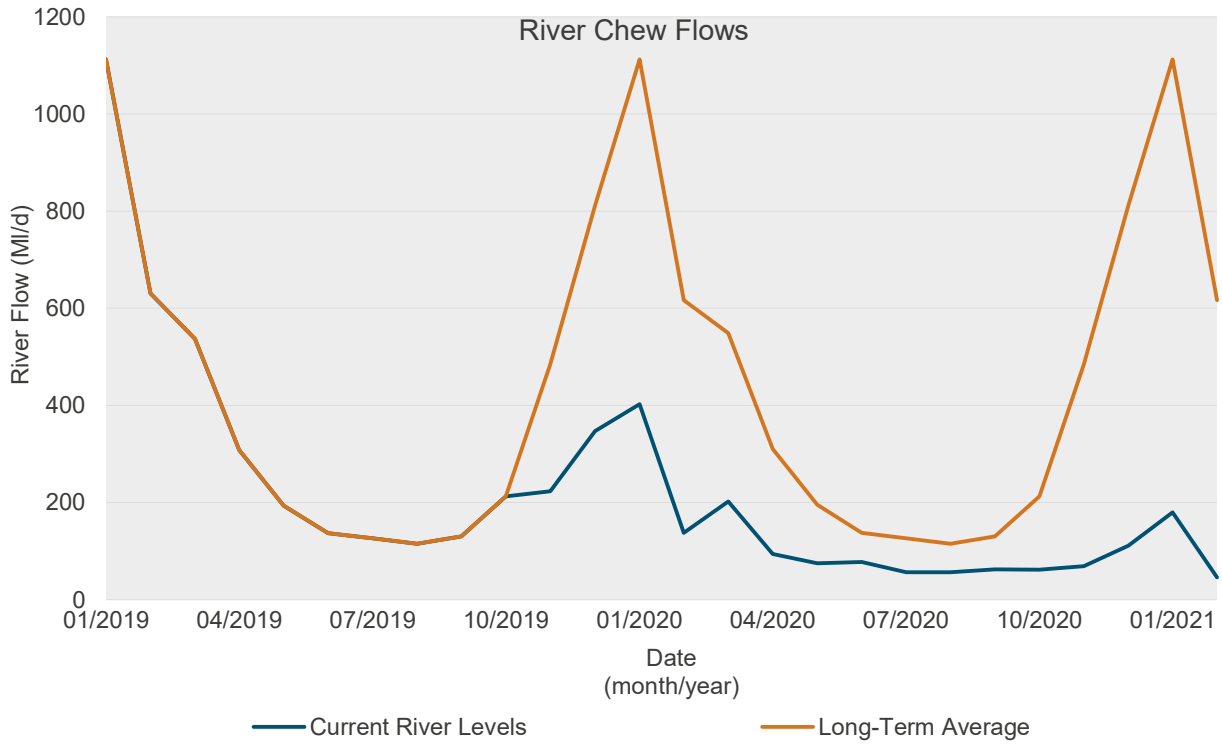


Figure 4.2: River flows at the River Chew

Figure 4.3: Flow duration curves for appropriate river gauge

4.3.3 Groundwater

Bristol Water's groundwater sources (see Figure 2.1) are situated in shallow unconfined aquifers, hydraulically connected to the local rivers. Therefore, these sources respond quickly to a lack of rainfall and high-resolution (15-minutes) groundwater level monitoring data is a useful indicator of the onset of drought conditions. In addition to the data collected by the company, the Environment Agency provides groundwater levels for a number of indicator sites for the major aquifers. The groundwater levels are ranked in the context of the historic data set for the specific site. Reviewing this data has enabled the company to identify that groundwater levels were receding rapidly over winter due to a prolonged rainfall deficit and gave an early warning of the drought conditions being experienced now. Details of the abstraction licence utilisation for the past **[XX]** years is found in Appendix 7.1.1.1.5.

Placeholder

Discussion of graphs showing current and historic groundwater levels (Figure 4.4) and groundwater licence utilisation (Figure 4.5). This is supported by the tables in Appendix E for abstraction licence utilisation.

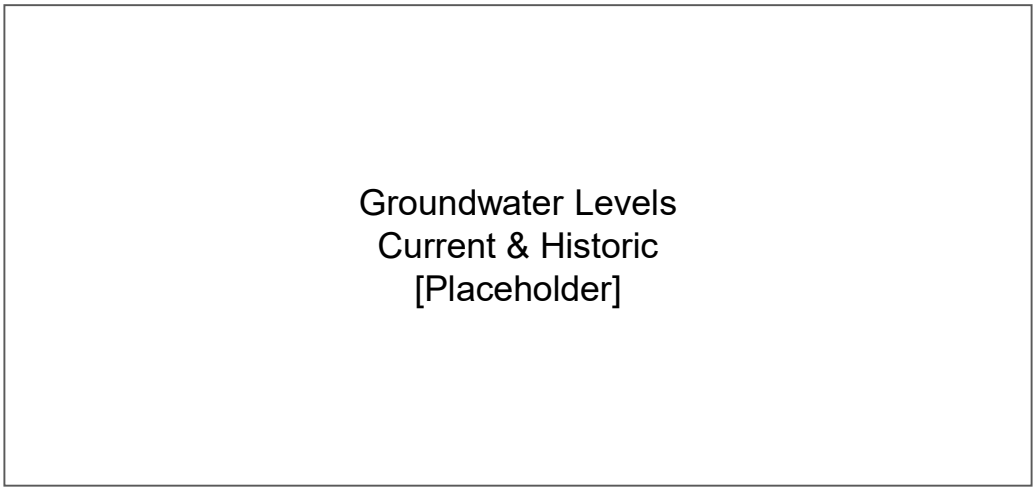


Figure 4.4: Current and Historic Groundwater Levels

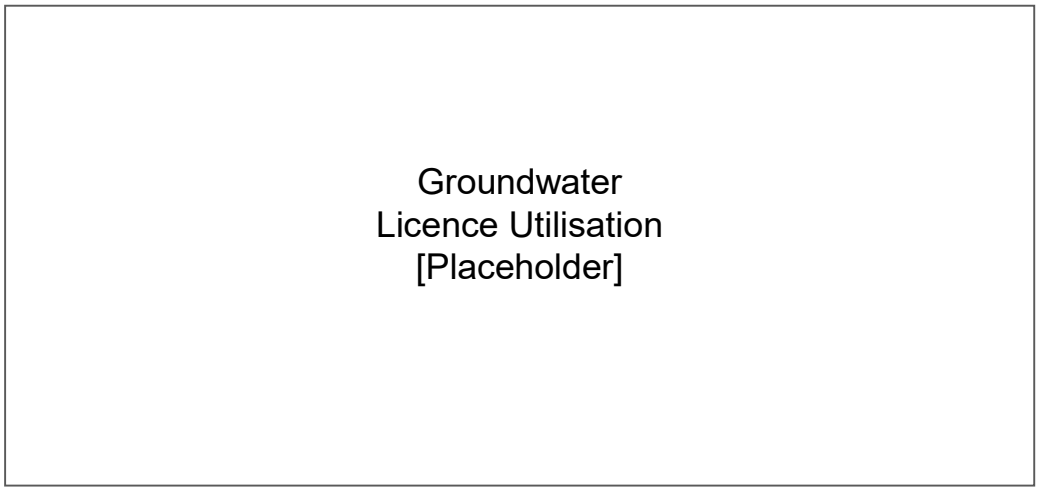


Figure 4.5: Groundwater Licence Utilisation

4.3.4 Reservoir Storage

Bristol Water operates four major reservoirs: Chew Valley Lake, Blagdon, Cheddar and Barrow, all of which are supplied from catchments in the Mendips. The storage levels of these reservoirs are monitored on daily basis and reported to the Environment Agency each week. The information is used to plan daily management of the water supply system and forms the basis to the evidence of a serious deficiency to supply. Since April 2020, Bristol Water has witnessed the continuous drawdown of these reservoirs as a consequence of extreme rainfall deficits and this is expected to continue over the summer of 2021 due to the lack of winter refill experienced thus far in winter 2020/21.

Figure 4.6 compares the present-day storage levels with the LTA reservoir levels. Reservoir storage levels are discussed as part of the threat to serious deficiency to supply in Section 4.6.

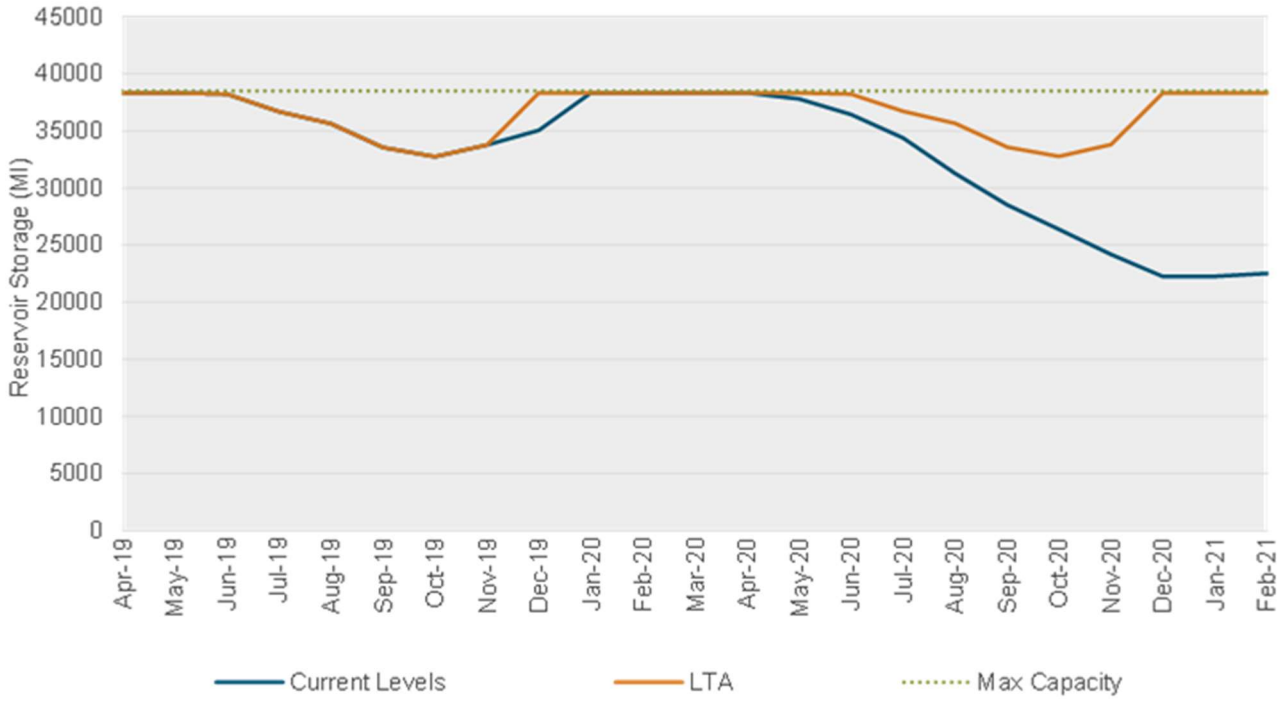


Figure 4.6: Mendip Reservoir Storage

4.3.5 Soil Moisture Deficit

Met Office Rainfall and Evaporation Calculation System (MORECS) data is downloaded from the Met Office on 40km square grid resolution for the agreed geographical extent of analysis. The level of soil moisture deficit (SMD) indicates the dryness of the soil. As the SMD levels increase, a larger amount of rain is required to wet the soil before the rainfall can be effective and impact recharge.

Soil moisture deficits have been high throughout the summer of 2020 and leading into the winter refill period, contributing to the lack of winter recharge and recovery in the Mendip reservoirs. At this time of the year the company would expect soil moisture deficits to be at their annual minima, but these high values of SMD have persisted throughout the past 15 months. These levels have likely contributed to the amount of effective rainfall and groundwater recharge that the Mendip reservoirs would experience.

SMD levels have been plotted in Figure 4.7 to demonstrate the increase of these values across the period of analysis.

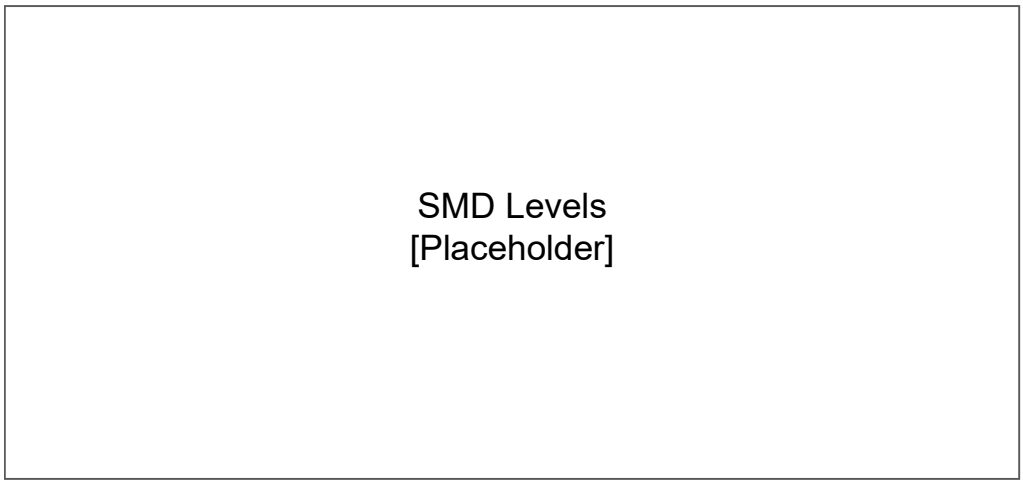


Figure 4.7: SMD levels for period of analysis, November 2019-January 2021

4.3.6 Temperature

Monthly mean temperature across this period of analysis has been obtained from the Met Office website and compared with historical droughts. High temperatures throughout 2020 have exacerbated the impacts of the ESoR through the increased evapotranspiration and soil moisture deficits.

We have also been monitoring demand during the summer months, as these high temperature periods often result in a greater demand for water, increasing the reservoir drawdown.

Placeholder

Graph/Table to show temperature profile during the drought period and compare to normal expected. Explanatory text also needed to conclude whether temperatures have been abnormal compared to normal range for summer/winter and contextualise with demand data.

Table 4.3: Temperature recorded for the past 12 months, the scenario monthly temperature starts in February 2020 to January 2021

Month	Average Monthly Temperature (°C)	Experienced Monthly Temperature (°C)
February	X	X
March	X	X
April	X	X
May	X	X
June	X	X
July	X	X

Month	Average Monthly Temperature (°C)	Experienced Monthly Temperature (°C)
August	X	X
September	X	X
October	X	X
November	X	X
December	X	X
January	X	X

4.3.7 Weather Forecasts

Weather forecasts provide an indication of the weather conditions likely to be experienced and can be used to inform decision making on the management of water resources over the short term. Bristol Water regularly reviews the weather forecast as part of normal operations. Since the onset of drought conditions (upon entering Zone 3), the frequency of weather forecast reviews have increased, with a range of both short- and long-range weather forecasts from the Met-Office being utilised to enable the company to understand the conditions that may be faced going forward. Although it is difficult to predict what will happen over the next few months, long term weather forecasts indicate that this period of drought is likely to continue.

4.4 Exceptional Shortage of rainfall

This drought permit application is made due to a threat to supplies in the Bristol Water system, resulting from an exceptional shortage of rain over the past 15 months, starting in November 2019.

Bristol Water have assessed rainfall across The Mendip Reservoir hydrological catchment, including relative to long term average (LTA) statistics. A range of rainfall metrics, and Extreme Value Analysis have been analysed and presented in Appendix 7.1.1.1.2.2 of this document. The development of the Exceptional Shortage of Rain (ESoR) case is based on the latest Environment Agency guidance.

In summary the analysis has found:

- Exceptional short-term rainfall deficits have emerged through winter and summer of 2019-2020, and have continued through winter 2020-21. Over the past 15 months, rainfall totals in the Mendip Reservoir catchments have been 47% of the long-term average (demonstrated in Figure 4.8 and Figure 4.9).
- During the preceding winter refill period (2019-2020), rainfall totals have been 49% of long-term average for this period. This is of particular concern as the winter is especially important for the Mendip Reservoirs refill from November-March. The current winter period is showing similar results but the company cannot produce final values as the months of February and March contribute to this total. Long term forecasts suggest similar conditions are to be expected.

- Standard Precipitation Index (SPI) analyses shows that for the past 15 months SPIs have been negative, signifying a prolonged period of below average rainfall. In particular strongly negative SPIs (<-3) occurred in the winter of 2020.
- SPI values remain negative for durations of 6,12-, 18- and 24-month periods prior to end of January 2021. Longer durations of 36 to 48 month do show the SPI value rising, but remain predominantly negative.
- The drought has a return period of at least 1000 years.
- As a result of this lack of rainfall, current levels of reservoir storage are less than 60% of LTA. The company does not expect them to recover before next drawdown period as only two months remain of the refill period with no forecast of high rainfall in the coming weeks.

