Dŵr Cymru Welsh Water

Environmental Assessment of Llys-y-Fran Freshet Drought Order (8206-7)

Final

October 2019

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NON-TECHNICAL SUMMARY

INTRODUCTION AND PURPOSE OF THIS REPORT

Welsh Water's Drought Plan provides a comprehensive statement of the actions Welsh Water will consider implementing during drought conditions to safeguard essential water supplies to customers and minimise environmental impact. It encompasses a number of drought management options that will only be implemented if and when required and includes drought permit / order options.

A drought permit or order is a management action that, if granted, can allow more flexibility to manage water resources and the effects of drought on public water supply and the environment.

The objective of this report is to provide an independent and robust assessment of the potential environmental effects of implementing a drought order at Llys-y-Fran (freshet release), over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

Llys-y-Fran Reservoir is located in Welsh Water's Pembrokeshire Water Resource Zone (WRZ) which covers the far south west corner of Wales, stretching from Pendine Sands in the east to the Pembrokeshire Coastal National Park in the west, and from the village of Manobier in the south to Fishguard in the north. Water from Llys-y-Fran reservoir discharges into the Afon Syfynwy, a tributary of the Eastern Cleddau.

The assessment also considers how the proposed drought order may affect the environment in combination with the effects of other existing abstraction licences, environmental permits and other drought management plans.

This report is a 'shelf-copy' report which would be updated to support an application to the Welsh Ministers for a drought order at Llys-y-Fran (freshet release), which may be required by Welsh Water in the future.

PROPOSED DROUGHT ORDER DETAILS

In order to protect public water supplies within Welsh Water's Pembrokeshire WRZ in the event of a future severe drought, Welsh Water would make an application to the Welsh Ministers for a drought order to vary the conditions of the Llys-y-Fran Reservoir Section 158 operating agreement.

In accordance with the Llys-y-Fran Reservoir Section 158 operating agreement, a total of 955Ml of the storage volume within Llys-y-Fran Reservoir is allocated to the freshet bank, to be released for fisheries management purposes at the direction of Natural Resources Wales (NRW). This volume allows for up to five releases of 190Ml each to be made. If granted, the drought order involves using 385Ml (approximately 40%) of

this volume of storage for public water supply, so that only a limited number (three) of freshet releases could take place during the period of implementation.

Retaining part of the freshet bank volume within the reservoir for public supply, rather than releasing it to the downstream watercourse, will conserve the longevity of reservoir storage and improve the probability of reservoir winter refill. The drought order scheme will influence the Afon Syfynwy downstream of Llys-y-Fran Reservoir outfall and its continuation as the Eastern Cleddau River until the tidal limit.

Welsh Water has determined through water resources modelling that the drought order would only be required during the months of August to November inclusive. However, the impact of the drought order will only occur at times when freshet releases for fisheries purposes would normally be made. Information available at the time of this assessment indicates that releases are typically requested for a short period (around 4-5 days) during the early autumn. It is assumed that this relates to the need to ensure spate flows during the key fish migration period of October to December. The assessment has therefore considered potential impacts during the autumn/early winter period of October to December inclusive. Freshet releases may also be requested by NRW in June to aid smolt downstream migration, however releases during June would not be impacted by the drought order which is restricted to August to November inclusive.

The revised arrangements would legally be authorised for three months but would be removed sooner if water resources have returned to adequate levels to safeguard future water supplies, as agreed with the Welsh Ministers / Natural Resources Wales (NRW).

NEED FOR THE DROUGHT ORDER

Application for a drought order is a precautionary approach. Due to the time needed to determine a drought order application, Welsh Water will potentially apply for a drought order more frequently than it will be used.

The justification for the drought order sought will be set out in a "Needs Statement". This will be produced by Welsh Water at the time of a potential future application, and will form part of the full drought order application.

ALTERNATIVE SOURCES CONSIDERED

Details of alternative sources considered by Welsh Water will be completed at the time of application for the drought order at Llys-y-Fran (freshet release). This will demonstrate justification for the proposed drought option details applied for.

POTENTIAL IMPACTS OF DROUGHT ORDER IMPLEMENTATION

The scope of the assessment has been defined by a screening and scoping exercise.

Summary of the Hydrological Assessment

The assessment has concluded that there is a **negligible** impact on river flows as a result of implementing the drought order. Consequently, there are **negligible** impacts on the physical environment of the river, including water quality.

Summary of the Environmental Features Screening

In accordance with national drought planning guidance, environmental assessment is neither required nor included for features where screening has identified a minor or negligible impact. Screening has not identified any environmental features for which environmental assessment is required. No environmental impacts have, therefore, been identified for any of the features identified in the screening exercise.

Cumulative Impacts

No cumulative effects of implementing the drought order with existing licences, consents and plans (including the 8206-2 Preseli drought order) are currently anticipated. However, this should be reviewed at the time of any future application for a drought order at Llys-y-Fran (freshet release).

MITIGATION AND MONITORING

The environmental assessment has identified significant impacts of implementation of a drought order at Llys-y-Fran (freshet release). Consequently, in line with the DPG, an Environmental Monitoring Plan has been proposed. Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.

CONCLUSIONS

In summary, it has been concluded that the environmental effects on river flows, water quality and ecology of implementing a drought order at Llys-y-Fran (freshet release) during the period August to November, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions, with the onset of a natural drought, would be **negligible**. The assessment included consideration of the capacity to provide spate flows during the key fish migration period of October to December if instructed to do so by NRW.

Contents

1 INTRODUCTION

1.1 PURPOSE OF THE ENVIRONMENTAL ASSESSMENT

The objective of this Environmental Assessment Report (EAR) is to provide an independent and robust assessment of the potential environmental effects of the implementation of a drought order by Dŵr Cymru Welsh Water (Welsh Water) which involves the use of a proportion of the freshet bank (part of the Llys-y-Fran Reservoir storage volume) for public water supply, so that freshet releases would be limited to 3 occurrences during the implementation period of the drought order. Water stored at Llys-y-Fran Reservoir is used to provide public water supplies to Welsh Water's Pembrokeshire Water Resource Zone (WRZ) (see Section 2.1).

This EAR is a 'shelf-copy' report which would be updated in the event that Welsh Water needs to make an application during any future drought to Natural Resources Wales (NRW) for a drought order at Llys-y-Fran (freshet release). A drought order is a management action that, if granted, can help ensure essential water supplies are maintained to homes and businesses. The circumstances under which a drought order may be required is set out in the Welsh Water Drought Plan.

The assessment presented in this EAR considers the effects of implementation of the drought order over the months of August to November inclusive, the period for which Welsh Water has determined it might require a drought order for this water source. However, the impact of the drought order will only occur at times when freshet releases for fisheries purposes would normally be made. Information available at the time of this assessment indicates that releases are typically requested for a short period (around 4-5 days) during the early autumn. It is assumed that this relates to the need to ensure spate flows during the key fish migration period of October to December. The assessment has therefore considered potential impacts during the autumn/early winter period of October to December inclusive. The purpose of the assessment is to determine the environmental impacts of the drought order over and above any effects arising from natural drought conditions.

The study area and focus of this environmental assessment of the Llys-y-Fran (freshet release) drought order, covers the following waterbodies:

- the Afon Syfynwy - Llys-y-Fran to confluence with Eastern Cleddau (GB110061030700)
- Eastern Cleddau - confluence with Syfynwy to tidal limit (GB110061030670).

This EAR includes discussion of the following:

- an assessment of the likely changes in river flow / water level regime due to implementing the proposed drought order (**for a summary, see Section 4 of this report**)
- identification of the environmental features that are sensitive to these changes and an assessment of the likely impacts on these features (**see Section 5 of this report**)
- identification of mitigation measures that may be required to prevent or reduce impacts on sensitive features (**see Section 6 of this report**)
- recommendations for baseline, in-drought and post-drought order monitoring requirements (**see Section 10 of this report**).

The environmental assessment has been conducted in accordance with Government regulations and using the Welsh Government / Natural Resources Wales Drought Plan Guideline[1] (DPG); specifically Section 5 and Appendices I and J, and Welsh Government / Defra / NRW / Environment Agency guidance on drought permits and drought orders[2].

Consideration has been given to the potential impacts of drought order implementation on statutory designated sites, including those designated under international law (Habitats Directive, Birds Directive and the Ramsar Convention) and national legislation (notably Sites of Special Scientific Interest (SSSIs).

In accordance with the DPG, the assessment also considers how the proposed drought order may affect the environment in combination with the effects of existing abstraction licences, environmental permits and other relevant activities and plans. This is discussed further in Sections 3 and 7.

1.2 SUPPORTING STUDIES

The DPG identifies in Section 5.4 that EARs are required as supporting documents to any drought permit or drought order application. The circumstances for which an environmental assessment is required are set out in **Box 1** below.

[1] Natural Resources Wales (2017) *Water Company Drought Plan Technical Guideline*. Available at https://cdn.naturalresources.wales/media/684414/final-wc-drought-plan-guidance-2017.pdf?mode=pad&rnd=131656713580000000, Accessed 04 February 2019.
[2] Welsh Government / Defra / Natural Resources Wales / Environment Agency (2015) *Apply for a drought order or emergency drought order*, https://www.gov.uk/government/collections/apply-for-a-drought-permit-drought-order-or-emergency-drought-order Accessed 21 December 2018.

