Dŵr Cymru
Welsh Water

Draft Drought Plan 2020: Annex 1o – Tywi Gower WRZ

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1. Tywi Conjunctive Use System (CUS) – WRZ Reference no. 8201

1.1. Tywi CUS Water Resources Overview

The Tywi Gower Conjunctive Use System is the largest WRZ in South West Wales, extending in the east from the Vale of Glamorgan to west of Carmarthen and stretching northwards past Llanwytrd Wells (see Figure 1).

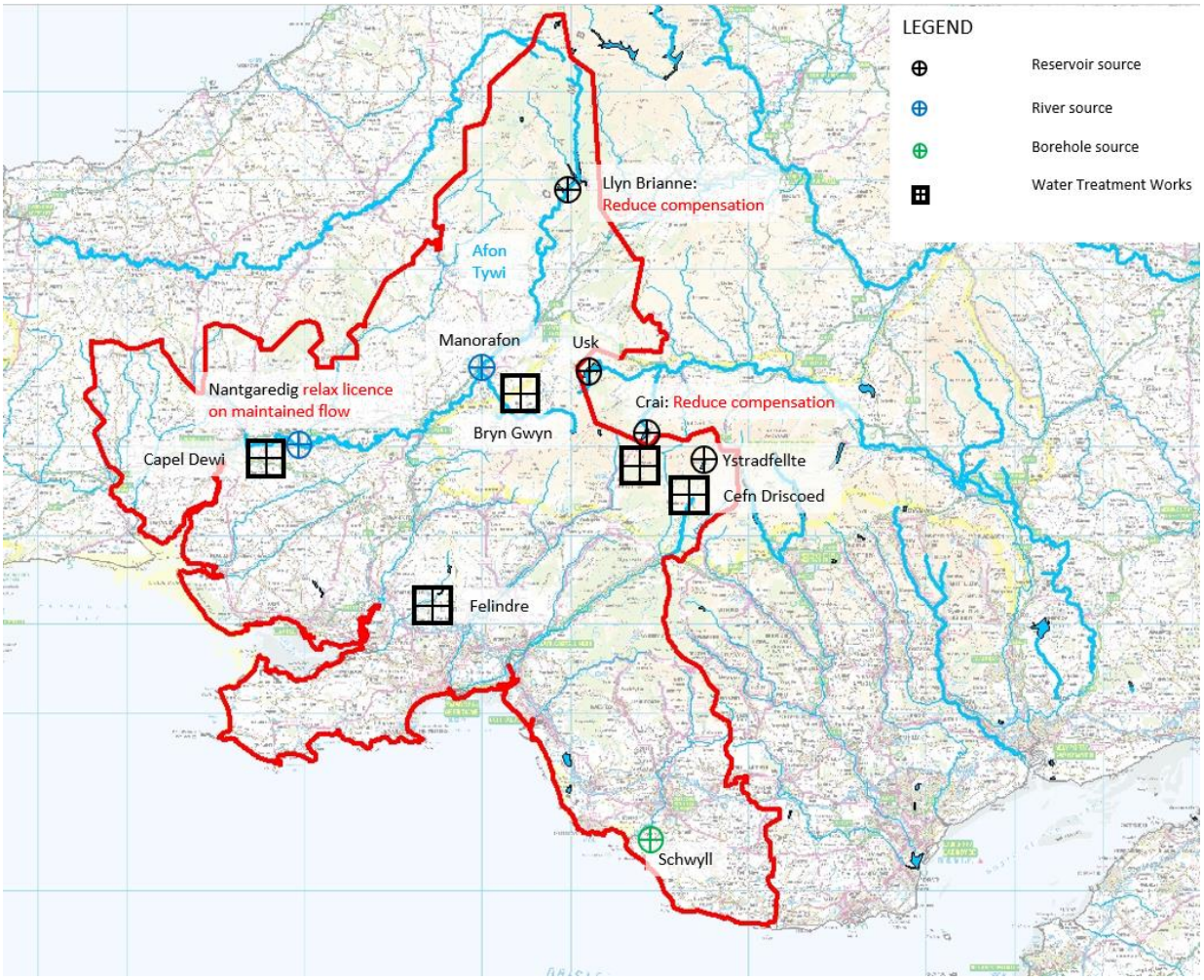

Figure 1 - Map of the Tywi Gower WRZ

The water resources within the zone consist of four impounding reservoirs (Brianne, Crai, Ystradfellte, and Usk) and two river abstractions (Nantgaredig and Manorafon) which are operated conjunctively to make best use of the available water during dry or drought years. A list of our raw water sources for the zone is presented in Table 1.