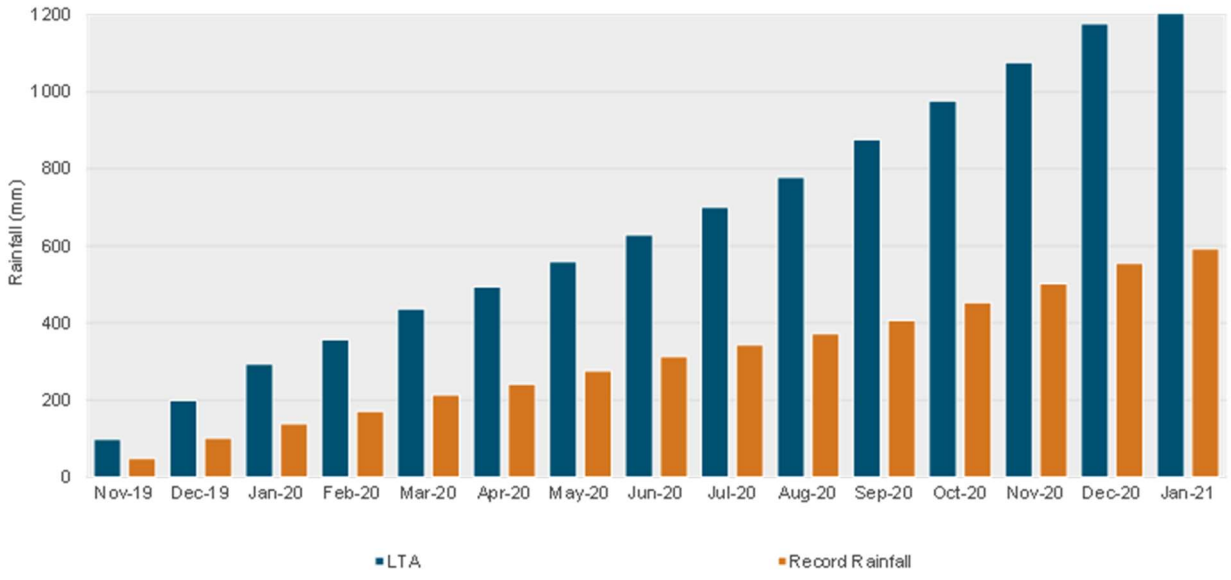


Figure 4.8: Cumulative rainfall experienced since November 2019 until present day, beginning of February 2021

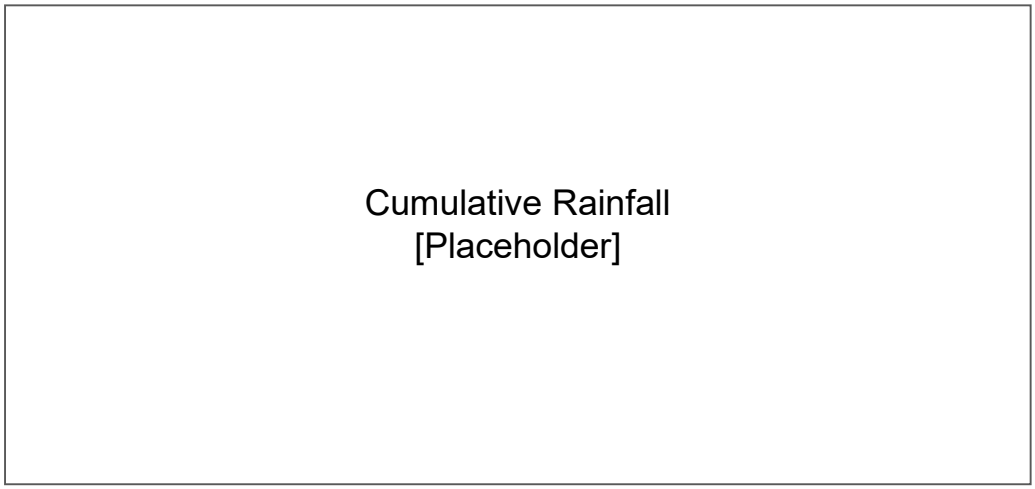


Figure 4.9: Cumulative rainfall plots of previous drought years against current drought and LTA

The exceptional shortage of rain over the period of November 2019 to the end of January 2021 supports the submission of this application. Extensive analysis supporting this information can be found in Appendix 7.1.1.1.2.

4.5 Abstraction and demand in the supply area

Bristol Water serves a population of approximately 543,620 households across its supply area, with 59,28% of households being metered (mid-year performance figures for 2020/2021). Per capita consumption (PCC) for 2020/2021 is forecasted at approximately 141.6 litres per head per day (l/h/d), which is lower than the national average of 150 l/h/d.

The total dry year annual average (DYAA) baseline demand for 2020-2021 was forecast in the WRMP 2019 to reach 271.06 Ml/d by 2021. Further information on levels of demand in over the past two years compared to historical demand is provided in Appendix 7.1.1.1.6.

A number of factors influence this comparison of recent and historical data. It is difficult to isolate individual influences; increases in metering; leakage management; general water efficiency progress; population growth; trends in water-using white goods and other water usage; and the relative weather, are all influencing factors.

Placeholder

Text needed here to summarise observations from demand experienced during the drought affecting Bristol Water at the time of application and pre-drought conditions and WRMP forecasts (i.e. DYAA forecast from the relevant WRMP).

Table 4.4: Summary of demand (by component) for 2020-2021 (from WRMP19 forecasts)

Demand Components	2020/21
Measured non-household	60.34

Demand Components	2020/21
Unmeasured non-household	0.67
Measured household	94.10
Unmeasured household	80.24
Water taken unbilled	0.66
Operational water use	3.44
Supply pipe leakage from void properties	0.27
Distribution losses	31.34
Total DYAA Dry Year Demand (Ml/d) (Distribution input)	271.06

The DYAA scenario has been used as the basis of the demand forecast for WRMP19, supported by an assessment of the deployable output and Water Available For Use from the design drought scenario to determine supply availability.

Placeholder

Supply demand balance table and explanatory text to comment on the influence of reduced storage in the Mendip reservoirs on deployable output (to be updated at the time of application). Suggested example of table included below – Table 4.5.

Table 4.5: Supply-demand balance and assumptions

Supply -demand balance summary for DYAA	
Component	Amount (Ml/d)
Target headroom	xx
Demand	xx
Industrial Demand	xx
Export	xx
Total demand	xx
Outage	xx
Other losses	xx
Total Losses	xx
Imports	xx
1:2 years drought (normal year)	xx
Available headroom	xx
Supply-demand balance	xx

Supply -demand balance summary for DYAA	
1:200 years drought Deployable Output	xx
Available headroom	xx
Supply-demand balance	xx
1:500 years drought Deployable Output	xx
Available headroom	xx
Supply-demand balance	xx

During dry weather conditions, customer demand increases. As demand increases, as does the pressure on water resources. Abstraction and demand can therefore be used to indicate when resources are being stretched. A summary of population, property, demand, per capita consumption (PCC) and metering level figures is presented in Table 4.6 and Table 4.7 below.

Placeholder

Text needed to draw out key differences and similarities from tables below.

Table 4.6: Summary of demand (based on relevant WRMP figures)

Metric	Value
Total population (000s)	X
No. household properties (000s)	X
No. non-household properties (000s)	X
Proportion of metered households	X
Outturn demand (Ml/d) – for the current year	X
Normal Year annual average demand (Ml/d)	X
Dry year annual average demand (Ml/d)	X
Dry year critical period demand (Ml/d)	X
Dry year MDO demand (Ml/d)	X

Table 4.7: Summary of per capita consumption (PCC) based on relevant WRMP figures

Metric	Value
Current year outturn PCC (l/h/d)	X
Normal Year annual average PCC (l/h/d)	X
Dry year annual average PCC (l/h/d)	X
Dry year critical period PCC (l/h/d)	X
Dry year MDO PCC (l/h/d)	X

In accordance with abstraction licence conditions, the company records the volume of water abstracted from each source. A summary of licence utilisation over the past **XX** years can be seen in Appendix 7.1.1.1.5. In addition, Bristol Water also continuously monitors the demand from the water treatment works and report this data on a daily basis using a telemetry network. During normal operation this information is assessed on a monthly basis and a monthly forecast of the expected water into supply is produced to inform the management of resources under normal operational conditions. However, since the drought entered Zone 2, the company has increased the frequency of the analysis and forecasting of abstractions and demand.

Placeholder

Analysis from Figure 4.10, showing abstraction utilisation against demand. Explanatory text to discuss how demand and abstractions fluctuate and what this means for the drought permit application.

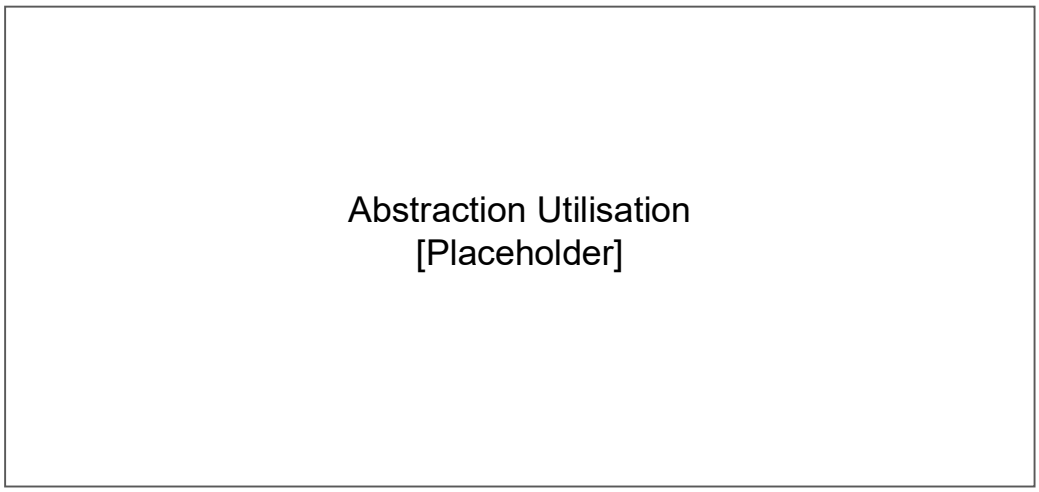


Figure 4.10: Abstraction utilisation against demand

During the summer of 2020 the company has experienced a shift in demand, with a reduction in non-household (NHH) and consequent increase in household (HH) demand due to the ongoing

COVID-19 pandemic which saw businesses close and more people working from home. Overall however, the distribution input (DI) has remained broadly the same. Summer 2020 therefore proceeded without any restrictions on customer supplies as reservoir stocks were not sufficiently low to trigger such demand management actions.

4.6 Threat of a serious deficiency of supply

During a drought, like the one currently being experienced, water availability and demand are reviewed on a regular basis. Bristol Water assesses the threat to water supplies throughout a drought to determine if there is a risk that the company may not have sufficient water (a serious threat to supply) in the future if the drought persists. This section provides the case of threat to supplies for this permit application.

As set out in the previous section, and summarised here the water resources available to Bristol Water are as follows:

- 46% of the supply is sources from outside the WRZ and that are transferred into its system from the Gloucester and Sharpness Canal.
- 42% of its available licenced resource includes the Mendip Reservoirs and associated surface water abstractions; and,
- 12% of the licensed resource is derived from groundwater.

Like other water companies in the UK, Bristol Water have a series of water resource models which are used to help manage water resources. These models help predict how water resources will respond to future rainfall and demand patterns.

To help with this resource management, Bristol Water's reservoirs are managed by reservoir operating control curves that indicate when storage levels are below normal for the time of year, and the extent to how low levels are. These are used each year to trigger normal operational changes in order to optimise the use of stored water and to balance reservoir storage.

Figure 4.11 shows the associated drought control curves developed to control the operation of the reservoirs in line with drought management assumptions and levels of service. Increasing levels of drought severity shown in Figure 4.11 have been defined in Bristol Water's Drought Plan and aligned with the Environment Agency's level 1 to 4 definitions as set out in their drought plan guideline (2020), to ensure that the drought actions are proportionate to the level of drought risk being experienced (Table 4.8). The shape of the curves reflects the expected drawdown of the reservoirs during the drier summer months when natural inflow into the reservoirs is less than the volume being abstracted to meet customer demand. Refill commences in the autumn when natural inflow to the reservoirs exceeds the volume being abstracted to meet customer demand. Zones 1 to 3 on the graph are the least severe, when reservoir levels are below the control curves but the drought is not causing a reduction in levels of service. Zones 4 to 6 represent points where reservoirs are much lower than the control curves and customer restrictions are likely to be required.

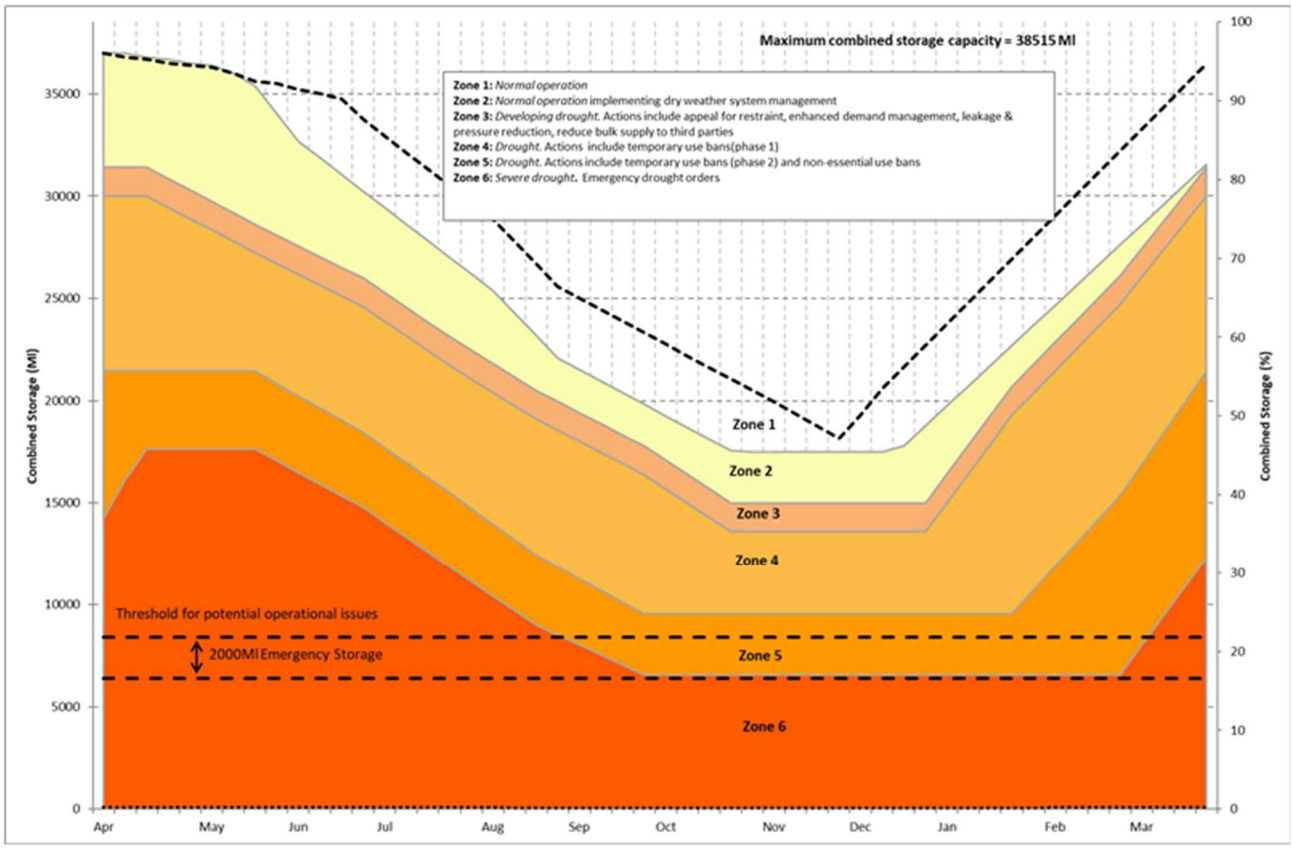


Figure 4.11: Current operational control curves

Source: Bristol Water Final WRMP 2019

In the event of a drought these plots are used to help the company implement actions to reduce the risk to customers.

The areas between the control curves defines the discrete zone indicating which of the drought measures should be considered for implementation.

- If combined reservoir storage remains within Zone 1, then it is not considered to be within a drought situation and the system will be operated as normal, optimising resources across the supply area. The company forecasts on a monthly basis to monitor the likely drawdown behaviour of the reservoirs under different rainfall scenarios.
- If reservoir storage drops into Zone 2, then the company's 'dry weather' system management processes would be implemented (if they have not been already), optimising the system on a resource basis.
- The remaining zones 3,4,5, are for the progressive implementation of drought actions, with the severity of the actions increasing as the combined reservoir storage declines.