Box 1: Drought Plan Guidance - requirement for environmental assessment

The DPG requires that all features that could be affected by implementation of a drought order /permit are listed in the EAR and that an assessment is made of how sensitive each feature is to the likely changes in hydrology, hydrogeology and geomorphology, due to implementing the drought order /permit.

The DPG requires a detailed environmental assessment for applications where sensitive features are likely to be subject to a major or moderate impact, or a minor impact where this applies to environmentally designated features. Further environmental assessment is **not** required for those drought orders / permits where there is certainty that there are no such impacted sensitive features.

This environmental assessment is based on data available at the time of writing and includes the environmental features and data types determined by Box 1 in Appendix I of the DPG (except where these are considered not to be relevant to this drought order). Data were requested from key consultees (including NRW).

Where appropriate, this report also identifies areas where there are deficiencies in data availability and makes recommendations for future data / information gathering and monitoring. Welsh Water will continue to engage closely with NRW to ensure that adequate and sufficient data / information are collated and kept up-to-date in subsequent years to inform future environmental assessments.

1.3 CONSULTATION

Consultation is identified as an essential exercise in the preparation of the EAR. In preparing this 'shelf-copy' EAR for a drought order at Llys-y-Fran (freshet release), consultation with regulators and wider stakeholders has been undertaken to gain feedback on potential adverse effects, gather data and discuss any required monitoring and / or mitigation measures.

Further consultation will be also be undertaken at the time of any future applications for the drought order.

1.4 STRUCTURE AND CONTENT OF THE REPORT

This EAR comprises the following sections:

Section 1: Introduction

Section 2: Background to the Drought Order

Section 3: Approach

Section 4: Hydrology and the Physical Environment

Section 5: Environmental Features Assessment

Section 6: Mitigation

Section 7: Cumulative Impacts

Section 8: Summary of Residual Impacts

Section 9: Impacts on Statutory Designated Sites

Section 10: Environmental Monitoring Plan (EMP)

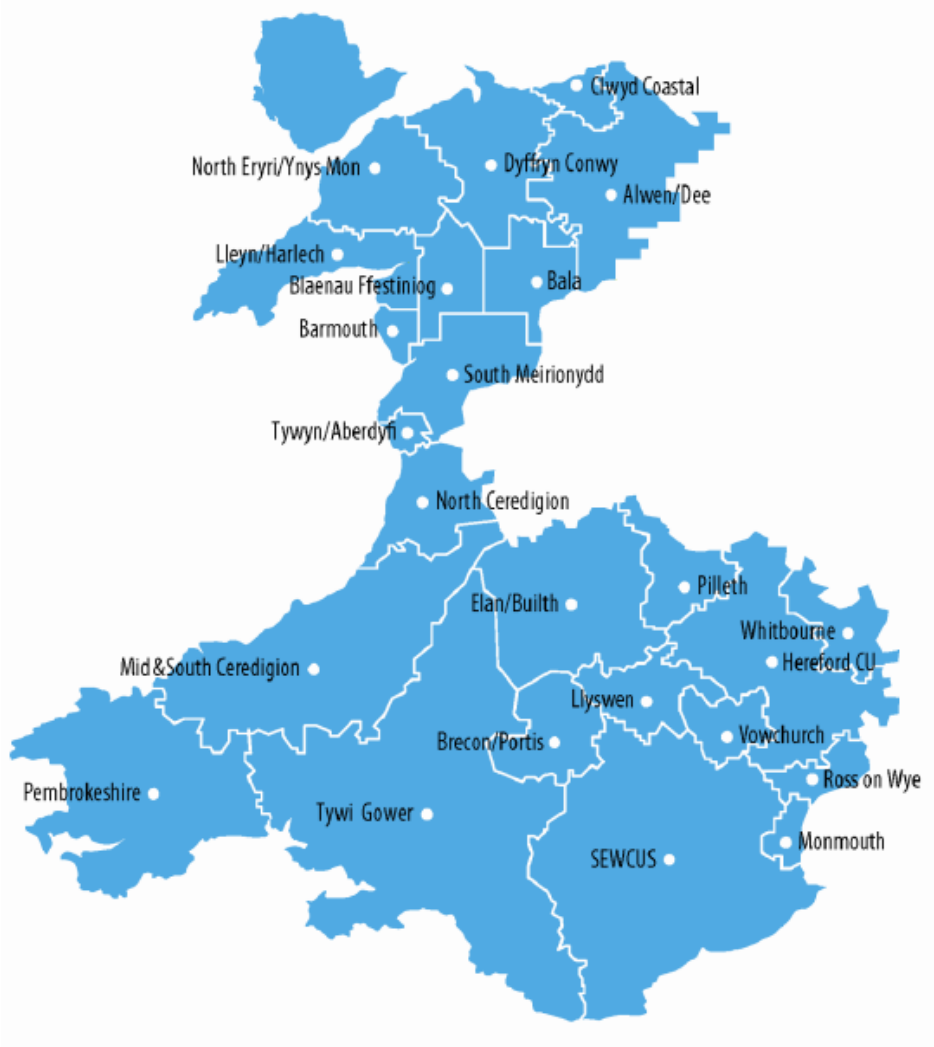
Section 11: Conclusions

2 BACKGROUND TO THE DROUGHT ORDER

2.1 WELSH WATER'S SUPPLY SYSTEM

Welsh Water supplies water to more than 3 million people. The Welsh Water supply area covers the majority of Wales and a small part of England. It is split into 24 WRZ's (see **Figure 2.1**).

Figure 2.1 Welsh Water Water Resource Zones

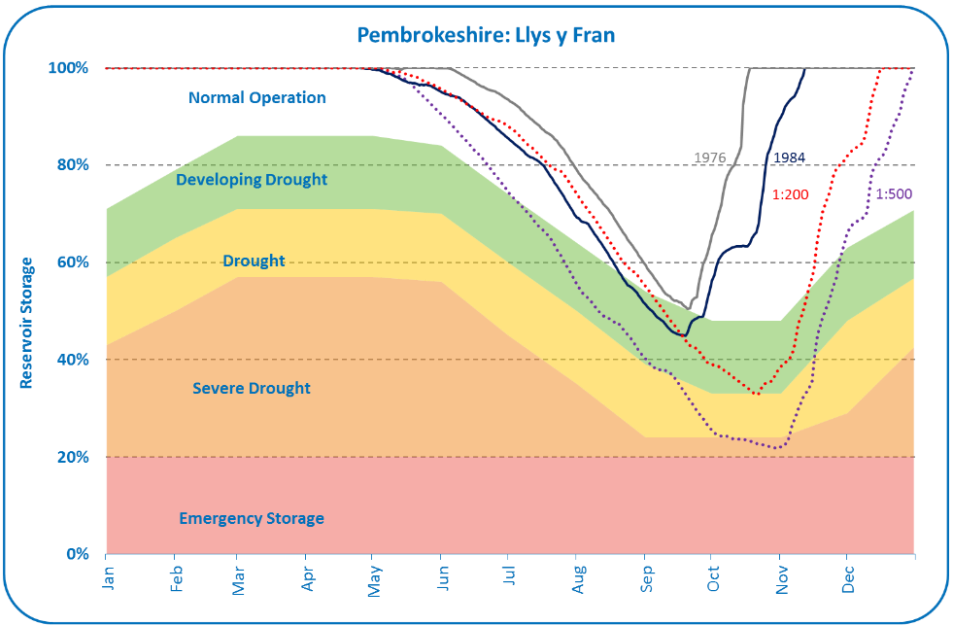


The Pembrokeshire WRZ covers the far south west corner of Wales, stretching from Pendine Sands in the east to the Pembrokeshire Coastal National Park in the west, and from the village of Manobier in the south to Fishguard in the north.

The trigger levels for applying for a drought order at Llys-y-Fran (freshet release) are based on water levels in Llys-y-Fran Reservoir falling below a defined threshold level as shown in **Figure 2.2** (orange shading labelled 'severe drought'). Welsh Water's assessment in its Revised Draft Drought Plan 2020 indicates that drought conditions severe enough to require an application for this drought option are unlikely to occur

more frequently than at a return period of around once every 200 years. Fuller details of the work undertaken to assess this risk are provided in Annex 1 to the Revised Draft Drought Plan 2020.

Figure 2.2 Pembrokeshire WRZ : Llys y Fran Drought Action Zones and Historic Droughts



2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT LLYS-Y-FRAN

Welsh Water owns and operates Llys-y-Fran Reservoir. The company is permitted to abstract up to 5.0Ml/d each day and 765Ml/year from the reservoir (as per licence number 22/61/4/38). There are further restrictions on the abstraction linked to an upstream abstraction at Rosebush Reservoir (also known as Preseli Reservoir) (licence number 22/61/4/1) and a downstream abstraction at Canaston Intake on the Eastern Cleddau river (licence number 22/61/4/10) as set out below:

- The aggregate quantity of water abstracted from Llys-y-Fran and Rosebush Reservoirs shall not exceed 5,909.8Ml/year
- The aggregate quantity of water abstracted from Llys-y-Fran Reservoir and at Canaston shall not exceed 25,000Ml/year
- The aggregate maximum daily quantity abstracted from Llys-y-Fran Reservoir and at Canaston shall not exceed a quantity determined from the volume of water available in Llys-y-Fran Reservoir in accordance with operating rules that have been agreed with Natural Resources Wales (NRW).