Site Name	Licence No.	Source Type	Status
Ystradfellte	21/58/71/0001	Impounding Reservoir	Operational
Crai	20/56/53/0002	Impounding Reservoir	Operational
Usk	20/56/54/0001	Impounding Reservoir	Operational
Llyn Brianne	N/A	River Regulating Reservoir	Operational
Upper & Lower Lliw	22/59/04/0065	Impounding & Pump Storage Reservoir	Operational
Upper & Lower Lliedi	22/59/03/0023	Impounding Reservoirs	Operational
Manorafon	22/60/01/0068	Regulated River Intake	Operational
Nantgaredig	22/60/03/0035	Regulated River Intake	Operational
Llygad Llwchwr	22/59/02/0050	River Intake	Mothballed
Parkmill	22/59/04/0048	Spring Intake	Mothballed
Schwyll Well	21/58/44/0006	Groundwater Source	Mothballed

Table 1 - Licensed sources in the Tywi CUS WRZ

The key water resource in this area is the River Tywi from which water is abstracted at two locations - Nantgaredig and Manorafon. When river flows in the River Tywi are low, we are required by our abstraction licences to make releases of water from Llyn Brianne reservoir and abstract this water at our intakes further downstream.

At Nantgaredig, a small portion of the water we take from the river supplies Capel Dewi water treatment works which serves Carmarthen. The majority of the abstracted water is pumped to Felindre treatment works, the largest in the company which supplies our customer demand in Swansea, Neath, Bridgend and the Vale of Glamorgan.

If storage in Usk is healthy, the reservoir provides the whole supply to Bryngwyn water treatment works which feeds the upper Swansea Valley. As storage in Usk reservoir becomes low then water can be pumped from Manorafon on the River Tywi to Bryngwyn in order to maintain the works output.

Ystradfellte and Crai reservoirs, and their associated treatment works (Cefn Driscoed and Crai, respectively) supply the upper parts of the Neath, Afan and Tawe Valleys. As storage in these reservoirs decline, the area served is gradually reduced in order to preserve supplies, with this additional demand supported from Felindre.

There are no imports of water in to the zone but a limited amount of water can be exported to the neighbouring SEWCUS zone.

1.2.Drought Triggers

The drought status of the zone is assessed by the reservoir storage position at any time in relation to the Drought Action Zones (DAZs), defined for Llyn Brianne, Crai, and Ystradfellte. The use of the DAZs are described in more detail in Section 2 of the main report and are similar for all of the reservoirs as

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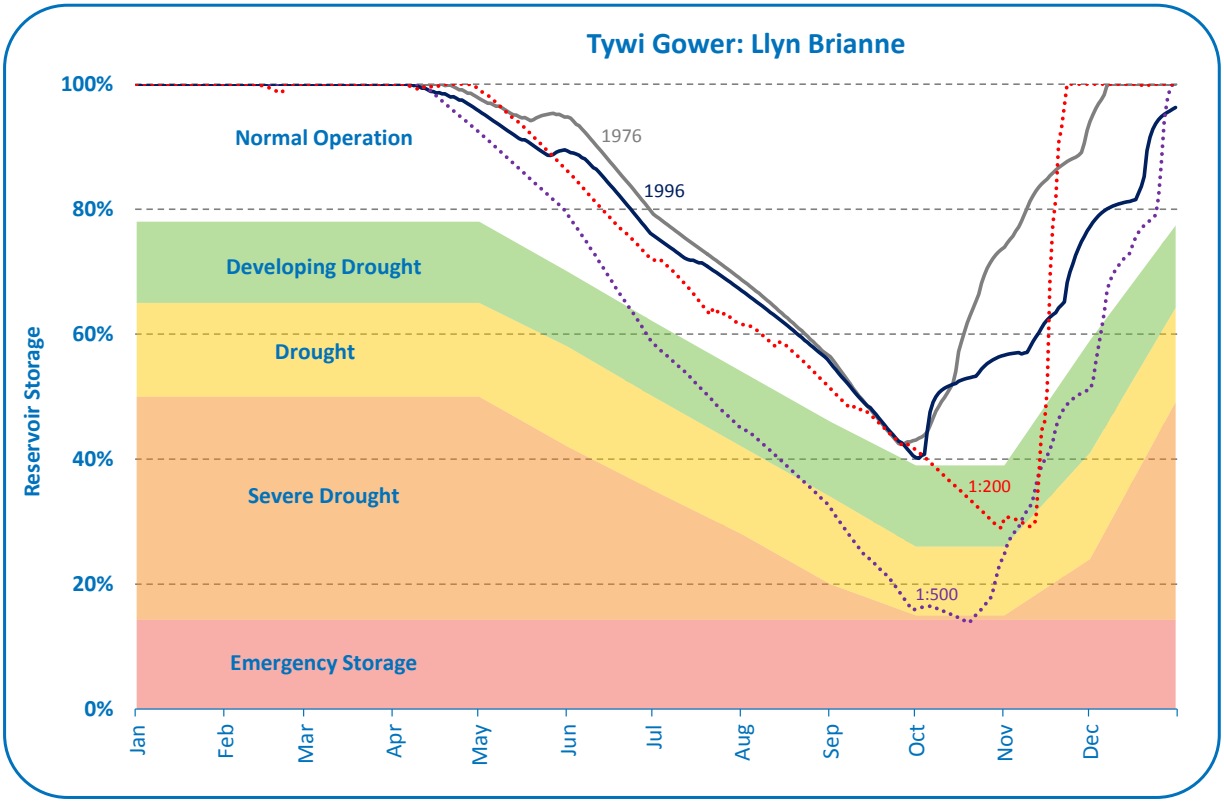