Drought triggers have been developed to identify when the water resource situation is moving into different severities of drought.

Table 4.8: Aligning Bristol Water Drought Zones with Environment Agency Level Restrictions

Zone	Actions	Associated level of service	Environment Agency Level 1-4 category
1	Normal Operation		
2	Normal operation but implement dry weather system management		
3	Drought actions: - Appeal for restraint - Enhance demand management - Enhanced leakage management - Reduce bulk supplies to third parties		Level 1
4	Drought actions: - Temporary use bans - R24R to R24Ra (well head) supply side option (existing licence)	1 in 15 years on average	Level 2
5	Drought actions: - Non-essential use bans - Supply side drought permits	1 in 33 years on average	Level 3
6	Emergency drought orders	1 in 200 years	Level 4

Source: These Zones and Levels have been compared during the pre-consultation process with the Environment Agency.

4.6.1 Mendip Reservoir Storage Assessment

In this section the company sets out the risks that the Mendip Reservoirs will run out of stored water during this drought. To do this the Mendip Reservoirs' storage levels have been predicted using a mass balance spreadsheet modelling approach. This mass balance model (MBM) is a simplified representation of the supply system and is one of the company's water resources planning tools. It allows the company to make predictions of "if and when" reservoir storage levels will change into the different zones described above.

The MBM [3] creates a monthly simulation of the reservoir storage. The modelling assessment has focused on the performance of the supply area in the context of the combined storage of the Mendip Reservoirs against the drought management zones defined by the combined reservoir control curves.

The MBM has been used to predict how much supply there will be in the near future given the current reservoir levels and given the predicted demand for water in 2021. To do this the company has used the forecast demand that is in the latest WRMP, which is an annual average demand of 317.49Ml/d[4]. This value includes allowances for headroom uncertainty, outage, treatment work losses, (TWL) operational use (OU) and raw water losses (RWL) and climate change. Table 4.9 provides more information on each of these components and also shows the actual demand that occurred in 2018/19. The MBM can also account for demand restrictions, including TUBs.

Table 4.9: Forecast demand for Bristol Water

Year	Distribution Input	Target Headroom	Outage	RWL TWL & OU	Climate Change	Total
2020/21 WRMP19 forecast	270.22	17.26	5.12	20.27	4.62	317.49
2018/19 (actual Distribution Input)	280.6	17.26	5.12	20.27	4.62	327.87

Source: 2020/21 WRMP19 forecast has been used for all of the subsequent modelling.

4.6.2 Current levels of storage

Due to the shortage of rainfall described in the ESoR, and specifically the dry preceding winter, reservoir storage has been significantly reduced. Figure 4.12 plots the LTA reservoir storage against the reservoir levels during this current drought.

[3] Exercise Note: In the event of a real drought permit being submitted, Bristol Water would use Miser/Aquator models for forecasting the reservoir levels. For this mock permit application, the MBM model has been used to generate the overall scenario.

[4] Exercise Note: A forecast demand has been used in this mock drought permit. In a real drought permit application Bristol Water will use the actual demand experienced as this will be more reflective of the current situation.

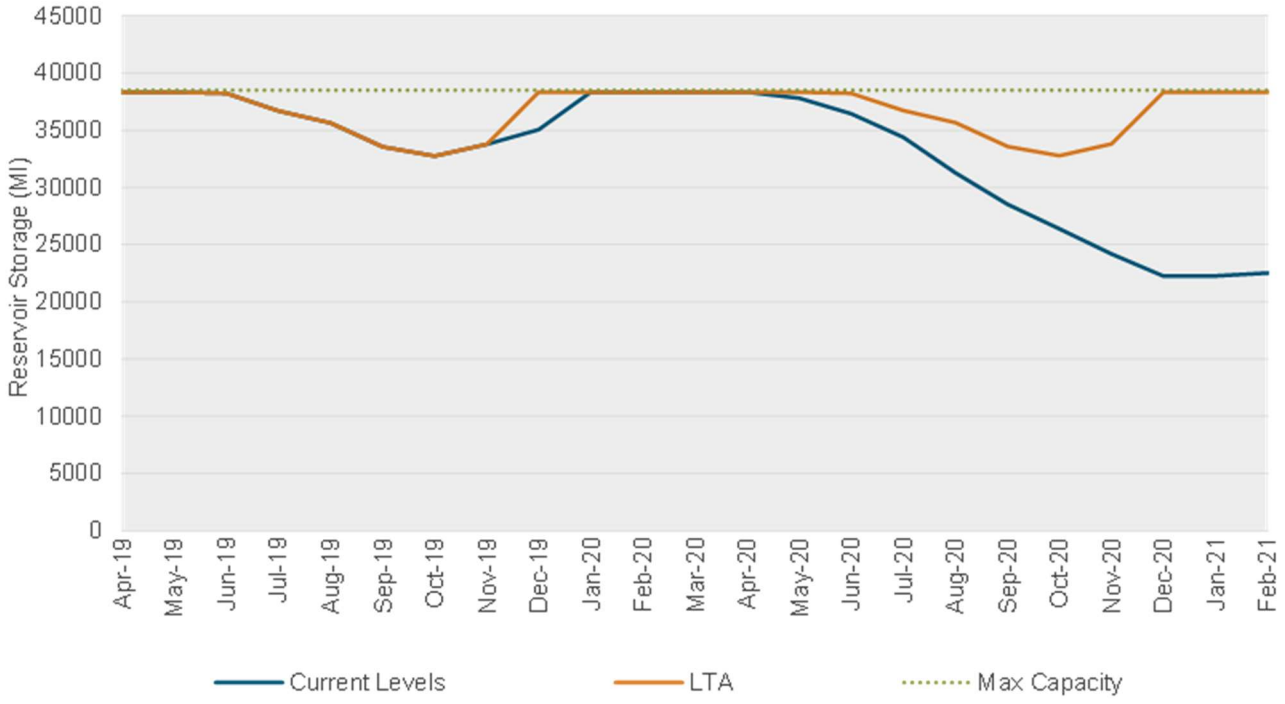


Figure 4.12: Current reservoir levels plotted against LTA levels

Source: Maximum capacity of the Mendip Reservoirs remains at 38515Ml.

As the company enters February, Mendip Reservoir levels are at 56.4% capacity (Table 4.10). By this time the company would expect winter rainfall to have recharged these storage levels and the LTA shows that reservoirs at this time of the year are expected to sit at 99.5% of capacity. This means that as the company plans for the coming drawdown period it will be starting with the Mendip Reservoirs at just over half of their capacity.

Table 4.10: Reservoir Levels in December

	Total Reservoir Volume (Ml)	% of Capacity
LTA	38343	99.5
Current Reservoir Levels	21712	56.4

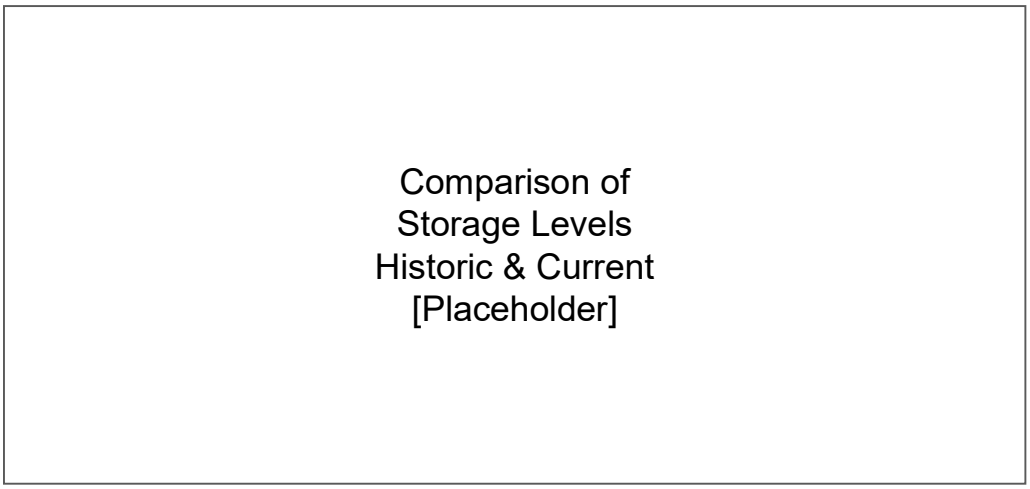


Figure 4.13: Comparison of the Mendip Reservoir storage levels against historic minimum or historic drought years

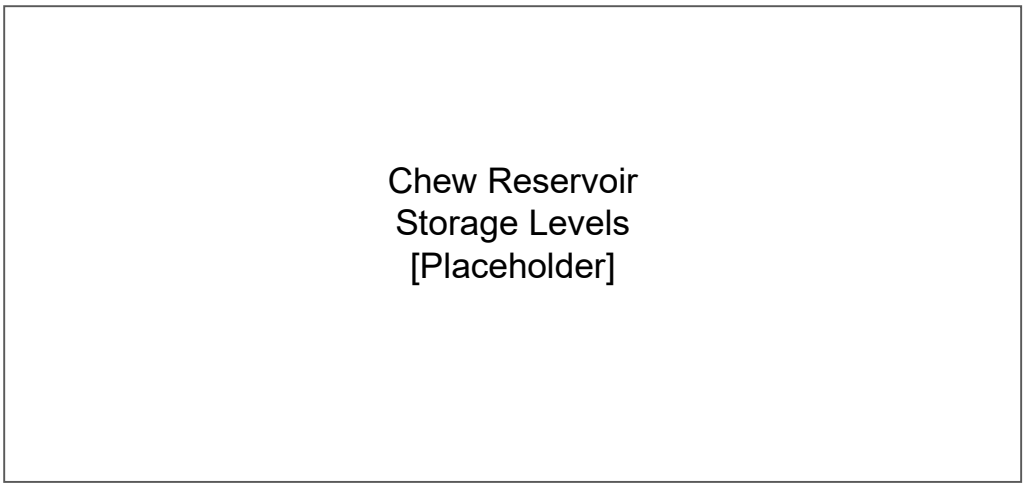


Figure 4.14: Chew Reservoir storage levels, separate from Mendip Reservoirs

Placeholder

Text discussing the comparison of storage levels of historic and current levels of storage. Further text to reflect on the Chew Reservoir storage levels individually.

Plotting the current Mendip Reservoir levels against the operational control curves (Figure 4.15), it is clear that the company is at a pivotal stage to control drought response. At this time, entering February 2021, the drought is now in Zone 4. This means that the company is now in the Drought

zone of its control curves. At this stage temporary use bans (TUBs) would normally come into play, however TUBs will not be implemented in the winter period, instead being kick-started in April if conditions prevail, ensuring they will have an impact.

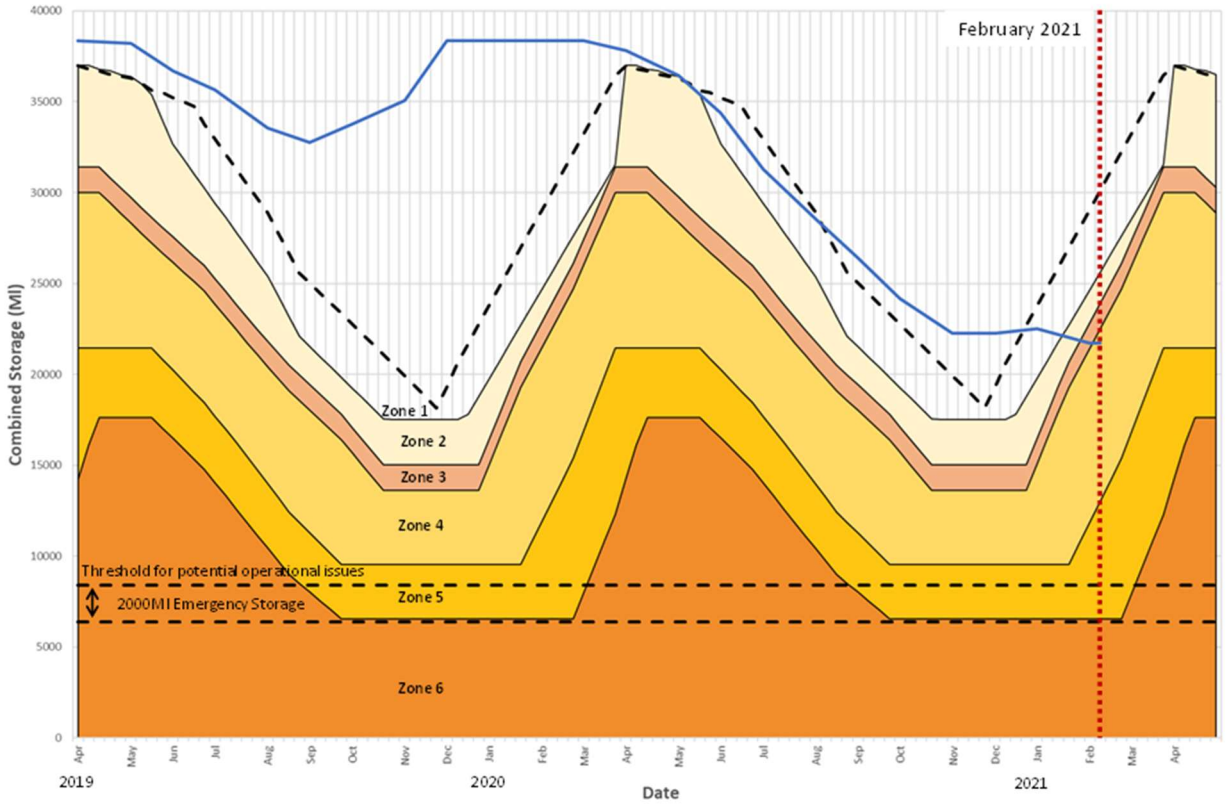


Figure 4.15: Current reservoir levels against Bristol Water's control curves

4.6.3 Forecast Reservoir Storage

Placeholder

The description of how the models were used to project inflows and reservoir levels will be updated for a real drought application. This method will not be used. This section only lays out potential plots and discussion points that would be used in a real drought permit.

Section 4.4 has shown that rainfall has been much lower than the LTA over the past 15 months and has a return period of >1000 years. This means that (as set out in Section 4.6.2) reservoir storage levels are much lower than would be expected. In this section, forecast rainfall has been modelled to predict possible reservoir levels to determine further risk to supply.

Approach to predictions

The company cannot accurately predict what rainfall will be in the future, so to understand the risk to supply the company has undertaken extensive analysis using synthetic droughts of a similar magnitude to the drought conditions the company is currently experiencing. By utilising these synthetic droughts, it allows analysis on the impact on the Bristol Water supply area and identify when the company will need to take timely actions to prevent loss of service to consumers. Synthetic Droughts were created as part of the Drought Vulnerability Framework. These synthetic drought events are created by sampling the historic rainfall data record on a monthly basis to construct drought events with defined characteristics. Each individual drought scenario has a specified duration and intensity, these cover:

- Drought durations of 6 to 36 months, with all periods ending in November.
- Drought severity ranging from 95% to 30% of LTA rainfall.

The company needs to be able to predict how river flows and reservoir levels will change in these synthetic droughts, so the synthetic rainfall records were input into the rainfall runoff models (HYSIM) to obtain flow inputs. The inflows were then run through the MBM to predict associated reservoir levels.

The reduced rainfall that Bristol Water has been experiencing since November 2019 has created a 15-month drought of approximately 47% of LTA rainfall. Due to the sensitivity of the systems and threat to supply from prolonged droughts, the company created a 24-month drought ending in November 2021 with a similar LTA rainfall deficit. Bristol Water also created alternative synthetic droughts of 60% and 80% LTA rainfall as sensitivity tests to align with usual dry weather forecasts provided to the Environment Agency for reporting of position[5].

In Figure 4.16, the recent reservoir levels have been plotted to present day and then progressing through early-February 2021, the three synthetic droughts are used. The results are:

- In all three forecasting scenarios, reservoir storage is projected to reach Zone 5 mid-March and remain in this Zone throughout the summer months. All three scenarios demonstrate depleted

[5] Exercise Note: Reservoir levels plotted in this section are fictitious. They have not been based on actual 45%, 60% or 80% forecasts, instead we have created reservoir storage forecasts to assist the case for mock permit. In a real permit application, Bristol Water can also make use of the 3-month forecast from the Met Office.

resources for the Mendip Reservoirs and the system requires a drought permit to stabilise storage volumes.

- The drought permit option for the reduction in reservoir compensation released for Chew Reservoir would be implemented as the reservoir storage enters Zone 5, in March.
- The best case 80% LTA forecast rainfall scenario still enters Zone 5, and remains there for 4 months, suggesting a return to Zone 4 in late-July.
- In both the 45% and 60% forecasts, reservoir levels enter the emergency storage levels in October and continue to demonstrate a downward trajectory towards a severe drought.