There are a number of additional conditions relating to the abstraction, as follows:

- Provision of a uniform statutory compensation water release to the Afon Syfynwy

of 13.64Ml/d at all times (when regulation releases are not occurring)

- At the request of NRW, release up to 955Ml into the downstream watercourse (at a daily rate no greater than 68Ml/d) for the benefit of fisheries

- Release water into the Afon Syfynwy to support the abstractions at Canaston (authorised under licence number 22/61/4/10, described below).

Welsh Water may release water from the reservoir into the downstream Afon Syfynwy in order to support flows in the Eastern Cleddau River so that it can continue to abstract a routine amount of water at the downstream Canaston intake. The timing of such regulation releases are described below with reference to the Canaston abstraction licence, as follows:

- Welsh Water may abstract up to 85Ml/d and 25,000Ml/year at Canaston intake, downstream of Canaston Bridge.

- Abstraction may not occur if it were to cause the rate of flow in the river downstream of the abstraction to be reduced to less than 2.84Ml/hour (68.2Ml/d) as a hands off flow (HoF) condition.

- As described above, Welsh Water may release water from Llys-y-Fran Reservoir (regulation releases) to support river flow during periods of low flow, so that routine abstractions are achieved without breach of the HoF.

- From April to June (inclusive) and October to December (inclusive), the maximum daily abstraction rate shall not exceed the values set out in **Table 1.1** if unsupported flow in the River Eastern Cleddau at the Canaston Bridge Gauging Station (gauged flow minus Llys-y-Fran reservoir releases plus abstractions at Pont Hywel) is within the specified ranges. Any abstraction in excess of these rates must be supported by regulation releases from Llys-y-Fran reservoir equating to the excess amounts.

Table 1.1 Flow-related seasonal daily abstraction limits

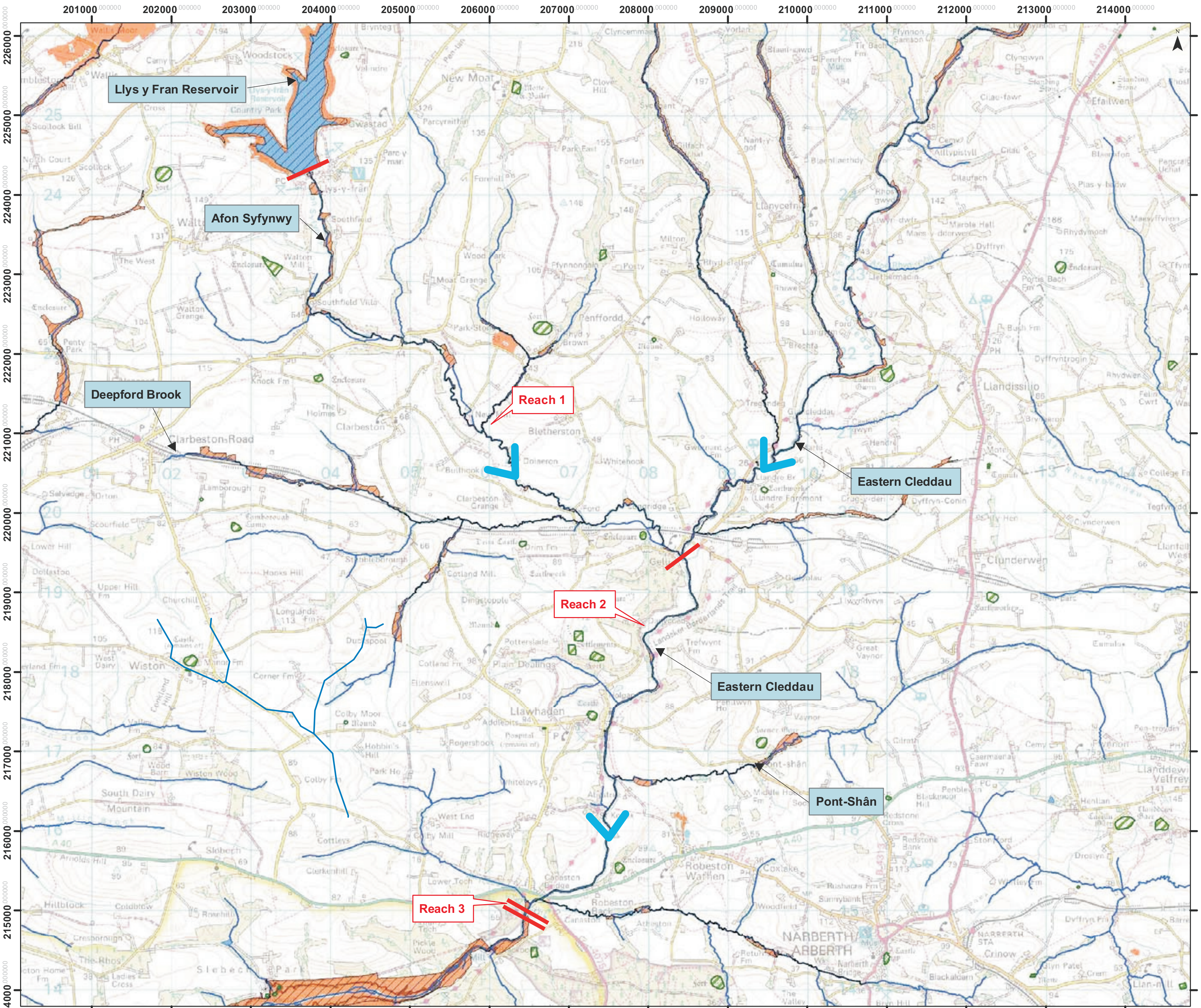
Unsupported flow in the Eastern Cleddau at Canaston Bridge Gauging Station (Ml/d)	Maximum daily abstraction (Ml/d)
Below 110.592	12.96
110.592 – 194.376	38.016
194.377 – 270.408	63.072

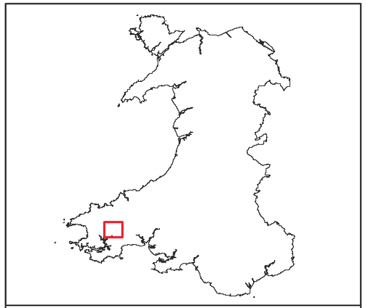
- At any time, the maximum hourly rate of abstraction and corresponding rate of discharge from Llys-y-Fran Reservoir shall be determined from the volume of water available in the reservoir in accordance with the reservoir operating rules.

- The aggregate quantity of water abstracted from Canaston, Llys-y-Fran Reservoir and Pont Hywel (licence number 22/61/4/3) shall not exceed 85Ml/d.

The Canaston licence conditions have been amended following a review of Welsh Water's abstractions by NRW under the environmental requirements of the EU Habitats Directive ("Review of Consents" process). The new licence conditions come into force on 31 March 2019 and therefore the drought option has been assessed relative to these new licence conditions, subject to the availability of hydrological data sets which currently do not include any periods with the new licence conditions in force.

The study area is illustrated on **Figure 2.3**.





Legend

- Water Courses
- Reservoir
- Hydrological Reach
- Direction of Flow
- Special Area of Conservation
- Site of Special Scientific Interest
- Scheduled Ancient Monuments

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1:45,000

Note: All locations are approximate

This drawing incorporates Ordnance Survey Information

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Study Area: 8206-7 Llys y Fran use of Freshet Bank

Figure Number: Figure 2.3

Date: February 2019

2.3 WELSH WATER'S DROUGHT PLANNING PROCESS

Water companies in England and Wales are required to prepare and maintain Statutory Drought Plans under Sections 39B and 39C of the Water Industry Act 1991, as amended by the Water Act 2003, which set out the management and operational steps a water company will take before, during and after a drought. The Water Industry Act 1991 defines a drought plan as '*a plan for how the water undertaker will continue, during a period of drought, to discharge its duties to supply adequate quantities of wholesome water,* with *as little recourse as reasonably possible to drought orders or drought permits*'.

The Drought Direction (Wales) 2017 states that revised Drought Plans should be submitted according to the following schedule:

> *4(b) for a revised drought plan –*
>
> *if section 39B(6)(a) of the Act applies, within 6 months after the date on which the material change of circumstances occurs; and*
>
> *if section 39B(6)(c) of the Act(c) applies, no later than 4 years after the date on which its drought plan, or its last revised drought plan, is published.*

2.4 STATEMENT OF THE NEED FOR DROUGHT ORDER

This section will be completed at the time of application for a drought order.

2.5 DROUGHT ORDER– REGULATORY ARRANGEMENTS

In periods of unusually low rainfall, when water resources become scarce, the Water Resources Act 1991, as amended by the Environment Act 1995 and the Water Act 2003, allows for three mechanisms for temporarily augmenting water supplies from rivers, lakes, reservoirs and groundwaters: drought permits; ordinary drought orders; emergency drought orders.