Figure 2 - Llyn Brianne Reservoir Drought Action Zones showing the results of scenario testing

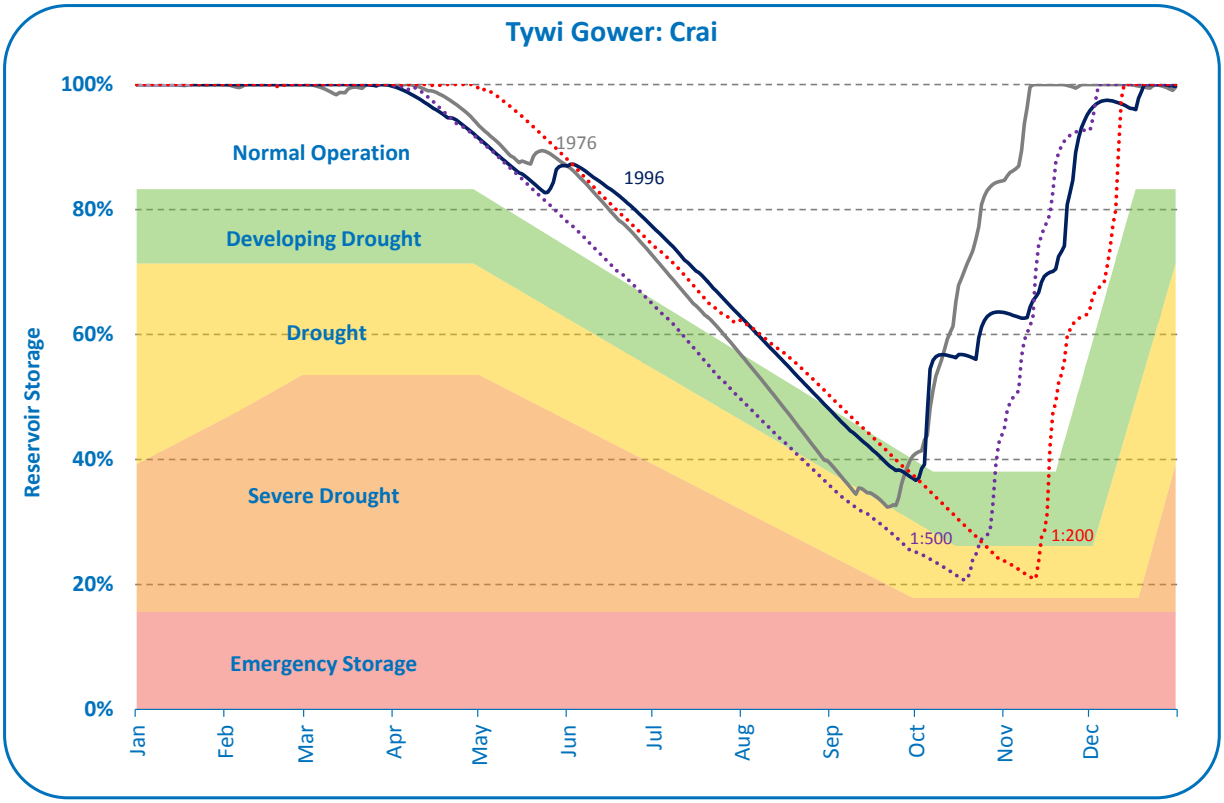

Figure 3 - Crai Reservoir Drought Action Zones showing the results of scenario testing