Throughout this modelling the company has applied appropriate demand restrictions[6] but it is evident from these forecasts that the drought permit will still be required to ensure supply to customers.
These projections demonstrate how quickly the system may be impacted by a prolonged drought, and how rapidly the company will need to react to get ahead of any impacts to supply. Now that the company has entered Zone 4, there are approximately 5-6 weeks until Zone 5 is entered in mid-March.

Placeholder

100% and 120% LTA scenarios as comparison/control are required on Figure 4.16 to indicate length of drought persistence. In a real drought a Drought Prospect report will have been completed and would provide data to update this accordingly.

[6] Exercise Note: In a real drought scenario, Bristol Water will have been implementing a number of actions in advance of the permit requirements, including leakage reduction and reduction of bulk supply to Wessex Water. These scenarios do not model the impact of these actions, but do include the addition of TUBs in April-September. In an actual permit application, other drought management actions will be included in modelling outputs but for this mock exercise we are assuming that all necessary actions have been accounted for.

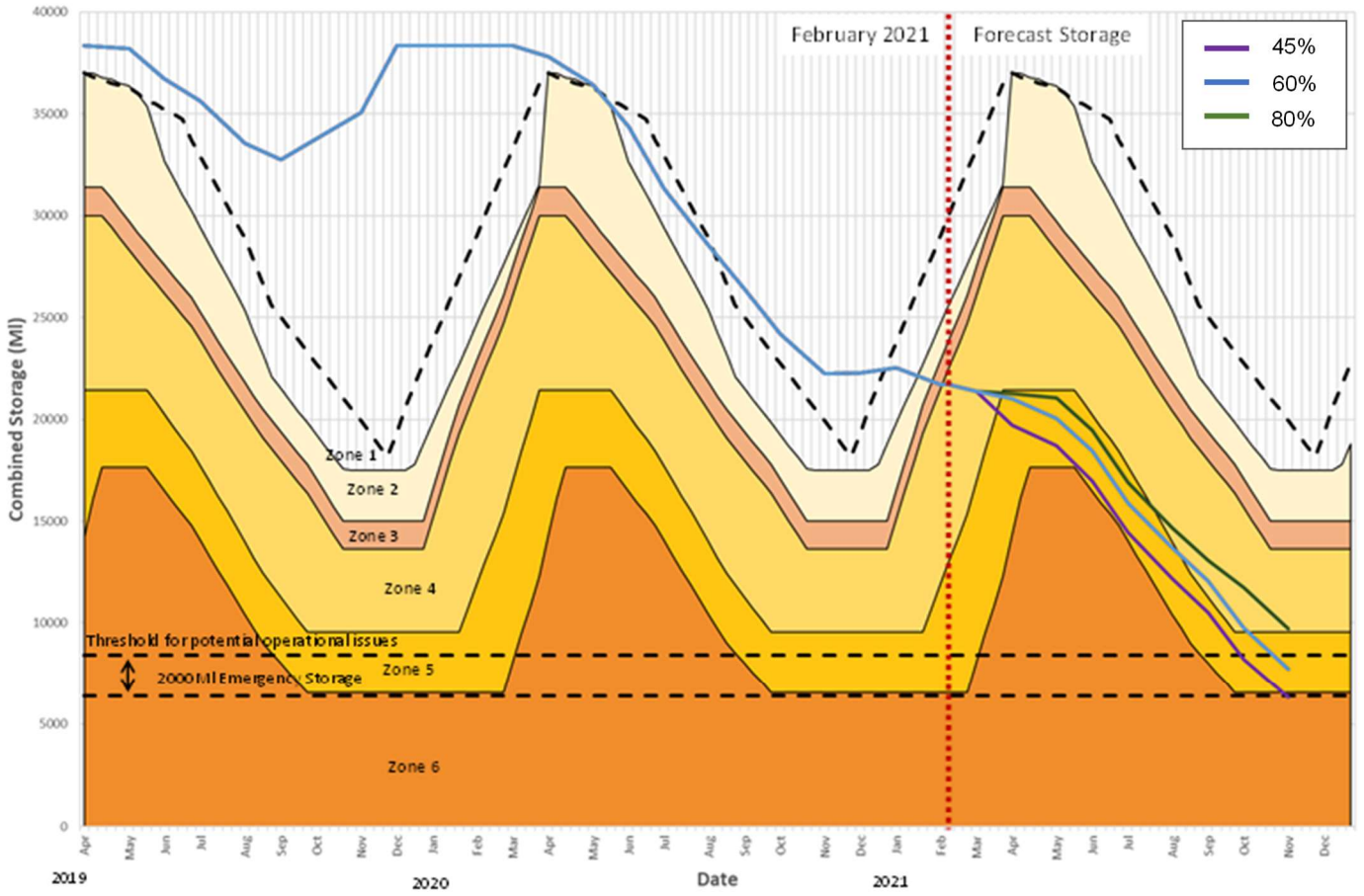


Figure 4.16: Forecast reservoir levels if drought persisted. Three forecasts include 45%, 60% and 80% LTA

4.6.4 Drought Permit impact to supply

Placeholder

Text to discuss the shortfall that Bristol Water has been experiencing during the current drought and the impact this has on meeting demand of customers. This will be both present, and projected using the demand at the time.

Figure 4.17: Resource shortfall due to this drought scenario

Placeholder

Models will be run with and without the drought permit to enable discussion and presentation of the drought permit impact.

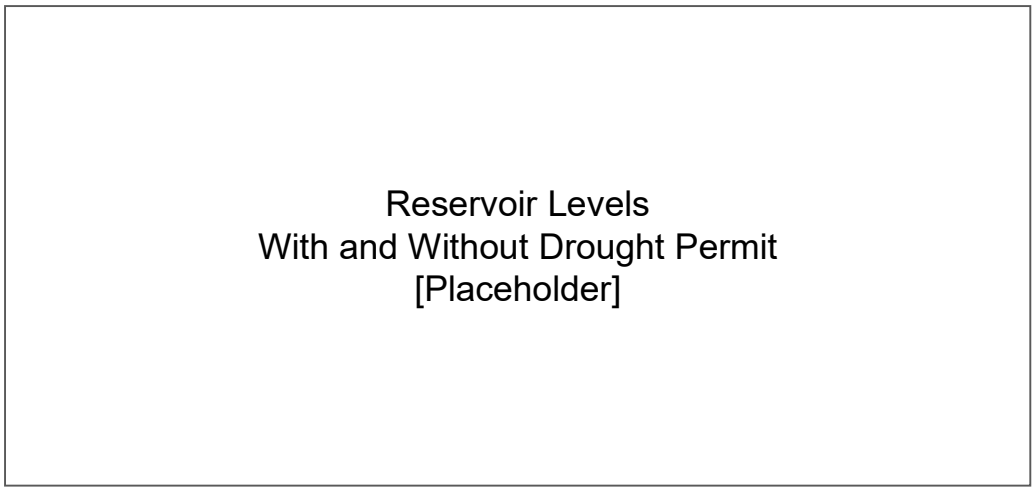


Figure 4.18: Reservoir levels modelled with drought permit applied for comparison with no drought permit

Placeholder

Text to discuss the impact of the permit approval on the shortfall. It was acknowledged in the final engagement of this mock exercise that one individual reservoir drought permit may not be enough to meet the shortfall, instead the intention was to potentially submit three drought permit applications together. At the time of this report, this is still in discussion with the Environment Agency.

4.6.5 Threat to supply summary

The Mendip Reservoirs, including the Chew Reservoir are a key asset to the Bristol Water supply system. Owing to a very dry preceding winter, the reservoir storage levels have not refilled in advance of the following season's drawdown period. A credible threat of a serious deficiency of supply exists if the current drought conditions are to continue, creating a multi-season drought with exceptionally low rainfall.

In the forecast scenarios of a similar 45% LTA rainfall, the reservoir levels would be depleted and are likely to reach Zone 5 in mid-March 2021. A similar forecast is demonstrated with 60% and 80% rainfall from this month, with reservoir storage levels entering Zone 5 for a number of months across the drawdown period.

The company perceives a serious threat to supply in the system and view this drought permit as an essential requirement to maintain supplies to customers, as demonstrated in Figure 4.18. The system has the potential to fail rapidly in 18 to 24-month drought scenarios when reservoir storage is unable to be replenished over the winter months and this drought permit would allow the Chew Reservoir levels to be better maintained under the drought conditions the company is currently experiencing. Given that the Bristol Water system is an integrated resource, when the reservoir storages reach Zone 5 of the operation curves, this equates to all 1.23million people in the supply area experiencing the same supply restrictions.

The company intends to apply Temporary Use Bans to commence in April 2021 in combination with this drought permit. TUBs are most effective between April and September, therefore applying TUBs in the current climate would have limited effect due to the winter months. Bristol Water propose to conduct the two-week consultation for TUBs and NEUBs mid-March, with the intention on imposing these sanctions from April when it would provide the most benefit to the system.

4.7 Drought permit alternatives considered

The following drought measures have been identified as supply-side actions to obtain additional water for the Bristol Water resource zone, in line with the Drought Plan 2018:

- Temporary variations to bulk supply agreements with Wessex Water.
- R24R & R24Ra (Well head).
- Reduction of Blagdon Reservoir compensation release (drought permit).
- Reduction of Chew Reservoir compensation release (drought permit).
- Reduction of Cheddar Ponds compensation release to Cheddar Yeo (drought permit).

4.7.1 Temporary variations to bulk supply agreements

Bristol Water has a supply agreement with Wessex Water to provide up to 11.3Ml/d of water via a treated water pipeline to the City of Bath. In its WRMP2014 and WRMP2019, it included an option to reduce this supply to 4.40Ml/d, thus providing Bristol Water with an additional available resource of 6.97Ml/d. Wessex Water also included this bulk supply reduction within the assumptions used to develop their WRMP2014 and WRMP2019. Since the drought entered Zone 2, the company has discussed the reduction of this bulk supply with Wessex Water and reduced this to 4.4Ml/d upon entering Zone 3. Given that the dry conditions are likely to continue and the drought has now entered Zone 4, the company is considering further reducing the supply to Wessex Water, in consultation with the Environment Agency, to ensure this would not be to the detriment of the regional supply.

Table 4.11: Proposed reductions to bulk supply to Wessex Water at different stages of drought

Drought Management Zone	Bulk supply volume to Wessex Water (Bath) (Ml/d)	Additional Yield to Bristol Water (Ml/d)
Zone 2 – Normal Operation (dry weather management)	11.37	0
Zone 3 – Developing Drought	4.4	6.97
Zone 4 - Drought	4.4-0	6.97
Zone 5 - Drought	4.4-0	6.97-11.37
Zone 6 – Severe Drought	0	11.37

Bristol Water also have some small imports of water from Wessex Water at the periphery of the system, typically no more than 1Ml/d. Wessex Water have not indicated a need to restrict these transfers during this drought **(to be formally confirmed at the time of application).**

Placeholder

Discuss Figure 4.19, showing the timeline of reduction in transfer to Wessex Water

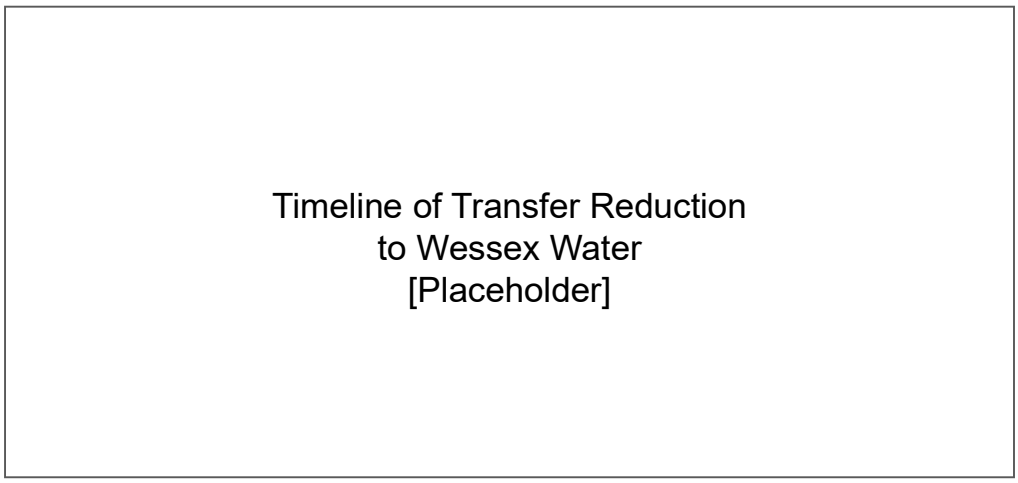


Figure 4.19: Timeline of reduction in transfer to Wessex Water

4.7.2 R24R & R24Ra (well head)

R24R & R24Ra (well head) is a licenced source that has been retained for emergency use. It has an anticipated yield of 2.4 Ml/d; however, the water quality is relatively poor, and therefore is unable to be put into direct supply as was done in the past. This option would involve constructing a 4.2km pipeline to Cheddar Reservoir and treating the water at Cheddar water treatment works. R24R is currently subject to environmental assessments and WINEP investigations. For the drought plan Bristol Water has completed a WFD assessment. The company has now begun work to recommission this site however it is anticipated that it would take at least 6 months to implement this option (subject to any environmental legislation requirements and engineering feasibility).

4.7.3 Other drought permits

Reduction of Blagdon Reservoir compensation release

Bristol Water is required as part of its abstraction licence to make a compensation discharge of 8.638Ml/d into the Congresbury Yeo from Blagdon Reservoir. A reduction of this discharge would potentially conserve additional water for public water supply. Under this option Bristol Water proposes the reduction of compensation flows by 4.038Ml/d to 4.6Mld between 15th May and 30th November. The company is now seeking to obtain a drought permit for this source and are submitting an application to the Environment Agency.

Reduction of Cheddar Ponds compensation release to Cheddar Yeo

Bristol Water is required as part of its abstraction licence to make a compensation discharge of 6.8Ml/d to the Cheddar Yeo from Cheddar Ponds. A reduction of this discharge would potentially

conserve additional water for public water supply. Under this option Bristol Water are proposing to reduce the compensation by 50% to 3.4Ml/d between December and May. The company is now seeking to obtain a drought permit for this source and are submitting an application to the Environment Agency.

Due to all three reservoirs having special designations (Table 4.12), and they are managed as one storage, applying for all three permits would allow management of the drawdown on reservoirs to a similar % volume and not necessarily put emphasis on one reservoir alone. Applying all three permits would increase resilience and holding water in the reservoirs would protect the designated sites.

Table 4.12: Reservoir special designations

Reservoir	Designations
Blagdon	SSSI
Chew	SSSI and SPA
Cheddar	SSSI

5 Evidence the company has followed its drought plan

As set out in the previous section, there is a risk that over a short period of time (between now and mid-March) the water resource situation will deteriorate even further. The company has already implemented a wealth of demand management actions to conserve supplies and is continuing to implement these, in line with the Drought Plan 2018. This section serves to evidence that the company has followed the actions outlined in the Drought Plan, in the context of the developing drought conditions that have been experienced over the past several weeks. A timeline of the actions which have been implemented and the dates (month and week) they have been applied (for actions between Zone 1 and 4) are presented in Table 5.1 below.

During normal operating conditions, the company's website provides water saving information and a link for customers to order free water saving packs and purchase water butts or other home retrofit devices. It includes a page dedicated to water resource management with the current Drought Plan and WRMP available to download.

Each summer, the Communications Team delivers a water efficiency campaign, which aims to promote the free packs and encourage customers to reduce water use in the home. This typically involves promotions on social media and attending community events and local shows.

The company also has year-round educational and community initiatives which form the basis of its efforts to educate customers on the value of water (see Section 5.2).

As part of the company's ongoing efforts to conserve demand (between entering Zone 2 and now), the company has:

- Monitored the water resources situation on a weekly basis, including the river flow/reservoir levels and making forecasts of how these may develop, discussing these with the EA;
- Implemented media campaigns and engagement events to promote water efficiency;
- Increased efforts towards leakage detection to reduce network leakage and conserve water;
- Maximised river and groundwater abstractions to conserve reservoir storage;
- Initiated the work required to bring drought only sources back on-line (e.g. R24R source);
- Optimised water treatment works operations to minimise losses;
- Reduced water pressure to reduce leakage and consumption;
- Reduced planned outage;
- Applied temporary variations to bulk supply arrangements with Wessex Water.

Despite ongoing and planned efforts to decrease demand and enhance supply, Bristol Water are now in a position where reducing compensation flows from Chew Reservoir is required to ensure supply can continue as normal. To this end, the company consulted with and notified stakeholders of its intention to apply for this drought permit and is consulting with the Environment Agency on the implementation of TUBs and NEUBs from April onwards.