Drought permits are granted by NRW, and allow a water company powers to abstract from specified water sources, or to modify or suspend the conditions set out in existing abstraction licences. Drought orders are granted by the Welsh Ministers and give powers either to a water company or to NRW to abstract from specified water sources, or to modify or suspend the conditions set out in existing abstraction licences, but also to allow the discharge of water to specified places, modify or suspend conditions relating to a discharge or prohibit or limit particular non-essential uses of water as set out in the Drought Plan (Wales) Direction 2017. Emergency drought orders grant the same powers as a drought order, but in addition, confer powers to prohibit or limit water uses as specified by the water company and allow the set up and supply of water by means of standpipes and/or water tanks or rota cuts.

Drought permits and orders may be granted for a period of up to six months and they can be extended for up to a further six months.

As part of the drought order/permit application process, water companies are required to prepare an Environmental Report setting out anticipated effects of the proposal, including the effect on other abstractors and sufficient information to inform assessments, where applicable, in relation to the Habitats Directive, Countryside and Rights of Way Act (CRoW), and the Water Framework Directive (WFD).

Further information on the requirements for the environmental assessment and reporting according to legislation and national guidance are provided in Section 3.

2.6 REVIEW OF ALTERNATIVE OPTIONS

This section will be completed at the time of application for a drought order, setting out the alternative options to the drought order that Welsh Water has considered in addressing the risks to essential public water supplies due to drought.

2.7 PROPOSED DROUGHT ORDER DETAILS

In accordance with the Llys-y-Fran Reservoir Section 158 operating agreement, a total of 955Ml of the storage volume within Llys-y-Fran Reservoir is allocated to the freshet bank, to be released for fisheries management purposes at the direction of Natural Resources Wales (NRW). The drought order involves using 385Ml (approximately 40%) of this volume of storage for public water supply, so that only a limited number (three) of freshet releases could take place during the period of implementation.

Retaining part of the freshet bank volume within the reservoir for public supply, rather than releasing it to the downstream watercourse, will conserve the longevity of reservoir storage and improve the probability of reservoir winter refill. The drought order scheme will influence the Afon Syfynwy downstream of Llys-y-Fran Reservoir outfall and its continuation as the Eastern Cleddau River until the tidal limit.

Welsh Water has determined through water resources modelling that the drought order would only be required during the months of August to November inclusive. However, the impact of the drought order will only occur at times when freshet releases for fisheries purposes would normally be made. Information available at the time of this assessment indicates that releases are typically requested for a short period (around 4-5 days) during the early autumn. It is assumed that this relates to the need to ensure spate flows during the key fish migration period of October to December. The assessment has therefore considered potential impacts during the autumn/early winter period of October to December inclusive. Freshet releases may also be requested by NRW in June to aid smolt downstream migration, however releases during June would not be impacted by the drought order which is restricted to the period August to November inclusive.

Table 2.1 Llys-y-Fran (freshet release) Existing and Proposed Drought Order Abstraction

Abstraction Water Source	NGR	Normal Abstraction	Proposed Drought Order Abstraction	Benefit
Llys-y-Fran Reservoir	SN 03737 24275	Welsh Water licence (22/61/4/38) permits abstraction of up to 5Ml/d each day and 765Ml/year from Llys-y-Fran Reservoir. Further restrictions on the abstraction linked to an upstream abstraction at Preseli Reservoir (22/61/4/1) and downstream abstraction at Canaston (22/61/4/10): • The aggregate quantity of water abstracted from Llys-y-Fran and Preseli Reservoirs shall not exceed 5,909.8Ml/year • The aggregate quantity of water abstracted from Llys-y-Fran Reservoir and at Canaston shall not exceed 25,000Ml/year The aggregate maximum daily quantity abstracted from Llys-y-Fran Reservoir and at Canaston shall not exceed a quantity determined from the volume of water available in Llys-y-Fran Reservoir in accordance with operating rules that have been agreed to by NRW. A statutory compensation flow release of 13.64 Ml/d must be released from Llys-y-Fran Reservoir each day whenever regulation releases are not being made.	In accordance with the Llys-y-Fran Reservoir Section 158 operating agreement, a total of 955Ml of the storage volume within Llys-y-Fran Reservoir is allocated to the freshet bank, to be released for fisheries management purposes at the direction of Natural Resources Wales (NRW). The drought order involves using 385Ml (approximately 40%) of this volume of storage for public water supply, so that only a limited number (three) of freshet releases could take place during the period of implementation.	385 Ml storage volume

[Note: it will probably be necessary to remove the NGR for any public domain version]

2.8 DROUGHT ORDER PROGRAMME

Drought orders may remain in force for a period of up to six months, and they can be extended for up to a further six months. However, the period of implementation for this drought order is restricted to October to December.

Prevailing weather conditions and rainfall in the intervening period may delay the requirement for applications, or even result in no requirement to apply. An order may be granted but not actually implemented if weather conditions improve or, equally, the order may only be partially implemented.

2.9 DROUGHT ORDER BASELINE

It is important for the assessment to establish the environmental "baseline" conditions that would exist in drought conditions but in the absence of the drought order being implemented. For the purposes of this assessment, the "without drought order" baseline includes the continuation of abstraction from Llys-y-Fran Reservoir and Canaston Intake on the Eastern Cleddau River and releases from Llys-y-Fran Reservoir, including occasional freshet releases, in accordance with the abstraction licence conditions. These also include the continuation of a daily compensation release of 13.64Ml/d from Llys-y-Fran Reservoir whenever regulation releases are not occurring. The assessed drought order involves using 385Ml of the storage volume allocated to freshet bank for public water supply, so that only a limited number (three) of freshet releases could take place during the period of implementation.

3 APPROACH

3.1 INTRODUCTION

The DPG states that the environmental report must include:

i. the likely changes in flow, level, channel/riparian form and sediment due to implementing the action;
ii. the features that are sensitive to these changes;
iii. potential impacts on sensitive features;
iv. a plan of baseline, in-drought and post-drought monitoring; and
v. mitigation or compensation measures that may be required

Items i and ii above were subject to an initial screening process as part of the scoping exercise. Section 3.2 below describes the approach taken. This has provided the relevant study area and a list of features scoped into the environmental assessment which are the subject of this EAR.

Section 3.3 describes how the environmental assessment has been undertaken, including discussion of the general approach, guidance used, provision of data, assessment methodologies and consideration of mitigation and monitoring. Limitations to the environmental assessment are described in Section 3.4, 4 and 5.

To set the context of the studies, it should be noted that EAR considers the environmental impacts of implementing a drought order during the worst environmental conditions (natural drought) that the order could be implemented in.

In accordance with the DPG and the Habitats Regulations, the assessment considers how the proposed drought order may affect the environment in combination with the effects of other existing abstraction licences, environment permits and other plans. This includes assessment of the potential cumulative effects of the following:

- Welsh Water's existing abstraction licences that operate within the hydrological zone of influence of the drought option, as well as other abstraction and discharge consents
- Assessment of cumulative impacts of the drought order with other Welsh Water supply side and drought permit / order options within the hydrological zone of influence (including both intra- and inter- zone options)
- Other plans and projects of relevance, including:
    - Welsh Water's WRMP schemes which are scheduled to be implemented and become operational within the time period of the Drought Plan (i.e. before 2025)

- Drought options from other neighbouring water company Drought Plans, Natural Resource Wales Drought Plans
- National Policy Statements for Wastewater and Renewable Energy Infrastructure.

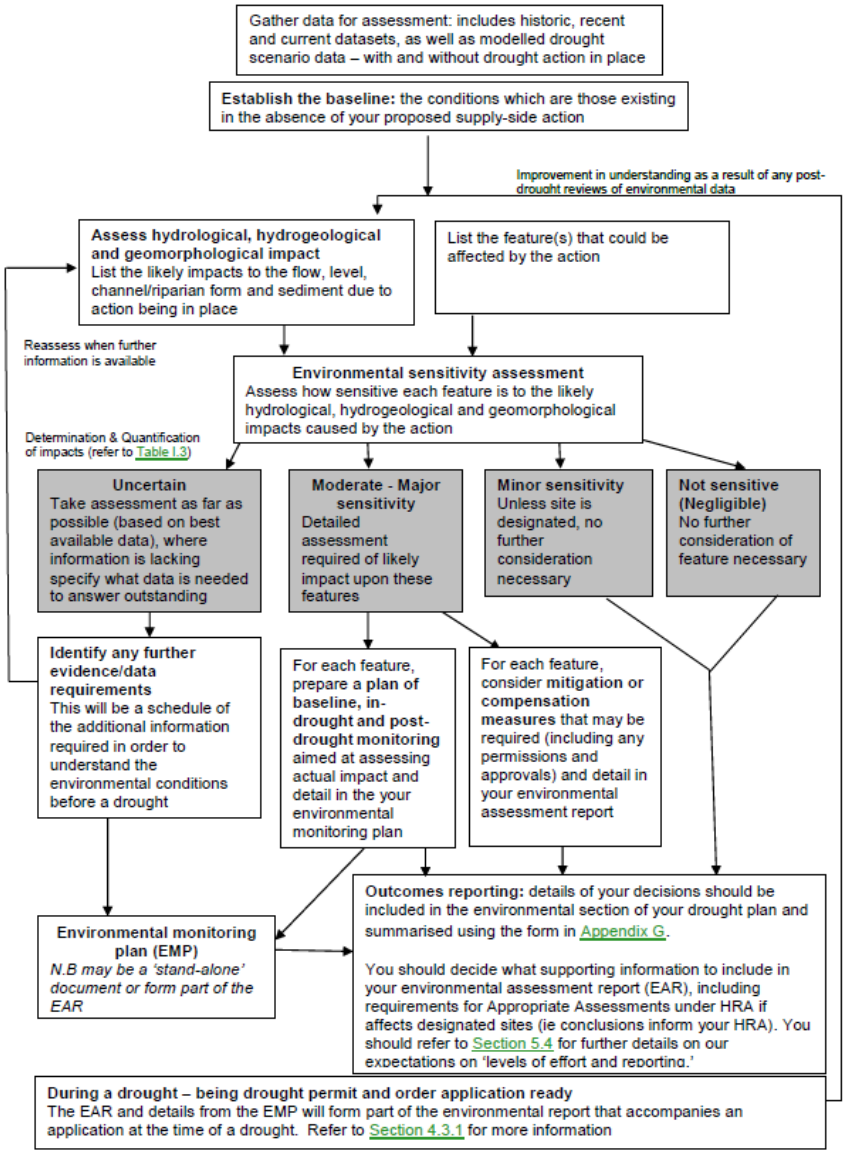
This is discussed further in Section 7.