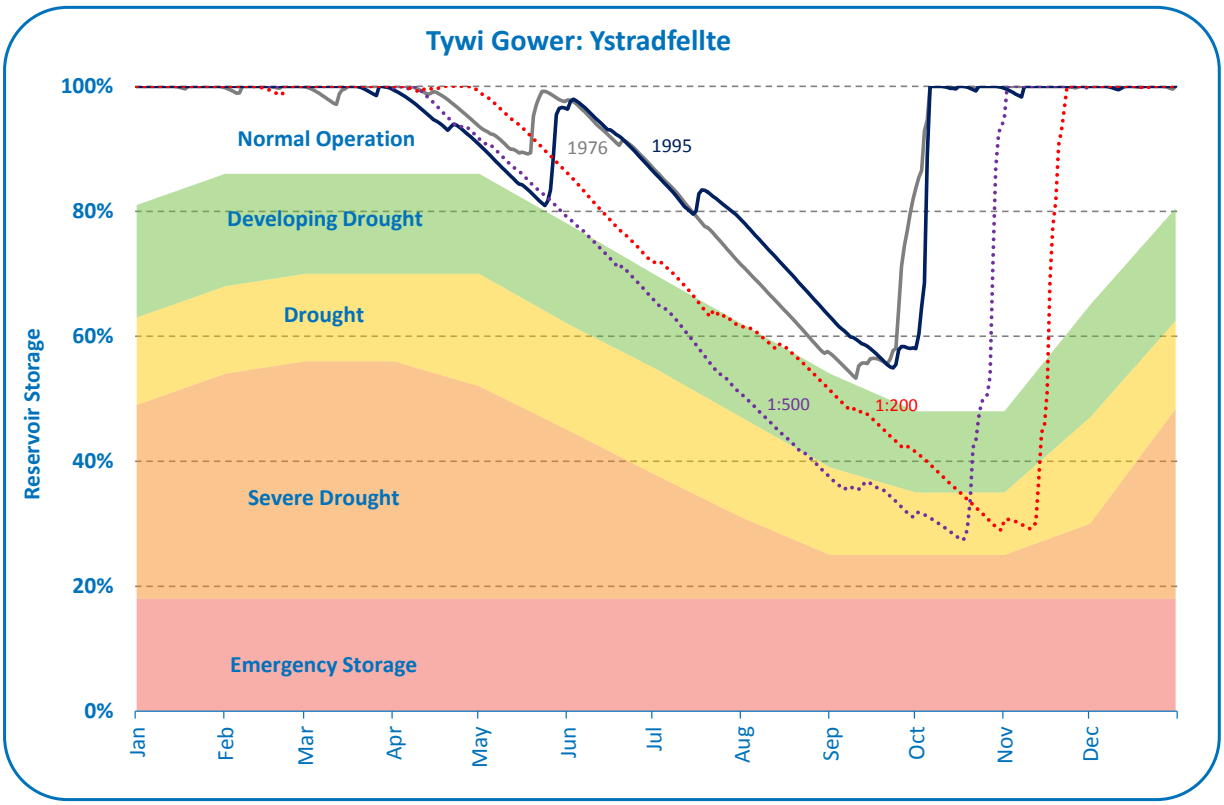

Figure 4 - Ystradfellte Reservoir Drought Action Zones showing the results of scenario testing

1.3.Assessment of Drought Risk

1.3.1. Scenario Testing

Using a stochastically generated time series, we've looked at the performance of our individual reservoirs against the most severe events in our historic record. Figures 2 to 4 show a sample of results from the drought library scenario testing together with output from our baseline scenario testing. The plots show that the zone is resilient to historic events such as 1976 and 1995, and we're unlikely to need a hosepipe ban to preserve resource. The testing also shows that at Brianne reservoir, it is only under more extreme events such as a 1:500 year return period drought (i.e. a drought that has a 0.2% chance of occuring in any year) that we may consider imposing wide spread pressure management and local water rationing on our customers.

The other important resources of Crai and Ystradfellte reservoirs remain above Emergency Storage even in a 1:500 year event, but the storage levels are very low. This indicates that we need to carefully manage the WRZ during a drought to ensure we optimally balance our resources and minimise any risk of having to take the most restrictive supply-side actions. The scenario testing results indictae that under these more severe droughts, our reservoir storages will fall to levels we have not experienced before. Based on this information we have therefore chosen to retain two Drought Order options to provide additional support, should these ever be required. Section 1.5 provides details of these.

1.3.2. Drought Response Surface

As outlined in Chapter 3, application of the Drought Vulnerability Framework (DVF) screening methodology indicated that the Tywi Gower WRZ is at moderate risk of significant drought impact and so advanced techniques (DVF method 4a) have been used to generate the data necessary to produce a Drought Response Surface (DRS) chart. Using this methodology, a 200 year 'Drought Library' made up of 6, 12, 18, 24 and 48 month drought events, of varying return periods between 1:50 and 1:5000, were run through our WRAPSim water supply model for the zone. Full details of this technique are provided in Section 4.7 of Appendix 1.

The DRS chart (Figure 5) shows that our risk of needing to implement extreme measures in the Tywi zone is extremely low. Our vulnerability is to short term drought events with a signficant rainfall deficit of approximately 35% - 45% of the long term average, i.e. an extremely dry six months. The DRS shows that the retun period of such an event is around a 1:200 year event and beyond a 1:1000 year event as the rainfall deficit gets closer to 35%, i.e there is only around 0.5% - 0.1% chance each year of this type of drought occurring. Figure 6 shows that the chance of this type of drought event occurring increases, but only to around 1% - 0.1% each year once the effects of climate change are accounted for.