Table 5.1: Drought management actions undertaken to date and timeline of implementation. This table is an example and will be modified at the time of application

Month	Week No	DMZ / Action level	Demand actions	Supply actions
X	1	DMZ 1 Normal	Normal operation	Normal operation.
X	2	DMZ 2 Dry weather management	Media campaign raising awareness and asking for voluntary restraint	Minimise reservoir storage and maximise use of River Axe and River Severn sources. Maximise groundwater abstractions. Discuss feasibility of reducing transfer to Wessex Water.
X	3	DMZ 3 Level 1	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Reduced transfer to Wessex Water (6.97 Ml/d benefit).
X	4			
X	5	DMZ 4 Level 2	Full scale publicity and media campaign (estimated to reduce household demand by 1%). Ongoing increase resource on leakage find and fix activity (up to 2Ml/d benefit when fully resourced).	Supply forecasting carried out to assess risk of entering DMZ 5 and whether Drought Permits are likely to be required.
X	7		Preparation for TUBS implementation in April. Public consultation week 1. Leakage activity working at full capacity (2Ml/d benefit)	Supply forecasts indicate that storage could reach DMZ 5 within x weeks. Initiate process for drought permit applications. Initiate work required to put R24R back into supply (6-month lead time to bring online). Reduced transfer to Wessex Water (6.97 Ml/d benefit) – maintained throughout DMZ 4.

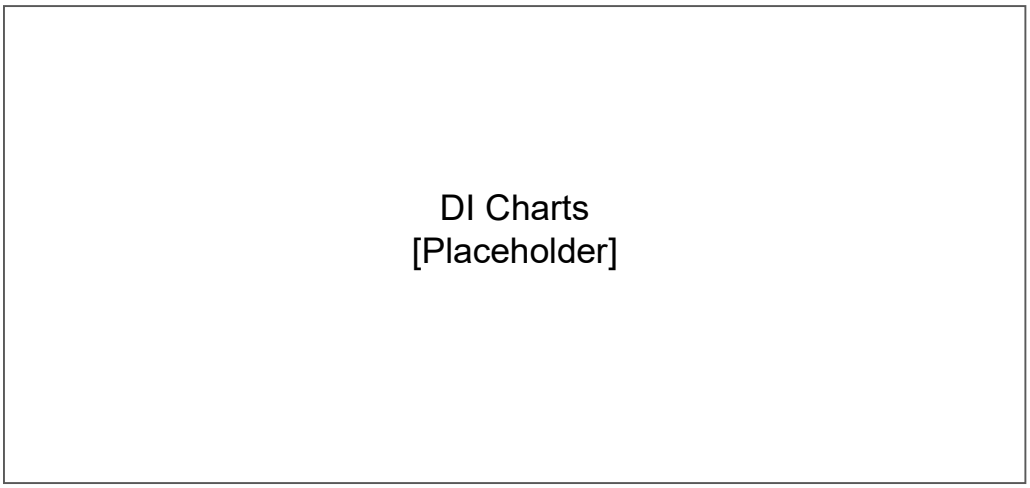


Figure 5.1: DI charts annotated with actions to help visualise the impact of campaigns and drought management actions

5.1 Metering and impact on demand

The company's demand statistics are influenced by the proportion of metered properties, currently standing at approximately 59%, an increase of around 15% since 2010. Since Bristol Water's supply area has historically been resilient to drought and not deemed as a water scarce area, the company implements an optional metering campaign via its company website and running a campaign called 'Beat the Bill'. The aim of this campaign is to demonstrate to customers that they could save money on their bill if a free meter is fitted.

The company's customer research does not provide a compelling case for compulsory universal metering or installation of new metering measures such as smart metering on a large scale. The company continues to see metering as an important part of the strategy to provide a resilient service, both in the short and long term, and in the absence of strong customer preference for any action other than the current policy, it has included in its baseline an assumption that the company will continue the current policy of a gradual increase in water metering by promoting meter optants and installing metering on change of occupancy, both of which activities are included the reporting of meter optants.

The company's baseline demand forecast takes account of the metering policy demand savings for each metered customer segment. However, the company's plan to achieve 67.70% meter uptake with customers in 2020/2021 has been severely affected by the COVID-19 pandemic. The restrictions that came into effect during the pandemic as well as a notable drop in customer demand for meters, left the company unable to install the number of meters required to achieve this target. The continuing uncertainty caused by the pandemic continues to impact the number of meter applications received, and consequently, the possibility of decreasing demand via metering. Bristol Water expect this to hinder its longer-term targets in achieving 87% meter penetration by 2024 as well as the ability to drive down PCC to 129.4 l/h/d.

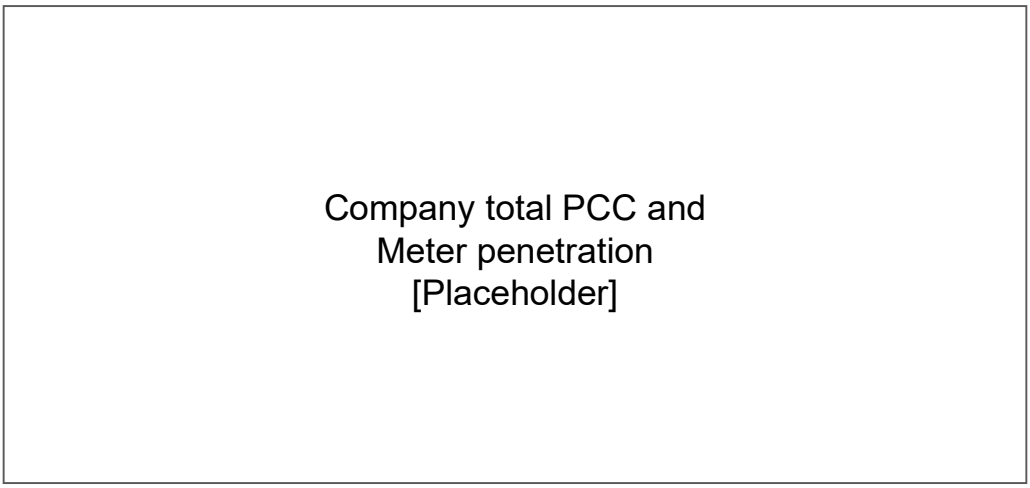


Figure 5.2: Company total PCC and meter penetration as well as forecast for end of year position regarding meter install

Placeholder

Text needed here to explain number of meters installed to date and whether meter installation has been accelerated since the onset of the drought and if so, by what % compared to a normal year. Narrative to any statistics available on engagement numbers to communications. For Figure 5.2 (Company total PCC and meter penetration) it is suggested to use a period to show 8-10 years depending on data availability.

In view of this, the company has focussed more effort on promoting the benefits of water efficiency and the links to metering. These campaigns are linked to the new resource efficiency partnership "Resource West" and social contract partnership approach on education and community engagement and are described in the next section.

5.2 Social contract and anticipated effect on demand

As mentioned in the above section, the company is undertaking a range of community initiatives and partnership campaigns as part of its social contract throughout 2020-25. These wider initiatives aim to help Bristol Water decrease PCC and drive responsible customer behaviour, although at this point, the effect of the social contract cannot be quantified. Example of some of the initiatives in 2020-21 are summarised below:

- **Resource West**: the aim of this programme is to work with local partners to deliver a joined up approach to reducing consumption across different sectors – combining resources and amplifying messages to customers. Lower consumption will also reduce the total energy Bristol Water use to treat and transport water, therefore reducing greenhouse gas emissions, as well as customers' carbon footprint. By doing so, Bristol Water will be encouraging reductions in public consumption of resources and increased local resilience.

- **Community Engagement projects**: the aim of this programme is to work collaboratively with community groups to address issues that impact the wellbeing of the community. By doing so, Bristol Water will provide public access to free drinking water, encourage reductions in consumption of single use plastic and provide public access to historic assets, providing education and wellbeing and education on the value of water.
- **Education projects**: the aim of this programme is to inspire a sense of collective responsibility through education on the value of water (and other resources) to develop citizens for the future. By doing so, Bristol Water will inspire the next generation on the value of water to foster a sense of responsibility and a willingness to act. This will encourage younger customers to reduce their consumption habits but to also contribute to harnessing 'pester power' to influence others.

Placeholder

Text to describe other actions taken such as increasing the offerings in Bristol Water's free pack, and community engagement with regards to water saving.

5.3 Leakage management

Managing leakage is one of the company's most important responsibilities and the leakage rate is lower than the industry average, placing Bristol Water in a leading position. Bristol Water's leakage performance commitment is measured in terms of total leakage, including customer supply-pipe leakage. Around 25% of leakage is attributed to households, with the rest being attributed to its network, noting that this is one of the oldest in Europe.

Leakage is measured on an ongoing basis and the company reports leakage formally an annual basis. Between 2017 and 2020, the company has decreased leakage by 22% and have an ambitious target to reduce this by a further 21.2% by 2025. The current target for the company agreed with Regulators is a three-year average of 38.2Ml/d and the mid-year leakage figures for 2020/2021 show that the company is on track to achieve this, with current leakage figures sitting at 39.5 Ml/d.

Placeholder

Text to explain how leakage has been reduced since the onset of the drought, over and above baseline leakage reduction efforts. Text should include details of any events such as freeze thaw, which might have led to an increase in the number of burst pipes, to contextualise the effort to detect and repair leaks.

Figure 5.3: Leakage trend over the past three years (including the drought event period)

Bristol Water has employed **XX** additional field crew members and made further investment in leakage reduction, in line with the Drought Plan as a result of the ongoing exceptionally low rainfall position. As part of this effort, it deployed **XX** additional loggers which helped detect an additional **XX** leaks in the system, over and above the normal leakage detection activity at this time of year. This additional effort translated into an additional **XX** leaks being repaired resulting in a saving of 2Ml/d of water (**this figure is in the current drought plan but may need revising in future**). This will continue as the company moves toward implementation of the drought permit and during its implementation but, it is not expected the achievable reductions will have any significant bearing on the need for the drought permit or the immediate or medium-term threat to supplies.

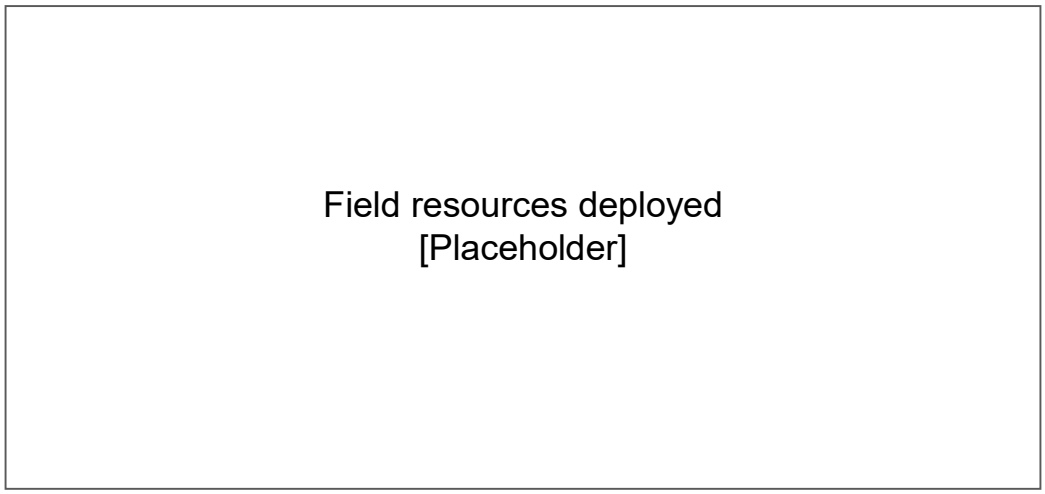


Figure 5.4: Trend in field resources deployed to tackle leakage over the past 3 years

The company has also increased the visibility of its "Leakstop" campaign publicity to encourage reporting of leaks by customers. The 'Leakstop' campaign has been advertised via **social media, radio and TV channels as well as online and written press**. As a result of this, there has been a **XX%** increase in the number of reported leaks. The company expects to sustain a reduction in leakage by continued active leakage control, improved leak repair performance, increased acoustic logging capabilities and, by maintaining a high level of flow and pressure data from the field.
The operations and maintenance teams have already been through a transformation process from the maintenance-centric approaches of the past that focused on fixing the burst as quickly as possible to the customer-centric approaches of today that focus first on maintaining service to customers wherever possible. This has led to the development of 'Continuous Water Supply' techniques (such as live clamp repairs) and a 'Safe Control of Operations' framework, which focuses on minimising stresses on the network.
In the long-term, Bristol Water plan to continue exploring innovative approaches to the management of assets through the continuation of optimised pressure management schemes, further development of dynamic and adaptive areas as well as exploration of Smart Network techniques to exploit the vastly increased number of logging devices that have been installed throughout the distribution network.

5.4 Promotion of water efficiency

Since the beginning of summer 2020 and particularly more recently, since entering Zone 2, the company has utilised a variety of media channels to promote a range of drought awareness raising and water efficiency messaging to encourage reduction in consumption as part of its Agile communication strategy. The communication campaign has been escalated proportionally based on the Drought Zones, as shown in Section 5. The particular actions undertaken since entering Zone 2 include:

- Increasing the prominence of the website homepage, which provides updated information on reservoir levels and features tips to save water to encourage voluntary restraint, in the context of the dry weather conditions being experienced at this time.
  - *Over the past few weeks since entering Zone 2, the efforts to promote the website page have resulted in a **XX%** increase in customer engagement via the website.*
- Promoting social media targeted adverts and video/animation for social media and/or website.
  - *In total, social media posts featuring calls for voluntary restraint and water saving tips have reached **XX** customers (based on the number of clicks and retweets).*
- Developing content for press releases/radio interviews to explain the evolving water resource situation.

Placeholder

In a real drought Bristol Water would have to provide more detail on the specific messaging to customers i.e. screenshots of banners, advert boards etc. to illustrate the scale of the drought communication campaign.

Figure 5.5: Promotion examples. Further snapshots of social media engagement should be included here

5.5 Outage

The company's overall outage position has been reported annually to the Environment Agency each year recently and a current summary is included in Appendix 7.1.1.1.7 to this application and source (abstraction licence) utilisation statistics have been presented in Appendix 7.1.1.1.5, including summary of unused sources.

Placeholder

Text to detail any unused sources due to outage and plans to bring them back online. Also include details for outage planning and improvements to this going forward (i.e. any investment and benefits). State whether the outage issues have any bearing on the drought permit application.

The level of unplanned outage for 2020 is 0.87% of peak week production capacity, which is below the company's target for 2020/2021 of 2.34%. Given that Zone 4 has been entered the company has started to minimise the level of planned maintenance to avoid outage during the coming weeks.

Placeholder

Text to discuss the actions taken to minimise outage and treatment losses, the sites that outage have been reviewed at, any additional actions have taken place to further reduce outage from happening at these sites, number of extra crews recruited or to be to speed up the recovery and savings made (ML/d) as a result of postponing or speeding outage works.

5.6 Implementing water use restrictions

As dry weather continues into drought conditions and the risk to water supply increases, more formal water use restrictions may be required such as temporary use bans (TUBs) and non-essential use bans (NEUBs). These can restrict garden watering and other non-essential use such as filling pools and washing cars. The company would normally implement TUBs upon entering Zone 4 and NEUBs upon entering Zone 5. However, previous work shows that implementing such restrictions in winter/early spring would not have a major impact on the water resources position, above and beyond the impact of voluntary restrictions as a result of the Agile Communication Campaign. Therefore, the company will start consulting on the implementation of TUBs in early-March and will commence the imposition of TUBs in April, if the resource position does not significantly improve. The company plans to gather data on the demand savings achieved by implementing TUBs and consider whether NEUBs would also be necessary. It will liaise closely with the Environment Agency to ensure the effective implementation of restrictions on customers.

Placeholder

Text and graphs – at the time of the application, more information should be included here to justify delaying TUBs implementation. The text should refer to the analysis of temperature and soil moisture data presented in earlier sections and must justify the delay in implementing TUBs in April based on the conditions experienced at the time of application and forecast weather, as well as a quantification of the benefit (or lack of benefit) TUBs might have if implemented earlier. If data is available, potential benefits of TUBs should be compared to situation if in the absence of TUBS.

Placeholder

SDB position – Table and associated text to highlight that despite all actions described above being undertaken, the savings achieved are still insufficient to meet demand and therefore a drought permit is needed.

6 Stakeholder Engagement

Upon entering Zone 2, Bristol Water has started consultations with the following organisations, providing them with the opportunity to raise any concerns prior to submission of the application. Details of the timeline for engagement with stakeholders is detailed in Table 6.1**.** The full list of organisations consulted with in regard to this drought permit application is provided below:

- Environment Agency
- DEFRA
- Natural England
- Avon Wildlife Trust
- Bristol Avon River Trust
- Bristol Avon Catchment Partnership
- Severn Vale Catchment Partnership
- Salmon & Trout Conservation UK
- Bristol Water Non-Household Retail Customers
- Wessex Water
- Severn Trent Water
- National Farmers Union
- Bath & North East Somerset Council
- Somerset Council
- Bristol City Council
- South Gloucestershire Council
- Council for the Protection of Rural England
- West Country Water Resources
- Chew Magna Flood Forum
- Keynsham Anglers Association
- Bathampton Angling Association
- Knowle Angling Association
- Chew Fly Fishing Club.