3.2 APPROACH TO SCREENING AND SCOPING

3.2.1 Screening

Screening was undertaken using the DPG; specifically Section 5 and Appendix I. Figure 2 of the DPG (replicated in **Figure 3.1** below) identifies the environmental impact activities required.

Figure 3.1 Environmental Impact Activities Identified in the Drought Plan Guideline



The screening fulfils the requirement to "Assess how sensitive each feature is to the likely hydrological, hydrogeological and geomorphological impacts caused by the action". Stage 1 (hydrological impact) fulfils the requirement to "List the likely impacts to the flow, level, channel/riparian form and sediment due to action being in place". Stage 2 (environmental sensitivity) fulfils the requirement to "list the feature(s) that could be affected by the action" and to "Assess how sensitive each feature is to the likely hydrological, hydrogeological and geomorphological impacts caused by the action"

It is important to acknowledge the basis of the assessment; i.e. impacts of drought order implementation should be considered in the context of what would occur without drought order implementation (see Sections 2.2, 2.7 and 2.9).

The approach to undertaking Stages 1 and 2 is described below.

Stage 1 – Hydrological and Hydrogeological Impact

Consideration is required (by the DPG) of the likely impacts on the hydrology, hydrogeology and geomorphology of every river reach, wetland or lake area influenced by the proposed drought management action, specifically:

- identify the drought conditions which trigger the proposed action;
- identify any changes that the action is likely to bring about, specifying their length, severity and location in relation to existing natural and artificial features;
- describe the likely conditions in the absence of the proposed action;
- describe how the likely conditions would differ with the action in place compared to the same (or analogous) watercourse under natural conditions; and
- identify the extent of the area affected by the planned actions.

The hydrogeological and hydrological information is used together with information on the other environmental features in the study area from Stage 2 - Environmental Sensitivity (see below) to identify the environmental risk of implementing the drought order.

Although the DPG informs the hydrometric data to be used as part of environmental features for consideration within the environmental assessment (see Box 1 Appendix I of the DPG), it does not provide a methodology for identifying the hydrological impact. A bespoke assessment has therefore been undertaken.

The full hydrological assessment approach is set out in **Appendix A**.

The output from these studies provides an understanding of the scale of change in the

hydrological characteristics as a result of implementing the drought order. Where changes have been identified, the potential significance of adverse or beneficial impacts has been assessed.

Quantitative and qualitative measures have been used to grade the impacts on surface waters. The assessment has identified the potential severity of impact based on the following criteria:

- **Positive or Negative Impact** – all impacts are considered to be negative unless otherwise stated in the feature assessment.
- **Extent** – the extent of the impact is covered as part of the magnitude consideration.
- **Magnitude** – the magnitude of the impact is identified as**:**
  - *High*: There is a long-term large-scale (i.e. catchment) change in the physical environment.
  - *Medium*: There is a short-term large-scale change or long-term short-scale (i.e. reach) change in the physical environment, however, no changes in the overall integrity of the physical environment.
  - *Low*: There is a short-term small-scale change in the physical environment, but its overall integrity is not impacted.
  - *Negligible*: No perceptible change in the physical environment.
- **Duration** – the duration of impact is considered to be for 6 months, which is the duration for which a drought option is implemented, unless otherwise stated.
- **Reversibility** – all hydrological impacts are considered to be reversible**.**
- **Timing and Frequency** – the drought option could be implemented at any point in the year, unless otherwise stated. The assessment is based upon the operation of a single drought order, with subsequent applications for a drought order required to consider cumulative effects of multiple drought order.
- **Probability** – all impacts are considered to be probable, unless otherwise stated.

The hydrological impact assessment is described fully in **Appendix B**.

Section 4 provides a summary of the hydrology and physical environment assessment as a result of implementing a drought order at Llys-y-Fran (freshet release).

Stage 2 - Environmental Sensitivity

With the extent and level of flow impact mapped, using GIS and other data sources, potentially sensitive receptors (sites / features) located within the extents of impact have been identified. Potentially sensitive features investigated in the screening have

been drawn from Box 1 in Appendix I of the DPG. These include:

- designated biodiversity sites (Local Nature Reserve (LNR), National Nature Reserve (NNR), Marine Protected Areas, National Parks, Areas of Outstanding Natural Beauty (AONB), SSSI, Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar) and Environment (Wales) Act Section 7 species / habitats which are located on or within 500m of the impacted reaches;
- protected species;
- ecological communities (fish, bryophytes & lichen, macro-invertebrates, macrophytes, algae) and, where identified, Water Framework Directive (WFD) status of designated waterbodies which contain the impacted reaches;
- invasive non-native species;
- sensitive ecological features as advised by NRW;
- wider features which should be taken into account in determining the potential impacts of drought option implementation – specifically socio-economic & health, amenity & aesthetics, recreation, navigation, architectural & archaeology heritage.

Each of the identified sensitive receptors within the extent of impact have been listed, alongside a brief summary of their potential susceptibility to flow impacts. For designated sites, this has included an indication as to whether the sites have water dependent qualifying interests.

The environmental sensitivity of each site has been identified according to the ecological and nature conservation interests of the area and, in particular, the proximity of and / or connectivity with the designated protected area. Each site has been assessed according to whether the extent of hydrological influence includes or is considered to affect a designated or protected site. Designated or protected sites outside the extent of hydrological influence are considered not to be influenced by the drought order.

The outcome of Stage 1 and Stage 2 of the screening exercise are presented in Sections 4 and 5 respectively.

3.2.2 Scope

The screening exercise establishes the study area for the Llys-y-Fran (freshet release) drought order together with identification of relevant, sensitive environmental features within those study areas (based on the risk of them being impacted by the drought order during the period of its operation).

As set out in **Figure 3.1**, the environmental sensitivity screening identifies the

outcome for each listed feature. Four outcomes are possible from the screening: uncertain; moderate-major sensitivity; minor sensitivity; not sensitive (negligible); and identifies appropriate next steps. Sections 4.2 and 5.2 present the findings which show that a number of features were identified as either: 1) uncertain; 2) moderate-major sensitivity; or 3) minor sensitivity in a designated site and in accordance with the DPG are features for which further assessment work will be required. These features alone form the scope of monitoring, environmental assessment, and consideration of mitigation actions.

The DPG states that environmental assessment, mitigation and / or monitoring is not required for features where screening has identified a minor (unless a site is designated) or negligible impact. However, the requirement for assessment, monitoring and / or mitigation has been reviewed on a case-by-case basis. In some cases, mitigation and / or monitoring has been recommended where minor impacts are identified, where considered appropriate on a precautionary basis.

3.3 APPROACH TO ASSESSING IMPACTS, MITIGATION AND MONITORING

3.3.1 General Approach

The assessment approach is in accordance with legislation, national regulations and guidance, including:

- NRW (2017) Water Company Drought Plan Technical Guideline (DPG)
- Welsh Ministers (2017) The Drought Plan (Wales) Direction
- Institute of Environmental Management and Assessment (2004) Guidelines for Environmental Assessment
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland[3]
- UKWIR (2007, updated 2012) Strategic Environmental Assessment – Guidance for Water Resources Management Plans and Drought Plans. Prepared by Cascade Consulting
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)
- Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat , December 1975

[3] CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial. Freshwater and Coastal. September 2018.

- Conservation of Habitats and Species Regulations 2017
- The Countryside and Rights of Way Act 2000.

All aspects of the drought order of potential environmental significance are considered in the environmental assessment.

The DPG states that a water company should clearly show what evidence and data have been used in decision making, that uncertainties should be identified, and which additional data requirements are provided for through the environmental monitoring plan.