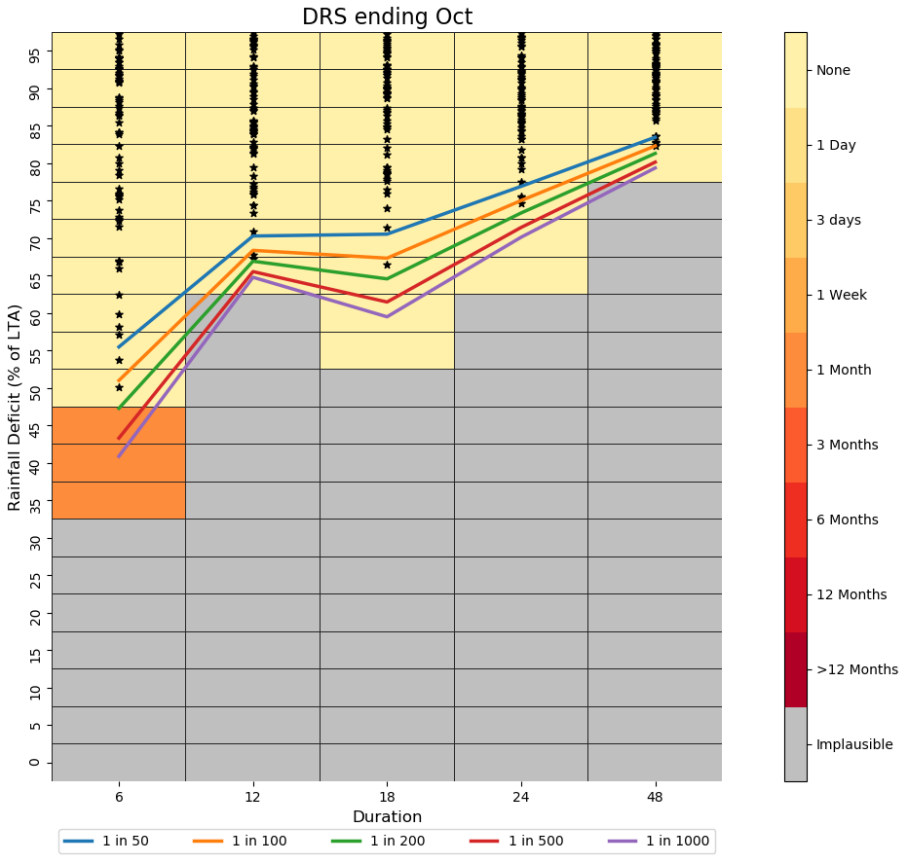

Figure 5 - Tywi DRS Chart for droughts ending October

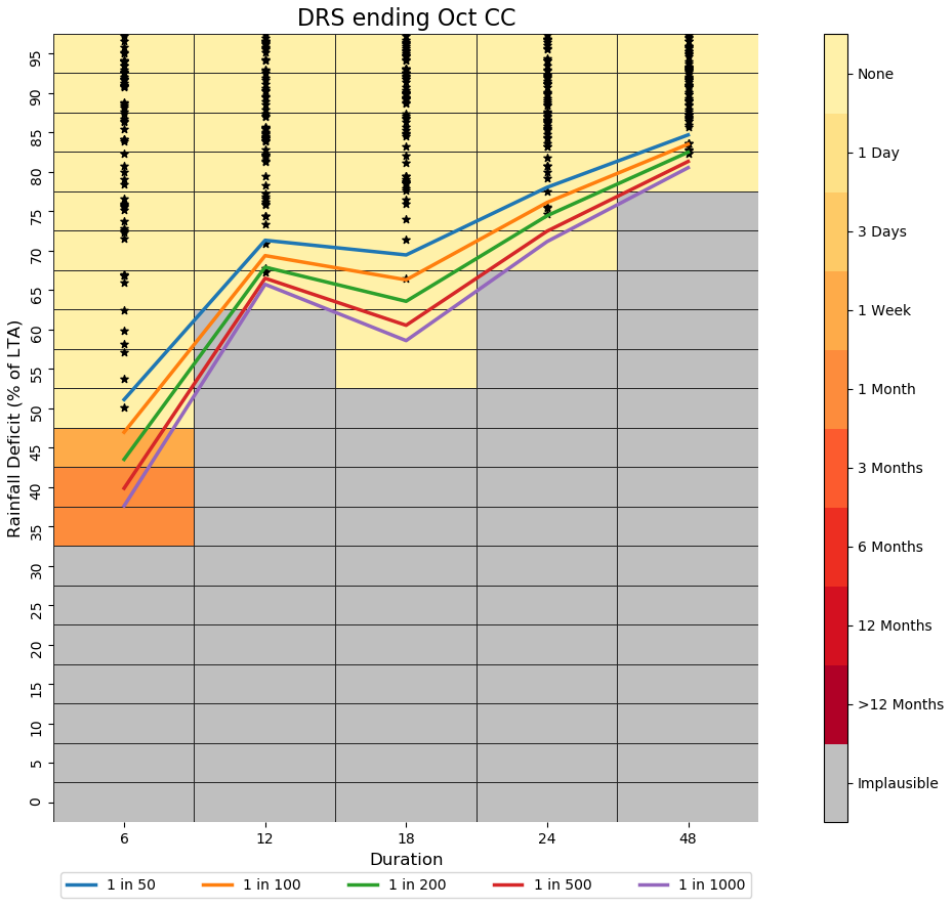

Figure 6 - Tywi DRS Chart for droughts ending October with the effects of climate change

1.4.Drought Management of the WRZ

As the identified drought risk in the zone is low then our management philosophy is to ensure we operate our water resources in line with our control curves and take all necessary actions in good time, in order to maintain this high level of drought resilience.