The same parties have now been formally notified of the company's intention to apply for a drought permit at Chew Reservoir. The draft notice has been sent to these parties and published

in local newspapers (including the London Gazette) and online publications in the supply area, is included in Appendix 7.1.1.1.1. Following consultation with these parties, the company does not expect any objections to the proposals. The company research did not indicate the potential for impact on any other abstractors apart from Bath and North East Somerset Council who have an abstraction near Keynsham. However, the impacts of the drought permit implementation on this reach are expected to be minor and therefore the company does not expect any objections from the council.

Table 6.1: Summary of stakeholder engagement in line with Bristol Water's drought plan

Dates on which stakeholder engagement took place	Stakeholder liaison actions	Details
xx/xx/xxxx	Advise key stakeholders of situation (Environment Agency, Consumer Council for Water)	
xx/xx/xxxx	Implement increased Environment Agency liaison in line with Management and Communication plan	
xx/xx/xxxx	Briefing and working with stakeholder groups	
xx/xx/xxxx	Briefing of Environment Agency, Consumer Council for Water, Defra and stakeholder groups	
xx/xx/xxxx	Planning supply security for vulnerable customers	
xx/xx/xxxx	Increased frequency of briefing of Environment Agency, Consumer Council for Water, Defra and stakeholder groups	

Placeholder

At the time of application, this table will be expanded to include details of all stakeholders engaged, the dates of each engagement and general topic of engagement under the 'Details' column (including pre-application consultation).

7 Conclusion

Due to the exceptional shortage of rainfall described in Section 4.4, specifically the dry preceding winter, reservoir storage has been significantly reduced. Mendip Reservoir levels are currently at less than 60% capacity, having not had sufficient winter rainfall to recharge these storage levels. This means that as the company plans for this summer the drawdown will be starting with the reservoirs at just over half of their capacity. This poses a direct threat for a serious deficiency of supply and level of service for customers.

Bristol Water has implemented a series of drought management actions and maintained agile communication throughout this period, however evidence has deemed it necessary to apply for this drought permit to stabilise any threat to supply over the next few months. Section 4.6 demonstrates the impact that this drought permit could have on supply security and why it is necessary to apply at this time.

Appendices

7.1.1.1.1 Notice of Application for Drought Permit

Bristol Water Plc
NOTICE OF APPLICATION FOR DROUGHT PERMIT
River Chew Catchment

TAKE NOTICE that due to the threat of a serious water shortage in the area served by Bristol Water PLC, caused by an exceptional shortage of rain in our supply area, **BRISTOL WATER PLC (company number 02662226)** whose registered office is at **Bridgwater Road, Bristol, BS13 7AT** is applying to the Environment Agency for a drought permit under Section 79A of the Water Resources Act 1991.

Bristol Water has a licence (**number 17/53/14/S/016**) to abstract water under the Water Resources Act 1991 at Chew Reservoir. The licence also authorises two stream capture systems which permit the transfer of stream flows into Chew Reservoir from outside the reservoir's natural catchment area. These are Chew Stoke Stream and Winford Brook (impounded at Chew Magna Reservoir), both tributaries of the River Chew.

Abstraction for public water supply is made directly from Chew Reservoir and piped by gravity to Chew Stoke Pumping Station. From there water is pumped into storage at Barrow or direct to Bristol Water treatment works (Stowey). When the reservoir is full and overflowing, the excess water flows into the River Chew immediately downstream of the reservoir.

The abstraction licence from Chew Reservoir includes the following conditions:

- A daily maximum abstraction of 113.65Ml/d (million litres per day).
- An annual limit of 22,000Ml (1 April to 31 March)

For the River Chew, the licence requires a compensation release downstream of the Chew Reservoir impoundment of:

- 14.32Ml/d during the period 1 May to 30 November

  and
- 6.819Ml/d between 1 December to 30 April.

At Chew Magna Reservoir, the licence requires the continuous, uniform release of compensation water to the Winford Brook downstream of the Chew Magna Reservoir impoundment of:

- 3.41Ml/d during the period 1 May to 31 September

  and

- 2.273Ml/d at other times.

The proposed drought permit is intended to apply until mid-September 2021 and will involve the reduction of the compensation flows released from Chew Reservoir to the River Chew (NGR ST570616). By lodging the drought permit application for Chew Reservoir, Bristol Water is seeking to reduce the compensation flow requirement as outlined below:

- A reduction in summer compensation flows of 7.32 Ml/d (51%) between May and November, resulting in a compensation flow of 7 ML/d to the River Chew, for this period.
- A reduction in winter compensation flows of 3.419 Ml/d (50%) between December and April, resulting in a compensation flow of 3.4 Ml/d to the River Chew, for this period.

The proposed drought permit will allow Bristol Water to retain more water in the Chew Reservoir until the mid-September 2021. This will help Bristol Water maintain reservoir stocks over the next six months, therefore supporting water supply to customers in the Bristol Water supply area.
Bristol Water is required to show that the threat to a deficiency of water supply relates to an "exceptional shortage of rainfall." within its drought permit application.
The anticipated effect of the drought permit, if granted, is described in the Environmental Assessment Report which has been prepared in consultation with the Environment Agency and Natural England. The report highlights potential impacts on the hydrology and ecology of the River Chew and as a consequence, Bristol Water has prepared a monitoring and mitigation programme in consultation with the Environment Agency and Natural England.
Anyone may inspect the drought permit proposal documentation (including the Environmental Assessment Report) at the following locations, free of charge, during normal working hours for a period of seven working days from the publication of this notice:

- Bristol Water Offices at Bridgwater Road, Bristol, BS13 7AT;
  Open Mon-Fri between 9am and 5pm. Closed on Saturday and Sunday
- Hartcliffe Library at Symes Community Bldg, Peterson Ave, Bristol BS13 0BE
  Opening times TBC
- Defra - Environment Agency South West at District Office at Bath Road Industrial Estate, Chippenham, SN14 0AB
  Open Mon-Fri between 9am and 5pm. Closed on Saturday and Sunday

Copies of the proposals are also available to view on our website:
https://www.bristolwater.co.uk/about-us/planning-for-drought/
Objections may be made in writing to the Environment Agency, by no later than 3rd of March 2021 at:

Water Resources Permitting Support Centre,
Environment Agency,
Quadrant 2,
99 Parkway Avenue,
Parkway Business Park,
Sheffield,

S9 4WF

or

Email: PSC-WaterResources@environment-agency.gov.uk

Objectors may send a copy of their objection to Bridgwater Road, Bristol, BS13 7AT or Water.Resources@bristolwater.co.uk (Please title the e-mail – Bristol Water Drought Permit Application).

5th of February 2021

Signed:
Mel Karam
Bristol Water CEO

7.1.1.1.2 Exceptional Shortage of Rain

7.1.1.1.2.1 Mock Exercise Advisory Notes

As part of this mock application there are a few important notes to take into account while reviewing this ESoR.

- Synthetic rainfall has been used to create a period of drought to provide evidence for this ESoR. The rainfall analysis below is a combination of HYSIM model rainfall inputs for the Mendip reservoirs, and synthetic droughts created for the inflows. This rainfall analysis does not reflect real data, but is based on realistic rainfall volumes. Throughout this section, this synthetic rainfall will be referred to as real data, any notes regarding the data origin or calculations will be included as footnotes.
- It is acknowledged that in the event of a real drought permit application, Bristol Water will use areal rainfall data for the hydrological area of interest, provided by the Environment Agency.
- The period of analysis has been chosen to coincide with the synthetic drought starting (November 2019) to the end of January (2021). In reality, the period of analysis will be agreed in advance of submission of the drought permit with the relevant Environment Agency hydrologist, the Area Drought Coordinator and Bristol Water Lead. This exercise assumes that this period of analysis has been agreed prior to submission.
- The area of interest is the Mendip Reservoirs, specifically Chew Reservoir. For this mock exercise, existing rainfall that covers these reservoirs' HYSIM models was used. In real drought permit Bristol Water will need to liaise with the Environment Agency to establish a suitable hydrological area of focus. Bristol Water WRZ overlaps multiple Environment Agency hydrological areas. It is assumed that a chosen shapefile that covers the Mendip reservoir catchments would be used, this custom shapefile would need to be provided to the Environment Agency to extract relevant rainfall data. This area is significantly over 10km^2 so is within the appropriate sizing declared in the Environment Agency guidance.
- Footnotes are provided throughout this document for clarity and placeholders for text and charts that are not available for this mock exercise have been included for guidance. The ESoR has been drafted in a format that can be followed for a real permit so we assume in-text that all of the above assumptions have been made and approved.

- All ESoR plots are to be reviewed by the ESoR tools that will be provided by the Environment Agency (March, 2021). Existing charts are included to provide context for discussion. The ESoR tools were not available at the time of report release.

7.1.1.1.2.2 Exceptional Shortage of Rain

Placeholder

This section requires Bristol Water to liaise with the Environment Agency when the intention to apply for the permit becomes apparent. Bristol Water will agree the period of analysis and geographical extent of analysis with the Environment Agency hydrology team. At the stage of agreeing geographical extent, the rainfall records can be requested from the Environment Agency dataset.

This Drought Permit application is made due to a threat to supplies in the Bristol Water system, resulting from an exceptional shortage of rain over the past 15 months, starting in November 2019. The winter recharge of the Mendip Reservoirs has been affected by the low rainfall levels over this period and has resulted in a depletion of the water storage levels in Chew Reservoir.

Rainfall is essential to the supply of water. This appendix sets out the analysis of the rainfall data to quantify this rainfall event as an ESoR. A comparison is made between the amount of rainfall experienced recently and the amount of rainfall that would usually be expected, as well as setting out comparisons of historic events. Supporting the rainfall analysis, other climatic metrics set out in Section 4.3 have been analysed and presented in this appendix.

The development of our ESoR case is based on Environment Agency guidance (Environment Agency, 2021) as well as guided by other Water Company Drought Permit and Order Applications that have been made in recent years.

The key elements of the analysis laid out in this section are:

- General background to rainfall records, period of analysis and geographical extent of analysis.
- Presentation of rainfall records, analysing the current event against historic and long-term average rainfall records.
- Presentation of ranking methods, calculation of Standard Precipitation Indices (SPI) and estimated return period analysis.

Rainfall Data

Bristol Water monitors the water resource situation throughout the year and across its supply area as part of the daily operations and water supply planning.

As stated in Section 4.3.1 Bristol Water has seven rain gauges across the supply area. The data recorded from the company's rain gauges is available on Bristol Water's telemetry system as a daily total. Rainfall is reviewed on a weekly basis, but in times of a drought, like present day, this rainfall is monitored daily. This rainfall gauge data has been used to support the case for an ESoR. Rainfall supports the inflows into the Mendip Reservoirs. The lack of rainfall in recent months has resulted in the reservoirs not filling as fast, or to the level expected. For this drought permit application, the rainfall has been assessed for the Mendip Reservoir catchments (Blagdon, Cheddar, Chew, River Axe (Henley) and Chew Magna (Winford)).

The data used to assess the rainfall for this ESoR is the areal HadUK dataset[7], provided by the Environment Agency. Comparisons have also been made with the local rainfall gauged data[8] to support evidence of an exceptional shortage of rainfall.

Period of Analysis

> **Placeholder**
> For the purpose of this mock exercise it is assumed that this assessment period has been agreed prior to this application. This would be discussed with the Environment Agency in the initial engagements when notifying of a potential application.

The period of analysis has been chosen to coincide with the start of the dry period we are experiencing, starting in November 2019, to January 2021. This allows the winter recharge seasons to be analysed and compared with historic events and reservoir levels. Section 7.1.1.1.2.3.1 further highlights why this is an appropriate period of reference by plotting the existing rainfall event against the long-term average.

Geographical extent of analysis

> **Placeholder**
> For the purpose of this mock exercise it is assumed that this has been agreed with the Environment Agency prior to this application. This would be discussed in the initial engagements when notifying of a potential application.

The area of interest is the Mendip Reservoirs, specifically Chew Reservoir. As an integrated water resource for Bristol Water, this area was chosen specifically to cover all of the reservoirs as this will give us a true reflection of the state of the resource situation as a whole.
Ahead of this application Bristol Water has agreed with the Environment Agency hydrology team that the Mendip Reservoirs area is a suitable area of focus. As the Bristol Water WRZ overlaps multiple Environment Agency hydrological areas, a shapefile that covers the Mendip reservoir catchments was provided to the Environment Agency to extract relevant rainfall data.
Figure 7.1.1.1.2.1: shows the geographical extent of analysis, covering the Mendip Reservoirs and the location for our drought permit application.

[7] Exercise Note: For the purpose of this exercise, existing hydrological model rainfall inputs and synthetic records were used to provide appropriate evidence for this synthetic drought. The areal HadUK Environment Agency dataset would be used in a real drought permit.
[8] Exercise Note: The rainfall gauged data is not real. It has been derived from synthetic rainfall for the area HYSIM inflow models. The Chew model rainfall has been used to represent the rainfall gauge in this catchment.

Geographical Extent of Analysis
Map
[Placeholder]

Figure 7.1.1.1.2.1: Geographical extent of rainfall analysis for the ESoR for this drought permit application

Source: Bristol Water Mendip Reservoir shapefile.

7.1.1.1.2.3 Technical rainfall analysis

7.1.1.1.2.3.1 Recent rainfall in the Mendips

The Mendip Reservoirs are key assets for Bristol Water. The rainfall records for the hydrological area covering the Mendips Reservoir are covered in this section. This analysis demonstrates the lack of rainfall this area has been experiencing for the past 15 months.

Figure 7.1.1.1.2.2 plots the LTA[9], against the recorded rainfall of the Mendip Reservoir Catchments. This figure indicates that:

- Prior to November 2019, monthly rainfall totals in the catchment were very consistent with the long-term average (LTA) record.
- Rainfall in this catchment has been less than the LTA in every consecutive month since November 2019.
- Two winter recharge periods have been affected by this drought.

[9] Exercise Note: Values for LTA have been taken from a previous consultancy project and the period of reference is 1961-2009. It is acknowledged that any evidence presented for the real permit with have the LTA value of 1961-1990 to remain consistent with Environment Agency guidance.

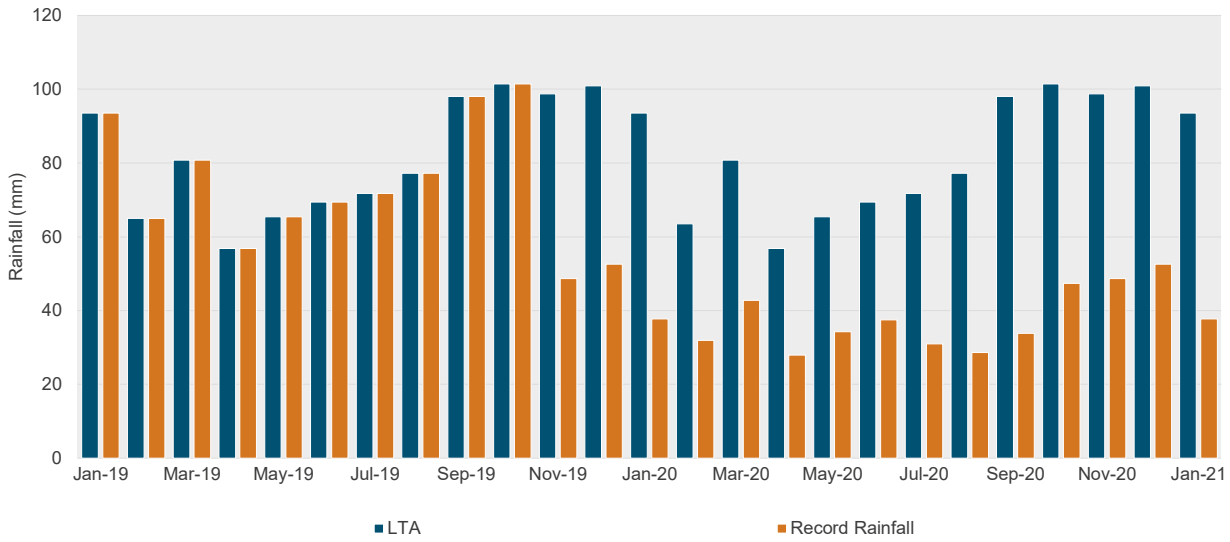


Figure 7.1.1.1.2.2: Monthly rainfall totals from January 2019-January 2021

The deficit portrayed in Figure 7.1.1.1.2.2 has been further summarised in Table 7.1.1.1.2.1, calculating the percentage of LTA rainfall experienced in the region. In the six months prior to the end of January 2021 only 249mm of rainfall had occurred, which is 44% of the LTA and in the 12-month period rainfall has been 46% of LTA. Over the longer periods (18 and 24 months) rainfall has been below the LTA, but the difference is less severe.