In accordance with the DPG the approach to the assessment addresses the following: i) potential effects on each sensitive receptor; ii) definitions for impacts (adverse / beneficial); iii) the data requirements; iv) assessment methodology (including the treatment of uncertainty where the complete data requirements are not available).

This EAR presents the environmental baseline, i.e. habitats and environmental pressures (including flow and water quality) in the study identified zone of hydrological influence without the drought order in place, utilising a description of the catchment, geomorphology, anthropogenic features and water quality. Key changes to the physical environment as a result of implementing the drought order have been identified and described and, where appropriate, this information is used to frame and support the assessments of features which have been scoped in further to the screening and scoping exercise (see Section 3.2).

3.3.2 Assessment Methodologies

The aim of the Environmental Assessment is to provide:

- A clear summary of the outcome of each assessment (per feature) from which NRW can readily identify the significance of the impact when determining the drought order application
- Identification of those predicted impacts which are to be taken forward to consider additional monitoring and mitigation actions.

The assessment considers the environmental impacts of implementing the drought order against baseline operating conditions of Welsh Water's abstraction licence in advance of drought order implementation. Environmental sensitivity has been assessed considering the context of the timing of drought order implementation. **It is important to acknowledge the basis of the assessment; i.e. impacts of drought order implementation are assessed against what would occur without drought order implementation**.

The impact assessment for sensitive features is feature specific and is dependent on

the availability and resolution of available data. Where possible, quantitative assessments have been undertaken. However, for many features, it is acknowledged that the assessments are qualitative and based on professional judgement, and using, where relevant, experience of local knowledge and reference to literature. This introduces uncertainty into the impact assessment. A precautionary approach has been used to assigning impact significance where data are absent or found not to be robust.

The assessment of impacts on designated sites has been undertaken using professional judgement with reference to conservation objectives and condition status of habitats and species, for which a site has been designated. The ecological assessment has been undertaken recognising the IEMA[4,5] and the CIEEM study guidelines[6]. The assessment of impacts on other environmental receptors e.g. recreation and landscape has been carried out largely by qualitative expert judgement.

Assessment of impacts on specific features has then been undertaken. Specific assessment methodologies have been developed for key environmental features. These are set out in **Appendix C** (assessment methodologies for the ecological assessment of Environment (Wales) Act Section 7 species, designated sites and other flora and fauna).

Other abstractors, including other water company abstractions, are features that have been reviewed within the assessment. This has been undertaken to determine whether other abstractors could potentially be affected by changes to surface water flows and levels as a result of implementation of the drought order.

3.3.3 Mitigation and Monitoring

Section 5.3 of the DPG identifies the specific requirements for mitigation of serious impacts on the environment as a result of implementing a drought management measure. The assessments undertaken in this EAR confirm the features requiring consideration of mitigation and appropriate monitoring triggering mitigation. Appropriate mitigation actions identified are both available and practicable.

The DPG also identifies the specific requirements for monitoring. The assessments undertaken in this EAR inform the features requiring consideration for monitoring prior to, during, or after implementation of the drought order.

The mitigation and monitoring proposals (see Sections 6 and 10) will act as a safeguard that responds and is responsive to both predicted and unpredicted drought impacts. Future data collection and monitoring can then be focused to identify the aquatic

[4] IEMA (2004) Guidelines for Environmental Impact Assessment.
[5] IEMA (2011) Special Report – The State of Environmental Impact Assessment Practice in the UK
[6] CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland.

ecosystem interaction to better quantify the potential impacts where gaps in the evidence base are identified and ensure the appropriate targeting of monitoring and mitigation response. The EMP will need to be finalised in agreement with NRW.

3.4 LIMITATIONS OF THE ASSESSMENT AND UNCERTAINTIES

The DPG states that a water company should clearly show what evidence and data have been used in decision making, that uncertainties should be identified, and which additional data requirements are provided for through the environmental monitoring plan.

The assessment presented in this document draws on available information from surveys and investigations undertaken by Welsh Water, NRW, as well as other bodies over a number of years. Reference has also been made to wider studies from published and grey literature, i.e. academic literature that is not formally published, where appropriate.

Specific details are provided on the quality of the data collected and used in the assessment. Where uncertainties remain with respect to the quantification and prediction of impacts, the limitations and any assumptions made are included in the relevant technical sections (Sections 4 and 5).

Overall, it is considered that the conclusions are based on information that is robust and valid at the time of writing. However, it should be noted that this EAR would be updated to support any future actual application, including a review of data.

4 LLYS-Y-FRAN FRESHET DROUGHT ORDER - HYDROLOGY AND THE PHYSICAL ENVIRONMENT

4.1 INTRODUCTION

Consideration of hydrology and the water physical environment sets the context for the potential range of environmental effects of the drought order. **Appendix B** sets out an assessment of the potential impacts on the physical environment of Llys-y-Fran (freshet release) during the period of implementation of the drought order. The "without drought order" baseline is set out in Section 2.9.

The water physical environment assessment includes consideration of hydrology and hydrodynamics; geomorphology; and water quality. The assessment has three key objectives:

1. It is used to "list likely changes in flow, level, channel/riparian form and sediment due to implementing the action' as required by the DPG and set out in Figure 2 of the DPG

2. It is used to support the screening and assessment of sensitive features (including ecological features and designated sites) as required by the DPG and set out in Section 5 of this report

3. Where sensitive features are the physical environment itself, it provides supporting technical information for their screening and assessment.

Each of these are summarised below.

4.2 SUMMARY OF STAGE 1 SCREENING

This fulfils the DPG requirements of Stage 1 of the screening of potential drought order impacts, identifying the likely changes in flow/ level regime due to implementing the drought order. The specific requirements of the DPG are summarised as:

- identify any changes that the drought order is likely to bring about, specifying their length, severity and location in relation to existing natural and artificial features (e.g. flow, water level, channel dynamics and sediment changes);
- describe the likely conditions in the absence of the drought order;
- describe how the likely conditions would differ with the drought order in place compared to the same (or analogous) watercourse under natural conditions; and
- identify the extent of the area affected by your planned actions.

These requirements are addressed in the following sections.

1. The perceived extent of potential impact:

The study area (see **Figure 2.3**) is identified as the Afon Syfynwy and Eastern Cleddau from downstream of Llys-y-Fran Reservoir to the tidal limit.

2. The nature and duration of the potential impact:

A description of the likely conditions with the drought order in place, in comparison to the baseline conditions (absence of the proposed action) is provided in **Appendix B**. Given the conditions of the proposed drought order, the key areas for the assessment of the physical environment have been identified as:

- Change in river flows downstream of Llys-y-Fran Reservoir.

The **Appendix B** assessment has been summarised in **Table 4.1** in terms of the magnitude and duration of each of these potential physical environment impacts.

3. The length of the potential impact:

The **Appendix B** assessment has been summarised in **Table 4.1** in terms of the timing of each of the potential physical environment impacts. The drought order is most likely to occur during the autumn and winter period, considered to not extend outside the period October to December.

4.3 SUMMARY OF POTENTIAL EFFECTS ON THE PHYSICAL ENVIRONMENT

The potential changes to the physical environment (water quality and geomorphology) due to implementation of the drought order are summarised in **Table 4.1.** These impacts are presented in detail in **Appendix B**.

Table 4.1 Summary of Potential Hydrodynamic and Water Quality Impacts of the Drought Order

Issue	Identified Impact
Afon Syfynwy (Reach 1)	
Flows in the Afon Syfynwy *Negligible impacts during October to December*	• Impacts to river flow (hydrology) in the reach downstream of Llys-y-Fran Reservoir have been assessed as negligible, as up to three freshet releases could still be made.
Eastern Cleddau (Reach 2)	
Flows in the Eastern Cleddau *Negligible impacts during October to December*	• Impacts to river flow (hydrology) in the reach downstream of the Afon Syfynwy confluence have been assessed as negligible, as up to three freshet releases could still be made.
Eastern Cleddau (Reach 3)	
Flows in the Eastern Cleddau *Negligible impacts during October to December*	• Impacts to river flow (hydrology) in the reach downstream of the Canaston abstraction intake have been assessed as negligible, as up to three freshet releases could still be made.

4.3.1 Support to the Screening and Assessment of Sensitive Features

The assessment included in **Appendix B** has provided information to support the screening and assessment of sensitive features in Section 5. This includes information on short and long term (acute and chronic) direct and indirect, cumulative, and permanent and temporary effects. The assessment is also specific on the difference between the drought order impacts and the baseline condition without a drought order in place.

4.3.2 Supporting Technical Information for Assessment of any Physical Environment Sensitive Features

As described in Section 5, several sensitive features relate to the physical environment, rather than ecology or human interaction (e.g. landscape, recreation). The assessment included in **Appendix B** has provided supporting technical information for their screening and assessment in Section 5.

5 LLYS-Y-FRAN FRESHET DROUGHT ORDER ENVIRONMENTAL FEATURES ASSESSMENT

5.1 INTRODUCTION

As set out in **Box 1** above (Section 1.2), environmental assessment is neither required nor included for features where screening has identified a minor (where there are no environmentally designated sites) or negligible impact. However, for completeness, and in compliance with the DPG, environmental sensitivity screening has been undertaken within the zone of hydrological influence.