The following sections describe the operation of the zone as we move into a drought period and the actions that we will take to ensure that we minimise the impact on our customers. In the event of extreme drought, options to increase the quantity of water resource available for public water supply may be required – these are also outlined, with supporting summary information on the requirements of those options.

1.4.1. Normal Operation

During normal weather conditions we optimise our sources to minimise the cost of operations. In the Tywi Gower zone this means that we make maximum use of Bryngwyn, Crai, and Cefn Driscoed treatment works that gravitate supplies to our customers.

As reservoir storages start to decline we make small, stepped reductions in the supply areas of Bryngwyn and Cefn Driscoed. To enable a reduction in the supply area of Bryngwyn, a number of operations will be undertaken by our Water Distribution Team: customer demand west of Llewitha Bridge, including Gowerton, Garden Village and Penclawdd will be rezoned so that it can be supplied by water from Felindre treatment works through valve changes in the distribution system. The supply area to the south of Cocket, including Sketty, down to the Mumbles will be supported by more water which will be pumped from Felindre. To supplement these changes we will increase our leakage efforts to minimise losses in the network. Demand on Cefn Driscoed will be reduced by a valve operation at the end of the network, which enables Felindre water to push into the Cilfrew and Aberdulais areas in the lower part of the supply system. We would also gradually but significantly reduce the supply area of Crai by decreasing the flow through a control valve governing flow between the Crai and Felindre systems, increasing the flow from Felindre into the Clydach, Trebanos and Pontardawe areas.

As flows in the River Tywi reduce, we will commence regulation releases from Llyn Brianne to support our abstraction at Nantgaredig.

1.4.2. Developing Drought Action Zone

As reservoir storages move into the developing drought action zone, the operations which may be necessary to preserve resource are less frequently undertaken. This increases the risk of the operations impacting our customers, and so to authorise these activities, the 'Gold' incident command centre will convene. In 2018 local action plans were provided to Gold command which instructed teams to commence a number of operations which are not routinely undertaken.

As drought conditions continue, more water is pumped from Felindre into areas normally supplied by the Crai and Bryngwyn treatment works. This reduces Crai and Bryngwyn treatment works to their minimum operating levels and accordingly lowers the demand on Crai and Usk reservoirs. We will increase our leakage effort and targeting with attention paid to supporting the systems which are under the greatest strain.

Depending on the water resource position of the neighbouring SEWCUS zone, we may also consider abstracting from our Manorafon intake to support Bryngwyn and reduce demand on Usk reservoir. This is not normally necessary but may be used more often in the future as a result of environmentally driven changes to our operations that means Usk reservoir will have to support greater regulation of the River Usk to enable abstraction. The amount of additional water we take from the River Tywi at Manorafon must be matched by an additional release of water from Llyn Brianne.

1.4.3. Drought Action Zone

Once all changes to our water supply systems have been made, the operation of the zone will be fully optimised to preserve water resource and balance available water resources across the zone. As reservoir storage approaches the Drought Action Zone we will consider the feasibility of bringing mothballed sources (listed in Table 1) back into supply. For example, Schwyll, which is a groundwater source south of Bridgend could be used to support water from Felindre in the east of the zone, potentially freeing up treated water from Felindre to support other areas. This is likely to require a significant amount of work to bring back in to supply and we will need to ensure that any water produced is compliant with drinking water quality governance prior to being used.

In the event that dry weather continues and our forecasts indicate that storage will continue to decline, we will start preparations to request drought orders. Our modelling shows that to reach this trigger we

would be experiencing an unprecedented level of drought not seen in our historic records. These permissions from NRW and Welsh Government would enable us to take more water from the River Tywi, and preserve more water within our reservoirs. To support these requests, we will commence environmental monitoring in line with our Environmental Assessment Reports (Appendix 21 to 24) and submit our applications for the options identified in Section 1.5.

1.4.4. Severe Drought Action Zone

As reservoir storage enters the Severe Drought Action zone, subject to receiving the necessary permissions from NRW and Welsh Government, we will look to implement our two Drought Order schemes. As set out in Section 1.5, the options available to us are: 1) preserve the freshest bank at Brianne for public water supply, 2) relax the maintained flow requirement at Capel Dewi, and (for winter refill) reduce the compensation release requirement from Brianne. These options all have the effect of preserving storage in our reservoirs which will enable us to maintain customer supplies for longer.

1.5.Supply-side drought management action

The following tables provide the information required by Appendix G of NRW's Water Company Drought Plan Technical Guideline (Dec 2017). The tables summarise the key information from within the associated Environment Assessment Reports (EARs) including any potential environmental impacts, risks to the scheme implementation and any necessary mitigation that may be required.