Table 7.1.1.1.2.1: Accumulated rainfall deficits over the past 6-24 months

	Long term cumulative rainfall deficits to end of January 2021			
	Aug20-Jan21	Feb20-Jan21	Aug19-Jan21	Feb19-Jan21
Number of Months	6 Months	12 Months	18 Months	24 Months
Rainfall (mm)	249	454	870	1279
Rainfall Deficit (%) of LTA	44	46	56	65

Table 7.1.1.1.2.2: demonstrates a more comprehensive comparison of the rainfall against the LTA record. The record has been displayed from February 2020 to the end of January 2021, and cumulative rainfall has been recorded for periods of up to 12 months prior. The LTA (%) has then been recorded for each duration. For example, the 9-month cumulative rainfall from Jan-21 is 351.36mm, this is only 45.2% of the LTA value. This further demonstrates the deterioration in cumulative rainfall since November 2019 in this catchment.

Table 7.1.1.1.2.2: Cumulative monthly rainfall with %LTA (1961-2009)

Period (months) of cumulative rainfall	Period Ending in Month											
	Feb 20	Mar 20	Apr 20	May 20	Jun 20	Jul 20	Aug 20	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21
1	31.90	42.78	27.93	34.20	37.48	30.96	28.63	33.82	47.36	48.61	52.57	37.75
	49.0%	53.0%	49.1%	52.3%	54.0%	43.1%	37.1%	34.5%	46.7%	49.2%	52.1%	40.4%
2	69.65	74.69	70.71	62.13	71.68	68.43	59.58	62.44	81.17	95.97	101.18	90.32
	43.9%	51.2%	51.4%	50.8%	53.2%	48.5%	40.0%	35.6%	40.7%	47.9%	50.7%	46.5%
3	122.22	112.43	102.61	104.91	99.60	102.63	97.06	93.40	109.80	129.78	148.54	138.93
	47.1%	47.0%	50.6%	51.7%	52.0%	49.7%	44.4%	37.8%	39.7%	43.5%	49.3%	47.4%
4	170.83	165.01	140.36	136.81	142.38	130.56	131.26	130.88	140.75	158.41	182.36	186.29
	47.7%	48.5%	47.4%	51.0%	52.3%	49.6%	46.2%	41.4%	40.4%	42.2%	45.7%	47.2%
5	272.32	213.62	192.93	174.56	174.29	173.34	159.19	165.07	178.23	189.37	210.98	220.10
	59.2%	48.7%	48.6%	48.3%	51.6%	50.4%	46.7%	43.2%	42.6%	42.3%	44.3%	44.7%
6	370.36	315.10	241.54	227.13	212.04	205.25	201.97	193.00	212.43	226.84	241.94	248.73
	66.4%	58.3%	48.7%	49.1%	49.2%	50.1%	47.9%	44.0%	43.9%	43.9%	44.1%	43.6%
7	447.57	413.14	343.03	275.74	264.61	242.99	233.87	235.78	240.36	261.04	279.41	279.69
	70.5%	64.7%	57.4%	49.1%	49.7%	48.3%	48.1%	45.4%	44.5%	44.8%	45.2%	43.6%
8	519.33	490.35	441.07	377.23	313.22	295.56	271.62	267.69	283.14	288.97	313.61	317.16
	73.5%	68.5%	63.4%	56.9%	49.7%	49.0%	46.8%	45.8%	45.6%	45.2%	45.9%	44.6%
9	588.76	562.11	518.28	475.27	414.70	344.18	324.19	305.44	315.04	331.75	341.54	351.36
	75.9%	71.4%	67.1%	62.5%	56.6%	49.0%	47.6%	45.0%	45.9%	46.1%	46.2%	45.2%
10	654.18	631.54	590.04	552.48	512.74	445.66	372.80	358.01	352.79	363.66	384.32	379.29
	77.7%	73.7%	69.9%	65.9%	61.8%	55.4%	47.8%	46.0%	45.3%	46.3%	46.8%	45.5%
11	711.03	696.96	659.47	624.24	589.96	543.70	474.28	406.62	405.36	401.40	416.23	422.07
	79.1%	75.6%	72.2%	68.6%	65.0%	60.3%	53.8%	46.3%	46.0%	45.7%	47.0%	46.2%
12	791.80	753.81	724.89	693.67	661.72	620.91	572.33	508.10	453.97	453.97	453.97	453.97
	80.9%	77.0%	74.0%	70.8%	67.6%	63.4%	58.5%	51.9%	46.4%	46.4%	46.4%	46.4%

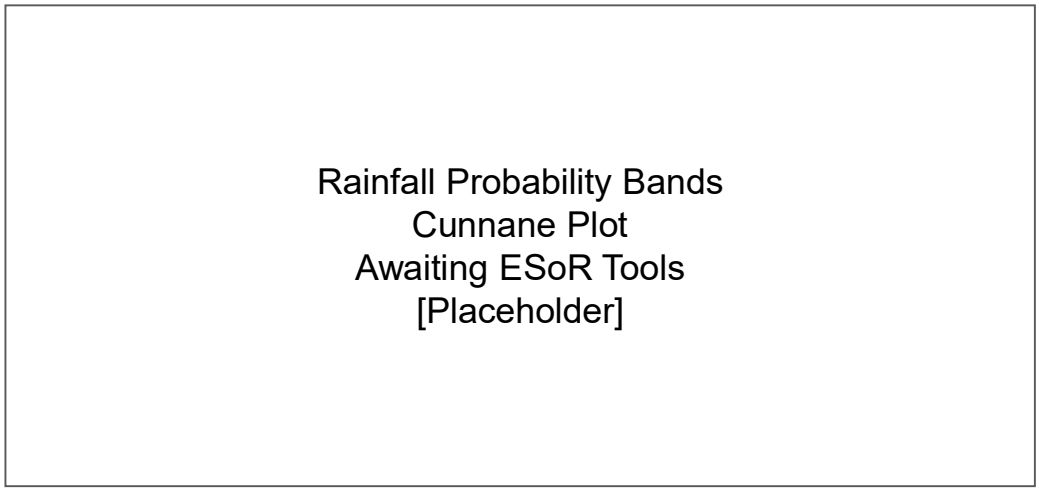


Figure 7.1.1.1.2.3: Analysis of rainfall probability bands by monthly duration on cunnane plot

Analysis of rainfall probability bands by monthly durations are plotted on a Cunnane plot in Figure 7.1.1.1.2.3. This rainfall ranking allows the comparison of the current dry period against the historic record, contextualising the severity of the event.

Placeholder

Further observations of the rainfall probability bands to be inserted in a real drought permit. Rainfall probability bands will be created using the ESoR Environment Agency Tools to be shared as part of this drought exercise.

Figure 7.1.1.1.2.4 plots the cumulative LTA and recent rainfall and focuses on the same period of November 2019 to January 2021. The plot shows that we would have expected to have had ~1270 mm of rain since November 2019 but actual rainfall has been ~593mm.

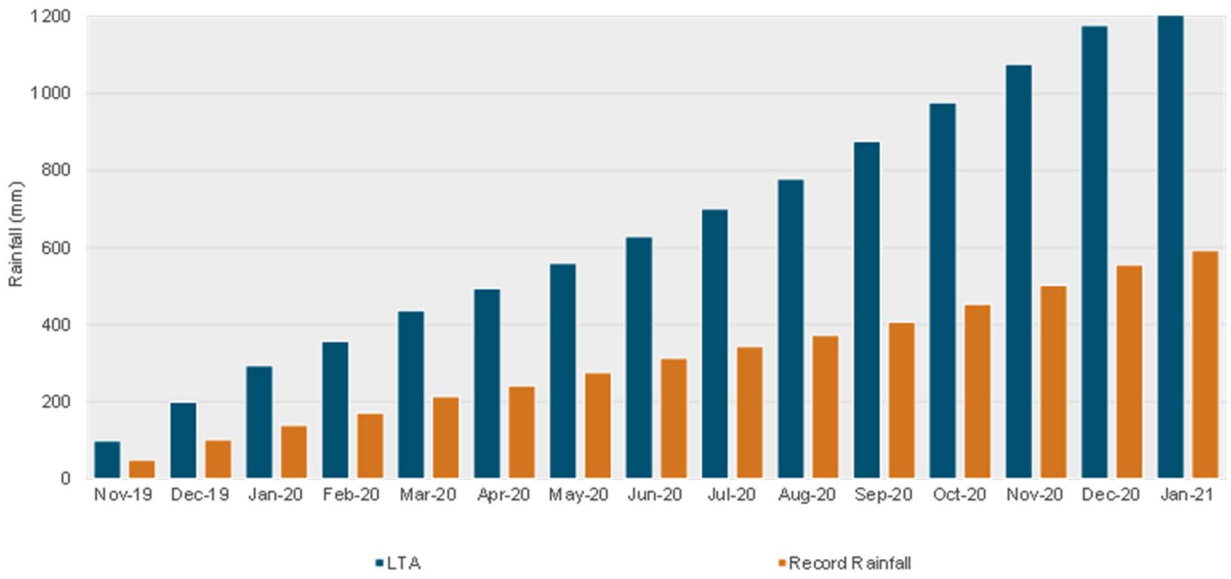


Figure 7.1.1.1.2.4:Cumulative rainfall plots, November 2019 – January 2021

7.1.1.1.2.3.2 Rainfall at Chew Reservoir

Chew Reservoir is located in the Mendips and is the site of this drought permit application. In Table 7.1.1.1.2.3 the rainfall measured at the gauge[10] at Chew Reservoir and the Mendip Reservoir Catchment data is presented. All analysis for the ESoR is based on the areal data from the Environment Agency, however observing the gauged data that is from the precise location supports the case. It is clear that the shortage of rainfall is universal across the catchment area, with very similar deficits felt at gauges in key areas. Since February 2020, rainfall levels have been 47% of LTA at Chew Reservoir.

Table 7.1.1.1.2.3: Accumulated rainfall deficits over the past 6-24 months

	Long term cumulative rainfall deficits to end of January 2021			
Number of Months	**6**	**12**	**18**	**24**
Chew Rainfall (mm)	255	476	901	1312
Mendip Reservoir Catchment Rainfall (mm)	249	454	870	1279
Chew Deficit (%) / (mm)	43 / 343mm	47 / 531mm	56 / 703mm	65 / 703mm
Mendip Reservoir Catchment Rainfall (%) / (mm)	44 / 321mm	46 / 524mm	56 / 677mm	65 / 677mm

7.1.1.1.2.4 Comparison with historic events

Whilst the previous section describes the current lack of rainfall, this section compares that deficit of rainfall to previous droughts experienced within our system.

[10] Exercise Note: This is not real gauged data, instead it is HYSIM inputs for the Chew model.

The exceptional shortage of rainfall that we have been experiencing is beyond that of our worst recorded historic drought. Figure 7.1.1.1.2.5: shows the cumulative rainfall over the current event, compared with the cumulative rainfall of our most notable historic droughts.

Placeholder

Further discussion will be entered here for the cumulative plots in a real drought permit application – including severity of deficit.

Figure 7.1.1.1.2.5: Previous drought years plotted with current rainfall event

Table 7.1.1.1.2.4 presents the rainfall totals for the most notable events for the Mendips Reservoir Catchment area. Here, we have included the rainfall record up to the end of January 2021 for comparison. The most notable droughts in Bristol Water's history were in 1921-22 and 1933-34, yet the table shows that 2019-2021 is significantly worse for the equivalent duration of these previous droughts. For instance for the last 6 months we have received 44% of LTA rainfall, while in the previous worst 6-month drought we received 53.6% of LTA rainfall.

Table 7.1.1.1.2.4: Rainfall deficits (%LTA) for selected events

Year	6 Months	12 Months	18 Months	24 Months
2021	**44**	**46**	**56**	**65**
1921	53.6	63.5	73.8	87.3
1922	88.9	94.9	80.6	78.8
1934	73.8	67.6	66.4	72.2
1947	58.7	83.8	96.9	100.3
1956	91.3	82.0	76.3	79.5
1964	66.9	65	81.8	83.2
1976	105.3	79.4	78.8	81.8
1978	63.9	83.3	85.7	93.4

Source: HR Wallingford, 2018. Drought Vulnerability Framework and Design Droughts.

Figure 7.1.1.1.2.6: Ranking of current and historic rainfall events by duration

Placeholder

Rainfall ranking is part of the ESoR tools package that the Environment Agency will be sending to support Bristol Water's application ready preparedness.

In Figure 7.1.1.1.2.6 the cumulative rainfall totals for the period of analysis are compared against the equivalent period within the historic record. The rainfall total from each year has then been ranked to determine the relative ranking of the current period against the historic context. While the cumulative rainfall plots and %LTA values compared in Table 7.1.1.1.2.4 similarly demonstrate

that this current event is an extreme drought, this ranking method provides a more period specific to draw comparisons.

7.1.1.1.2.4.1 Winter Rainfall

Winter rainfall is especially important for Bristol Water's supply systems as this period enables the Mendip reservoirs to refill. The winter refill period is from November to the end of March.
Table 7.1.1.1.2.5 presents the lowest historic winter (taken as November to March) precipitation totals as a percentage of the LTA. The winter of 2019/2020 is the second worst winter on record.

Table 7.1.1.1.2.5: Worst historic winter rainfall as a percentage of LTA (1960/61 to 2008/09)

Year	Percentage of LTA
1933/34	46%
2019/20	49%
1917/18	56%

7.1.1.1.2.5 Standardised Precipitation Index

The SPI values for the chosen catchment demonstrates that this drought period is exceptionally dry. SPI Values were calculated for 6,12-,24-,36- and 48-month droughts. A further plot of 15-month drought has been included to represent the length of the drought we have been experiencing so far for our analysis period. This provides a good visual comparison to the values of the other droughts.

Figure 7.1.1.1.2.7 demonstrates the SPI for the rainfall record[11] for a 12 month drought. It is clear that the period that we are in currently is lower than anything we have experienced for a 12-month drought. Figure 7.1.1.1.2.8 is similar, but is for a 15 month drought, the SPI values for this duration are also the lowest on record.

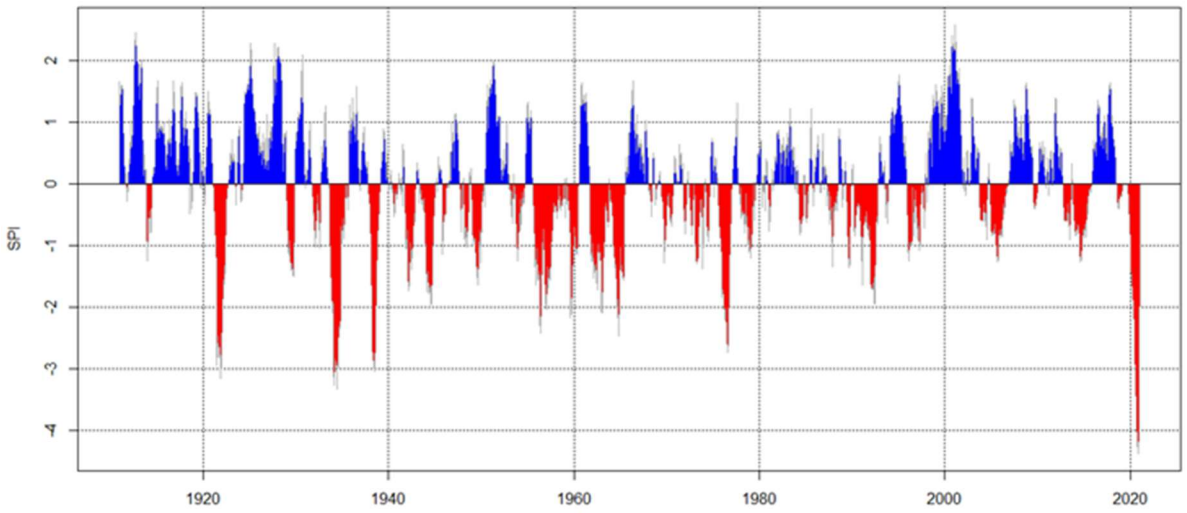


Figure 7.1.1.1.2.7: 12-month drought SPI Values for the Mendip Reservoir catchment

[11] Exercise Note: Mock exercise rainfall data only goes back to 1910. In a real drought permit the entire record of 1891-present day will be analysed with this method.