Points of interest referred to throughout the text in Section 5 are indicated on **Figure 2.3**.

5.2 SUMMARY OF STAGE 2 SCREENING AND SCOPING

5.2.1 Designated Sites and Other Sensitive Fauna and Flora

In accordance with the DPG, **Table 5.1** identifies designated biodiversity sites (including LNR, NNR, SSSI, SAC, SPA), Environment (Wales) Act Section 7 species / habitats and other sensitive receptors that could be affected by the drought order. Susceptibility to the flow / level impacts resulting from the drought order (see Section 4) is identified according to whether interest features of the site or the species are water dependent. Sensitivity is then determined according to professional judgment based on susceptibility and the level of hydrological impact at the location.

Table 5.1 Designated Sites and Other Sensitive Receptors Within the Zone of Influence of the Llys-y-Fran (freshet release) Drought Order

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, Moderate/ Major, Minor, Negligible)	Further Consideration Required (Yes/No)
Afon Syfynwy & Eastern Cleddau (Reaches 1-3)				
Afonydd Cleddau / Cleddau Rivers SAC / Eastern Cleddau Rivers SSSI	Negligible	The Cleddau Rivers SAC / Eastern Cleddau Rivers SSSI is designated for *Ranunculus* community habitat, *Potamogeton berchtoldii x P. polygonifolius* and a range of important fish species, which are sensitive to flow and level changes in the Afon Syfynwy and Eastern Cleddau.	Negligible	No
Macrophyte community	Negligible	Reduction in flows and level as a result of the drought order could reduce the overall extent of habitat availability for freshwater macrophytes in the study area.	Negligible	No
Notable Species – Macrophytes *Ranunculus and Chalico-Batrachion* communities *Potamogeton berchtoldii hybrid with P. polygonifolius*	Negligible	These species often develop within specific hydraulic and nutrient conditions, and thus alteration as a result of a drought order would impact on the species, although the level of impact beyond that of a natural drought is uncertain.	Negligible	No
Macroinvertebrate community	Negligible	Freshwater macroinvertebrates species live in niche habitats and their susceptibility to impacts are likely to increase if water levels fall. Although the level of impact beyond that of a natural drought is uncertain this community is likely to be sensitive to changes in flow and level as a result of the drought order implementation.	Negligible	No
Notable Species – Fish Atlantic salmon *Salmo salar* Brown trout *Salmo trutta* Bullhead *Cottus gobio* Brook lamprey *Lampetra planeri* River lamprey *Lampetra fluviatilis* Sea lamprey *Petromyzon marinus* European eel *Anguilla anguilla*	Negligible	The availability of riverine habitats for fish may be altered through modification to the velocity, wetted width or depth of water, while lower flows may affect migration activity of various species during October to December. Secondary effects of changes to flow regime include reduced water quality (often resulting from reduced dilution of point-source or diffuse pollution) and the potential for increased predation by birds/otter during periods of low flow.	Negligible	No

Site/Feature and designation	**Hydrological Impact at Location (Major, Moderate, Minor)**	**Susceptibility to flow and level impacts**	**Sensitivity (Uncertain, Moderate/ Major, Minor, Negligible)**	**Further Consideration Required (Yes/No)**
Phytobenthos community	Negligible	The phytobenthos community is likely to be sensitive to changes in flow as a result of the drought order.	Negligible	No
Notable Species – Mammals Otter *Lutra lutra*	Negligible	Otter are known to be present in the catchment. Implementation of the drought order is considered unlikely to lead to adverse effects on habitat or prey availability	Negligible	No
Invasive Species – Himalayan Balsam *Impatiens glandulifera* Non-native flatworm *Dugesia tigrina*	Negligible	Invasive plant species utilise flow of the watercourse for dispersal but are not reliant on it. Implementation of the drought order is unlikely to increase the risk of dispersal. Invasive non-native flatworm found on the Syfynwy and Eastern Cleddau.	Negligible	No
Landscape and visual amenity	Negligible	The Pembrokeshire Coast National lies less than 500m downstream of the zone of hydrological influence. As the flow and level impacts are assessed as negligible in Reach 3 no impacts on landscape and visual amenity are anticipated.	Negligible	No
Recreation	Negligible	The Afon Syfynwy and Eastern Cleddau River provide numerous recreational opportunities including; angling, canoeing, kayaking, walking, cycling and bird watching. Impacts on angling only are assessed as moderate.	Negligible	No
Archaeology	Negligible	Several Scheduled Ancient Monuments are located within the proximity of the study area including a number of defence enclosures Walton Mill Rath, Knock Rath, Drim Camp and Gelly Earthwork but none are dependent on flows in Afon Syfynwy.	Negligible	No
		A number of Scheduled Ancient Monuments are located within the proximity of the study area including Llawhaden Castle and Bridge. As the flow and level impacts are assessed as negligible in these reaches no impacts from implementation of the drought order are anticipated.		

5.2.2 WFD Waterbody Status

Table 5.2 identifies the WFD status classification of the WFD waterbodies that may be impacted by implementation of the drought order. Waterbodies classified as overall high / good status / potential, and / or high / good ecological status for fish or macroinvertebrates are likely to be more sensitive to flow impacts. **Table 5.2** summarises the risk to WFD status and indicates where further assessment has been carried out as reported in Section 5.3 below.

Table 5.2 WFD Status Classifications

Waterbody Name	**Syfynwy - Llys-y-Fran to confluence with Eastern Cleddau (GB110061030700)**		**Eastern Cleddau – confluence with Syfynwy to tidal limit (GB110061030670)**	
Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Negligible		Negligible	
Heavily Modified Waterbody (Y/N)	No		No	
RBMP Cycle	RBMP2 (2015)[7]	2018 C2 Interim	RBMP2 (2015)[8]	2018 C2 Interim
Ecological Status	Good	Moderate	Good	Moderate
Fish	Good	Good	Not classified	Not classified
Macrophytes	Not classified	Not classified	Not classified	Not classified
Phytobenthos	Not classified	Moderate	Not classified	Moderate
Macro-invertebrates	High	Good	Not classified	High
Total P/ Phosphate	Good	Moderate	High	Good
Ammonia	High	Good	High	High
Dissolved Oxygen	High	High	High	High
pH	High	High	High	High
Sensitivity (Uncertain, Moderate/ Major, Minor, Not sensitive)	Not sensitive		Not sensitive	
Further Consideration Required (Y/N)	No		No	

5.3 FEATURES ASSESSMENT

The hydrological impact of the drought order has been assessed as negligible. Screening has not identified any environment features for which environmental assessment is required. No environmental impacts have, therefore, been identified for any of the features identified in screening (see Section 5.2).

[7] NRW (2017) https://drive.google.com/file/d/0B2hsDbbdxz1tZHItRU9lNkg1YWs/view.
[8] NRW (2018 https://drive.google.com/file/d/14w17jL05sNuToVELqMCK_yc6DdHU7STb/view.

6 LLYS-Y-FRAN FRESHET DROUGHT ORDER– MITIGATION

The hydrological impact of the drought order has been assessed as negligible. Screening has not identified any environment features for which environmental assessment is required and, therefore, no mitigation is required during drought order implementation.

7 CUMULATIVE IMPACTS

In accordance with the DPG and the Habitats Regulations, consideration has been given to how the proposed drought order may affect the environment in combination with the effects of existing abstraction licences, environmental permits and other plans. This includes assessment of the potential cumulative effects of the following:

- Welsh Water's existing abstraction licences that operate within the hydrological zone of influence of the drought option, as well as other abstraction licences and discharge permits, as identified in NRW Review of Consents reports;
- Assessment of cumulative impacts of the drought order with other Welsh Water supply-side and drought order options within the hydrological zone of influence (including both intra- and inter- zone options);
- Other plans and projects of relevance, including;
    - Any Welsh Water WRMP schemes which are scheduled to be implemented and become operational within the time period of the Drought Plan (i.e. before 2025).
    - Drought supply-side and drought order / permit options from NRW Drought Plans.
    - National Policy Statements for Wastewater and Renewable Energy Infrastructure.
- Environmental monitoring before, during and after drought order implementation (see Section 10).

If a drought order application is progressed in the future, the potential for cumulative effects will be reviewed and revised to reflect any changes which are relevant to the timing of the drought order specified in the application.

Welsh Water's existing abstraction licences and other abstraction licences and discharge permits

The assessment of hydrological impacts presented in **Appendix B**, and summarised in Section 4, has considered how the proposed drought order may affect the environment in combination with the effects of existing licences and consents. Therefore, no relevant licences or consents have been identified as relevant for assessment of cumulative effects.

Other relevant Welsh Water drought permit / orders

No cumulative effects of implementing the Llys-y-Fran (freshet release) drought order with other drought order / permit schemes (including the 8206-2 Preseli drought

order) have been identified. However, this should be reviewed at the time of any future application for a drought order at Llys-y-Fran (freshet release).

Welsh Water WRMP schemes

No WRMP schemes identified with cumulative impacts.

NRW Drought Plans

No cumulative impacts of options in NRW Drought Plan with a drought order at Llys-y-Fran (freshet release) are anticipated. However, this should be reviewed at time of future application for a drought order.