Action Implementation Assessment	**Name:**	**Reduce Crai compensation flow by 50%**
	Trigger(s)	Crai reservoir crosses into Severe Drought Action Zone.
	Deployable Output or yield of the action	3.42Ml/d
	Location	Crai reservoir
	Implementation timetable	**Preparation time:** We assume a decision from NRW within 14 days of submitting the Drought Permit application. The practical implementation of the option could be effected immediately. **Time of year effective:** The option is most likely to be implemented during August to November. **Duration:** Drought orders are valid for up to six months, but is most likely to be three months.
	Risks associated with action	The application, as applied for, is not approved. Reduction in compensation releases have potential environmental impacts. These will be assessed through the EAR submitted with the application.
	Other considerations	N/A
Environmental Assessment: alone & in-combination	**Risk to the Environment**	Reduced flow in the Afon Crai and possibly the upper river Usk.
	Summary of likely environmental impacts	The hydrological assessment has concluded that there is a major impact on flows in the Afon Crai as a result of implementing the drought order. Impacts on the River Usk have been assessed as minor during August to September, and negligible during October to November. These hydrological impacts are assessed as leading to moderate impacts on the physical environment of the river, including water quality. The environmental assessment has concluded that during periods when there is a reduction in total flow release from Crai Reservoir to the Afon Crai there are major to moderate impacts on the River Usk (Upper Usk) SSSI, fish, moderate to minor impacts on macroinvertebrates and phytobenthos and moderate to negligible impacts on macrophyte. The HRA Screening could not conclude that implementation of a drought order would not result in likely significant effects on the brook and river lamprey, Atlantic salmon and bullhead populations within the River Usk SAC.
	Baseline information used	**Hydrological data:** • Daily Crai water level data • Daily abstractions from Crai Reservoir • Daily mean compensation flows to the Afon Crai • NRW Trallong River flow gauge on the River Usk **Ecological data:** • No baseline data is available from Natural Resources Wales (NRW) for the impacted reaches of the Afon Crai or River Usk. However, baseline data is available from two monitoring sites on the River Usk downstream of impacted Reach 3, i.e., D/S Cilieni and Aberbran Bridge. Whilst these sites are outside of the drought order zone of influence, they are considered to be indicative of the communities present in the impacted reaches
	Summary of additional monitoring requirements	• Spot flow gauging • Biochemical water sampling • Fish surveys (including salmon, brown / sea trout, lamprey, bullhead, eel)
	Mitigation & Compensation measures	The mitigation measures that could be considered at the on-set of drought, during implementation of the drought permit and post-drought permit implementation include:

		• Temporary reduction or cessation of the terms of the Drought Order/Permit • Fish distress monitoring with triggers and response plan • Protection of 'spate flows' • Reduction of fish predation • Physical in-river works • Provision of alternative compensation flows • Provision of alternative water supplies if other water users are at risk of derogation. Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.
	Impact on other activities	A reduction in flows on the Afon Crai to landscape, Recreation and Archaeology are not influenced by the drought order and are therefore determined to be negligible.
	Any permissions or approvals required and constraints that apply	N/A

Table 2 - Option 8201-1 Reduce Crai compensation flow

Action Implementation Assessment	**Name:**	**Relax the maintained requirement below the Nantgaredig intake on the River Tywi**
	Trigger(s)	Storage in Brianne Reservoir crosses into Severe Drought Action Zone.
	Deployable Output or yield of the action	Max 14Ml/d yield
	Location	Nantgaredig intake.
	Implementation timetable	**Preparation time:** We assume a decision from Welsh Government within 28 days of submitting the Drought Order application. The practical implementation of the option could be effected immediately. **Time of year effective:** The option is most likely to be implemented during September to November. **Duration:** Drought orders are valid for up to six months, but is most likely to be two months.
	Risks associated with action	The application, as applied for, is not approved. Relaxation in maintained flow has potential environmental impacts. These will be assessed through the EAR submitted with the application.
	Other considerations	N/A
Environmental Assessment: alone & in-combination	**Risk to the Environment**	Reduction in flows in the River Tywi.
	Summary of likely environmental impacts	The hydrological assessment has concluded that there is potential for minor impact on river flows and minor impacts on the physical environment of the river, including water quality. This could lead to moderate environmental impacts on fish and minor impacts on freshwater pearl mussels, macroinvertebrates, macrophytes, and phytobenthos. The assessment also concluded minor impacts on the Afon Tywi SSSI. The HRA Screening could not conclude that implementation of a drought order would not result in likely significant effects on the twaite and allis shad, brook and river lamprey and bullhead populations within the Afon Tywi SAC.
	Baseline information used	**Hydrological data:** • Monthly or weekly Llyn Brianne Reservoir storage volumes, 1984 – 1995. • Daily Llyn Brianne Reservoir storage volumes, 1996 to date. • Daily outflows from Llyn Brianne Reservoir, 2006 to date. • Daily abstractions from Nantgaredig intake, Afon Tywi, 1990 to date. • Ystradffin flow gauge, River Tywi; daily river flow 1983 to date. • Dolau Hirion flow gauge, River Tywi; daily river flow 1968 to date. • Capel Dewi flow gauge, River Tywi; daily river flow 1958 to date. **Ecological Data:** • NRW Macrophyte monitoring information from four sites on the Tywi in reach 1, 3 and 4 • Historic 2003 Macrophyte survey data – Nantgaredig Nr Carmarthenshire • NRW Macroinvertebrate monitoring data from six sites in on the Tywi reach 1, 3 and 4 • EMP for Afon Tywi baseline Fisheries data. • NRW lamprey, shad and salmonid monitoring data from last 10 years • NRW fish survey data from adjoining tributaries throughout reach 1 – 4 • APEM Lamprey survey 2004.
	Summary of additional	• Spot flow gauging's • Biochemical water sampling