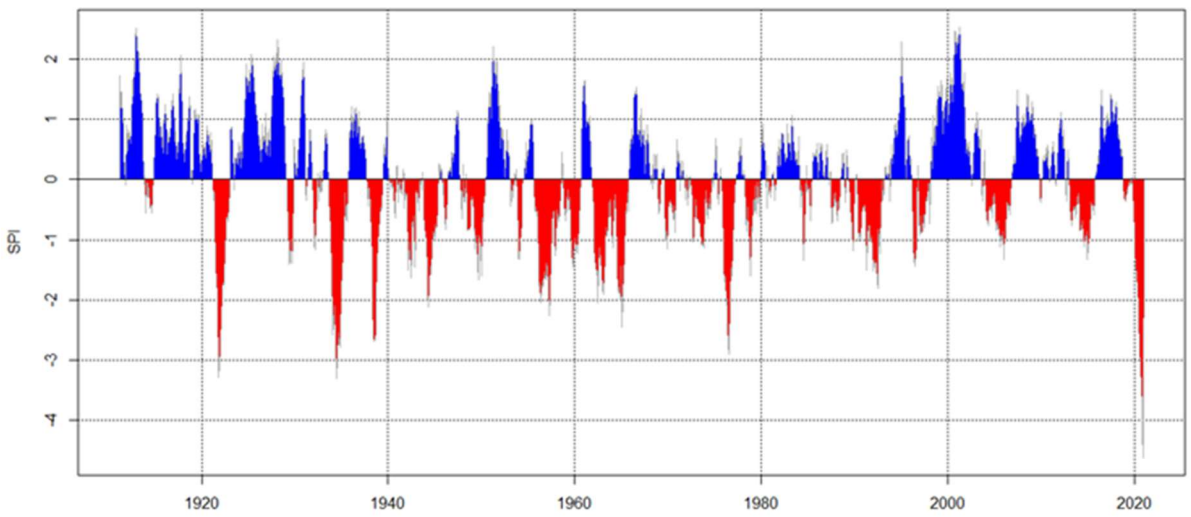


Figure 7.1.1.1.2.8: 15-month drought SPI Values for the Mendip Reservoir catchment

Standard Precipitation Index (SPI) analyses shows that for much of the past 12 months SPIs have been negative, signifying a prolonged period of below average rainfall. In particular, significantly low SPIs (< -3) occurred in Autumn and Winter 2020.

The current drought started in November 2019, and it is clear in the 6,12- and 15-month SPI values (Table 7.1.1.1.2.6) that this drought has been exceptionally dry (values less than -2.0 are deemed 'exceptionally dry'.). Figure 7.1.1.1.2.6 further demonstrates the negative SPI values and highlights the clear downward trend towards present day.

Placeholder

These charts would be further supported with short term SPI value plots of a similar format to Figure 7.1.1.1.2.6.

Table 7.1.1.1.2.6: SPI Table for current drought ending at the end of January 2021

Number of Months	6	12	15	24	36	48
SPI Value	-3.36	-4.12	-4.90	-3.31	-2.75	-1.91

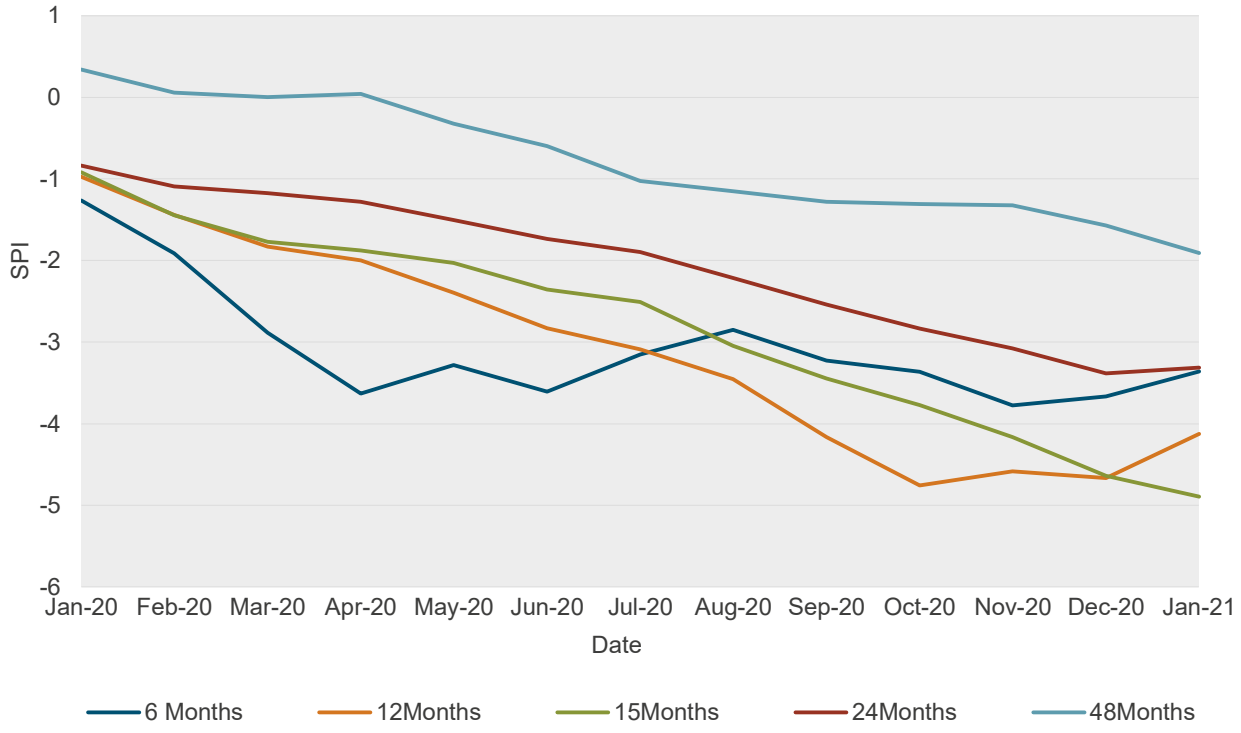


Figure 7.1.1.1.2.9: Variations in SPI's from present day (January 2021)

7.1.1.1.2.6 Extreme Value Analysis and Return Periods

Whilst the analysis above compares the actual rainfall with LTAs, below we compare the rainfall deficit against different return periods. This approach is based on the UKWIR Drought Vulnerability Framework (DVF) (UKIWR, 2017).

7.1.1.1.2.6.1 EVA Background

Extreme Value Analysis (EVA) was completed as part of Bristol Water's Drought Vulnerability Framework consultancy study in 2018. Here, the historical rainfall data was used to understand the rainfall deficits associated with different return periods for each duration.

The study explored fitting four distributions (PoT Gumbel, PoT Weibull, Generalised Extreme Value (GEV) and Generalised Pareto Distribution (GPD)) to the historic data (Figure 7.1.1.1.2.10:).

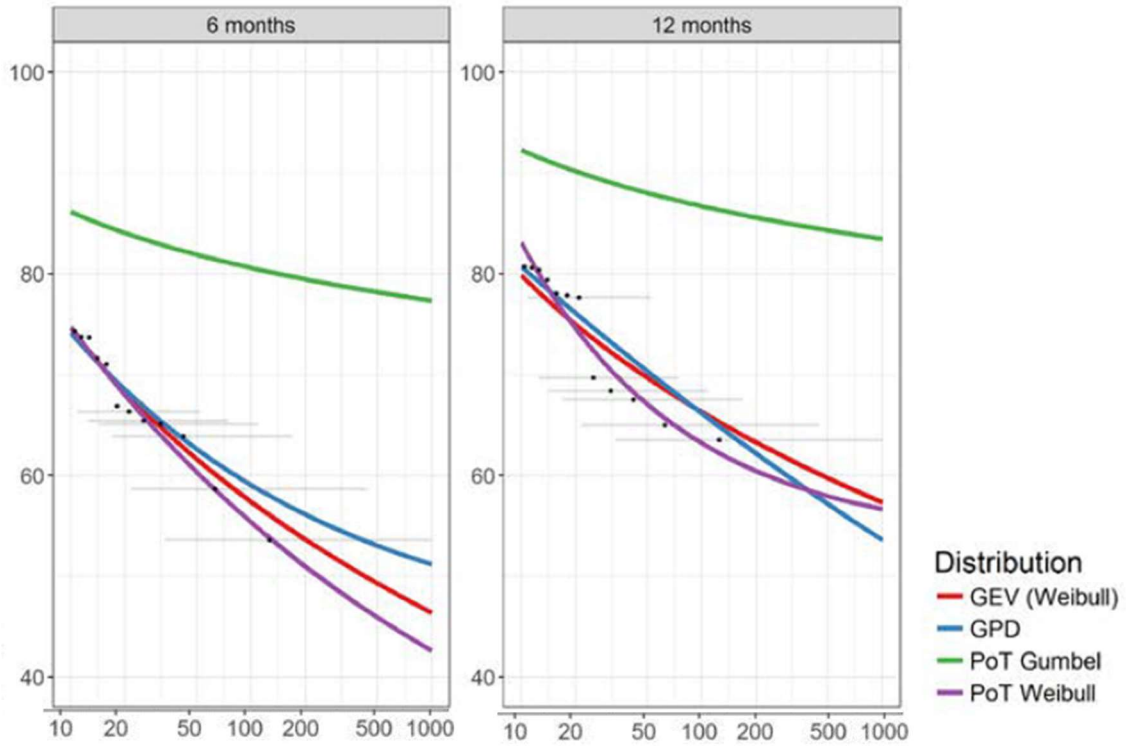


Figure 7.1.1.1.2.10: Extreme Value Curve fits for rainfall deficit (%LTA) for different durations (period ending in November) – focussing on higher return periods

Source: HR Wallingford, 2018. Drought Vulnerability Framework and Design Droughts.

Table 7.1.1.1.2.7 below shows the results of the analysis. In the table the rainfall deficit for different return periods is shown. For instance, it shows that for the GEV distribution you would expect a rainfall deficit of 57.3% to have a return period of 1:1000. To remain consistent with the EVA assessment assumptions, the current drought clipped to November 2020 has been used, this 12-month drought has an LTA of 46% (ending in November 2020), meaning that the event exceeds a 1 in 1000 year return period.

Table 7.1.1.1.2.7: Rainfall Deficit (%LTA) by return period for 12-month duration (period ending November)

Return Period	GEV	PoT Weibull	PoT Gumbel	GPD
1 in 50	69.7	67.0	88.0	70.4
1 in 100	66.3	63.2	86.7	66.1
1 in 200	63.3	60.4	85.6	62.0
1 in 500	59.7	57.9	84.3	56.6
1 in 1000	57.3	56.7	83.5	52.8

Source: Drought Vulnerability Framework, HR Wallingford, 2018.

There is significant uncertainty when estimating the low frequency return rates. The nature of drought probability is complex, this includes climatic effects that can cause persistence in low rainfall anomalies, as well as relatively short data records. This means that these estimations should be viewed as approximate.

Utilising the Extreme Value Analysis referenced above, we can observe an approximate return period for the event that we are experiencing. At the time of this application (February 2021), the current deficit in rainfall is beyond anything that we have experienced in historic timeseries. Table 7.1.1.1.2.8 estimates the return periods for this current drought lies beyond that of a 1 in 1000 return period for a 12-month drought. The dry summer (6 months) also has a return period of over 1 in 1000.

Table 7.1.1.1.2.8: Estimated return periods for the existing drought periods of 6 and 12 months

	6 Months	12 Months
% LTA	44	46
Return Period	>1 in 1000	>1 in 1000

Source: Return periods have been calculated to present day, December 2020.

7.1.1.1.2.7 Other meteorological and hydrometric measures

Other drought indicators were listed in Section 4.3 of the main document. Key contributing metrics for the ESoR are:

- Soil Moisture Deficit
- Temperature.

As discussed in this previous section, Soil Moisture Deficit values remain significantly higher than usual for this time of year. The lack of rainfall that we have experienced over these months has contributed to higher SMD values, that have remained high throughout this recent recharge period. These high levels of SMD will also contribute to the amount of effective rainfall and recharge that the Mendip reservoirs would usually experience.

The higher temperatures that we experience in the summer of 2020 exacerbated the impacts of the ESoR by increasing the SMD values as well as increased evapotranspiration from the reservoirs themselves.

Placeholder

A real drought permit will have actual Soil Moisture Deficit, Temperature, Groundwater and River Level values and therefore more of a discussion can be entered here ahead of submission.

7.1.1.1.2.8 Summary and Conclusions

The evidence that has been presented in this ESoR appendix demonstrates how severe the current drought is, and proved that it can be classed as an exceptional shortage of rainfall, unlike anything Bristol Water has experienced in historic records. Reservoir levels are significantly reduced due to this rainfall deficit, while river levels are also significantly lower than you would expect for this time of year.

7.1.1.1.2.8.1 Threat of a serious deficiency of supply

Section 3.6 of the main drought permit application covers the threat of a serious deficiency of supply. This is directly related to the exceptional shortage of rainfall that has been demonstrated in this appendix.

Bristol Water is a resilient WRZ, however exceptional events like this current event have created a threat of a serious deficiency of supply. Due to the integrated nature of Bristol Water's sources, the company plan on the basis of operating as a single WRZ, meaning all 1.23million customers face the same risk if there are deficiencies to the supply. Chew Reservoir remains an integral part of the supply system and this drought permit will make a direct impact to addressing the shortfall that is projected to occur due to this scenario.

7.1.1.1.2.8.2 Conclusions

- Exceptional short-term rainfall deficits have emerged through winter and summer of 2019-2020, and have continued through winter 2020-21. Over the past 15 months, rainfall totals in the Mendip Reservoir catchments have been 47% of the long-term average.
- During the preceding winter refill period (2019-2020), rainfall totals have been 49% of long-term average for this period. This is of particular concern as the winter is especially important for the Mendip Reservoirs refill from November-March. The current winter period is showing similar results but we cannot produce final values as the months of February and March contribute to this total. Long term forecasts suggest similar conditions are to be expected.
- Standard Precipitation Index (SPI) analyses shows that for the past 15 months SPIs have been negative, signifying a prolonged period of below average rainfall. In particular strongly negative SPIs (<-3) occurred in the winter of 2020.
- SPI values remain negative for durations of 6,12-, 15- and 24-month periods prior to end of January 2021. Longer durations of 36 to 48 month do show the SPI value rising, but remain predominantly negative.
- The drought has a return period of at least 1000 years.
- As a result of this lack of rainfall, current levels of reservoir storage are less than 60% of LTA. We do not expect them to recover before next drawdown period as only two months remain of our refill period with no forecast of high rainfall in the coming weeks.

7.1.1.1.3 London Gazette Drought Permit Notice Publication

Placeholder

A copy of the published drought permit notice in the London Gazette should be inserted here before submitting the application to the Environment Agency.

7.1.1.1.4 Environmental Assessment Report

Placeholder

Updated EAR that should accompany the drought permit application – to be inserted before submission to Environment Agency.

7.1.1.1.5 Abstraction Licence Utilisation

Placeholder

tables to illustrate licence utilisation over a few years, to capture both in drought and pre-drought utilisation. Suggested format below however this could be presented differently.

Placeholder

text would also be needed here to explain the utilisation numbers, including sources that are not used.

Table 7.1.1.1.5.1: Summary of Bristol Water's abstraction licences utilisation for year XXXX

Abstraction source	Annual abstraction limit	Daily abstraction limit	Average daily abstraction	Maximum daily abstraction	Minimum daily abstraction

Table 7.1.1.1.5.2: Summary of Bristol Water's abstraction licences utilisation for year XXXX

Abstraction source	Annual abstraction limit	Daily abstraction limit	Average daily abstraction	Maximum daily abstraction	Minimum daily abstraction

Table 7.1.1.1.5.3: Summary of Bristol Water's abstraction licences utilisation for year XXXX

Abstraction source	Annual abstraction limit	Daily abstraction limit	Average daily abstraction	Maximum daily abstraction	Minimum daily abstraction

Table 7.1.1.1.5.4: Summary of Bristol Water's abstraction licences utilisation for year XXXX

Abstraction source	Annual abstraction limit	Daily abstraction limit	Average daily abstraction	Maximum daily abstraction	Minimum daily abstraction

7.1.1.1.6 Demand profiling

Placeholder

At the time of the application, this appendix will have to be populated with graphs showing the demand profile for the duration of the drought compared to the average experienced historically (excluding the drought periods within that period). Include daily distribution input profiles.

7.1.1.1.7 Outage summary

Placeholder

Include outage situation as reported to the Environment Agency for the year the drought permit application is being lodged.

HR Wallingford
Working with water

Hydro-Logic Services

HR Wallingford is an independent engineering and environmental hydraulics organisation. We deliver practical solutions to the complex water-related challenges faced by our international clients. A dynamic research programme underpins all that we do and keeps us at the leading edge. Our unique mix of know-how, assets and facilities includes state of the art physical modelling laboratories, a full range of numerical modelling tools and, above all, enthusiastic people with world-renowned skills and expertise.

HR Wallingford, Howbery Park, Wallingford, Oxfordshire OX10 8BA, United Kingdom
tel +44 (0)1491 835381 fax +44 (0)1491 832233 email info@hrwallingford.com
www.hrwallingford.com

Certificate No. FS 516431
Certificate No. EMS 558310