	monitoring requirements	• Further Macrophyte surveys • Further Macroinvertebrate surveys • Further Fish • Further Lamprey specific surveys • Further Freshwater Pearl Mussel surveys
	Mitigation & Compensation measures	The mitigation measures that could be considered at the on-set of drought, during implementation of the drought permit and post-drought permit implementation include: • Temporary reduction or cessation of the terms of the Drought Order/Permit • Fish distress monitoring with triggers and response plan • Protection of 'spate flows' • Reduction of fish predation • Physical in-river works • Provision of alternative compensation flows • Provision of alternative water supplies if other water users are at risk of derogation. Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.
	Impact on other activities	A relaxation of the Nantgaredig maintenance flow has the potential to create minor impact on recreation. There is a minor effect on the landscape and visual amenity and a negligible effect of the Archaeology.
	Any permissions or approvals required and constraints that apply	N/A

Table 3 - Option 8201-3 Relax the maintained flow requirement below the Nantgaredig intake on the River Tywi

Action Implementation Assessment	**Name:**	**Reduce Llyn Brianne compensation flow by 50%**
	Trigger(s)	Llyn Brianne reservoir crosses into Severe Drought Action Zone.
	Deployable Output or yield of the action	34Ml/d
	Location	Llyn Brianne reservoir
	Implementation timetable	**Preparation time:** We assume a decision from NRW within 14 days of submitting the Drought Permit application. The practical implementation of the option could be effected immediately. **Time of year effective:** The option is most likely to be implemented during September to November. **Duration:** Drought orders are valid for up to six months, but is most likely to be three months.
	Risks associated with action	The application, as applied for, is not approved. Reduction in compensation releases have potential environmental impacts. These will be assessed through the EAR submitted with the application.
	Other considerations	N/A
Environmental Assessment: alone & in-combination	**Risk to the Environment**	Reduced flow in the Afon Tywi.
	Summary of likely environmental impacts	The assessment has concluded that there is a major impact on flows in the Afon Tywi as a result of implementing the drought order. These hydrological impacts are assessed as leading to minor impacts on the physical environment of the river, including water quality. The environmental assessment has concluded that there are major impacts on fish, moderate impacts on the Afon Tywi SSSI and macroinvertebrates, and minor impacts on macrophytes and phytobenthos. The HRA Screening could not conclude that implementation of a drought order would not result in likely significant effects on twaite and allis shad populations, sea, brook and river lamprey populations, and the bullhead populations within the Afon Tywi SAC.
	Baseline information used	**Hydrological data:** • Daily Llyn Brianne water level data • Daily outflows from Llyn Brianne Reservoir • Daily mean compensation flows to the Afon Tywi • Daily abstractions at Nantgaredig intake on the Afon Tywi **Ecological data:** • The Afon Tywi Special Area of Conservation (SAC) is designated for its important populations of a number of aquatic species • The Afon Tywi supports a large spawning population of twaite shad, which is considered to be self-sustaining. Spawning sites occur throughout the lower reaches of the river between Carmarthen and Llangadog, with most spawning occurring downstream of Llandeilo. The SAC is also one of the best rivers in Wales for otters. There are abundant signs of otters and they are regularly observed on the river. • The site is also considered to be of national importance for its protected bird species
	Summary of additional monitoring requirements	• Spot flow gauging • Biochemical water sampling • Fish surveys
	Mitigation & Compensation measures	The mitigation measures that could be considered at the on-set of drought, during implementation of the drought permit and post-drought permit implementation include:

		• Temporary reduction or cessation of the terms of the Drought Order/Permit • Fish distress monitoring with triggers and response plan • Protection of 'spate flows' • Reduction of fish predation • Physical in-river works • Provision of alternative compensation flows • Provision of alternative water supplies if other water users are at risk of derogation. Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.
	Impact on other activities	A reduction in flows on the Afon Tywi to landscape are considered negligible. Recreation impacts are considered minor as water dependant activities would be slightly impacted due to the drought order.
	Any permissions or approvals required and constraints that apply	N/A

Table 4 - Option 8201-4 Reduce Brianne compensation flow - winter refill only