National Policy Statements for Wastewater and Renewable Energy Infrastructure

No cumulative schemes have been identified for assessment.

Environmental Monitoring

Recommendations for environmental monitoring before, during and after drought order implementation have been made in the EMP which is presented in Section 10 of this EAR. The EMP has been developed in consultation with NRW.

It is assumed that all monitoring activities will be undertaken with the best interests of the site in mind, and in discussion and agreement with NRW. Where activities which require in-river working are proposed, a method statement for the survey will be prepared and agreed with NRW in advance of the survey.

Assuming rigorous implementation of the method statements, there will be no adverse impacts of the monitoring on hydrology, water quality or ecology, and no adverse impacts of environmental monitoring on the site are anticipated.

8 LLYS-Y-FRAN FRESHET DROUGHT ORDER - SUMMARY OF RESIDUAL IMPACTS

The residual impact on environmental features is dependent on the effects observed during environmental monitoring, and the mitigation measures that are taken forward and their timely and effective application once the trigger for their need has been identified.

At this stage, no mitigation measures have been identified as required as the hydrological influence of the drought order has been assessed as negligible (see Section 4).

9 HABITATS REGULATIONS ASSESSMENT: STAGE 1 SCREENING

The DPG (see Section 3.3) requires that an environmental assessment report provides all relevant information to enable Habitats Regulations Assessment Stage 2 Appropriate Assessment of the Llys-y-Fran (freshet release) drought order on European designated sites to be undertaken.

The Afon Syfynwy and Eastern Cleddau forms part of the Afonydd Cleddau / Cleddau Rivers SAC, which are designated for:

- Sea lamprey
- Brook and river lamprey
- Bullhead
- Otter
- Water Courses of Plain to Montane Levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* Vegetation
- Alluvial Forests
- Active Raised Bogs

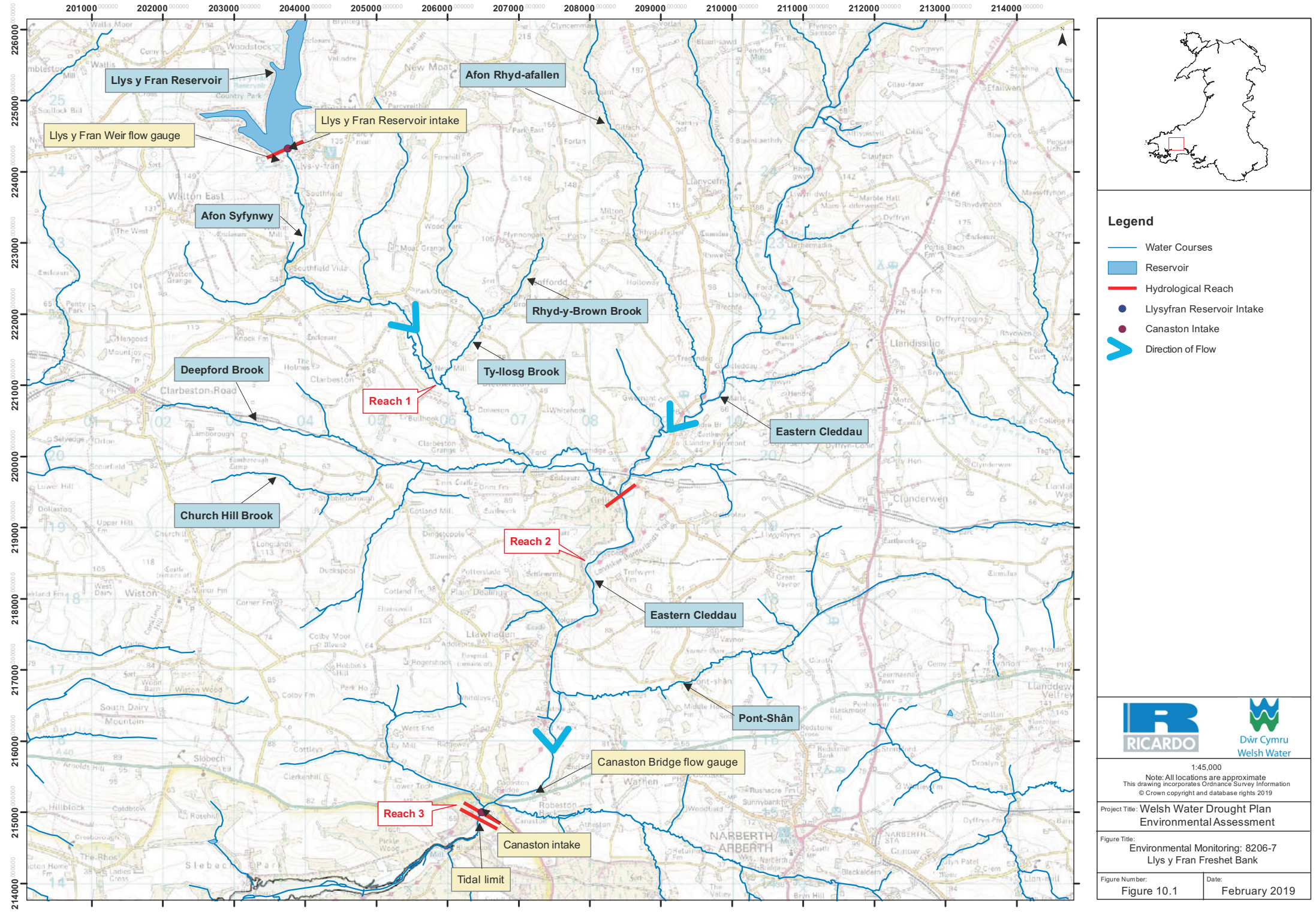
The hydrological impacts of the drought order at Llys-y-Fran (freshet release) drought order have been assessed as negligible (see Section 4) on Afon Syfynwy and Eastern Cleddau (0% flow reduction) and as such no likely significant effects on the features for which the SAC is designated are anticipated.

10 ENVIRONMENTAL MONITORING PLAN (EMP)

The hydrological impact of the drought order has been assessed as negligible. Screening has not identified any environment features for which environmental assessment is required and, therefore, no feature specific monitoring will be required.

However, it is recommended that current hydrological monitoring should continue to be carried out during the development of drought conditions and implementation of the drought order, in order to monitor the adherence (or otherwise) of the river system to that expected from the baseline assessment in Section 4. Such monitoring is mapped on **Figure 10.1,** and should include:

- Llys-y-Fran weir flow gauge: daily river;
- Measurement of the managed outflows made by Welsh Water from Llys-y-Fran Reservoir into the Afon Syfynwy: daily metered flow;
- Canaston Bridge flow gauge: daily river flow;
- Canaston intake abstraction: daily metered flow.



Legend

- Water Courses
- Reservoir
- Hydrological Reach
- Llysyfran Reservoir Intake
- Canaston Intake
- Direction of Flow

RICARDO

Dŵr Cymru Welsh Water

1:45,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Environmental Monitoring: 8206-7 Llys y Fran Freshet Bank

Figure Number: Figure 10.1

Date: February 2019

11 CONCLUSIONS

This EAR provides an assessment of the potential environmental impacts relating to the implementation of the Llys-y-Fran (freshet release) drought order. If granted and implemented, the drought order would enable Welsh Water to retain 385Ml of the total freshet bank volume within the reservoir for public water supply, rather than releasing it to the downstream watercourse, conserving the longevity of reservoir storage and improve the probability of reservoir winter refill.

The scope of the assessment has been defined by an impact screening and scoping exercise. In accordance with the DPG, the screening exercise involved two stages, a hydrological impact assessment (Stage 1) and the identification of the environmental features that could be affected by the drought order (Stage 2).

The hydrological impact assessment identified a **negligible** impact on flows in the Afon Syfynwy and a **negligible** impact on Llyn y Fran Reservoir.

The DPG states that further environmental assessment is not required for features where screening has identified a minor (if there are no designated environmental sites) or negligible impact. Screening has not identified any environment features for which further environmental assessment is required. No environmental impacts greater than negligible have, therefore, been identified for any of the features identified in the screening exercise. In light of this and in accordance with the DPG no mitigation or feature specific monitoring is identified. However, hydrological monitoring has been recommended during the development of drought conditions and implementation of the drought order, in order to monitor the adherence (or otherwise) of the river system to that expected from the assessment presented in this EAR.

No cumulative effects of implementing the drought order with existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for a drought order at Llyn y Fran (freshet release).

In summary, it has been concluded that the environmental effects on river flows and ecology of implementing a drought order at Llys-y-Fran (freshet release) during the period August to November, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions, with the onset of a natural drought, would be **negligible**. The assessment included consideration of the capacity to provide spate flows during the key fish migration period of October to December if instructed to do so by NRW.

APPENDIX A
HYDROLOGY AND HYDROGEOLOGY METHODOLOGY

A.1 HYDROLOGICAL AND HYDROGEOLOGY IMPACT METHODOLOGY (STAGE 1 SCREENING)

Consideration is required (by the DPG[1]) of the likely changes in flow / level regime due to implementing the drought management action, specifically:

- the perceived extent of potential impact
- the nature and duration of the potential impact
- the timing of the potential impact.

The hydrogeological and hydrological information is used together with information on the other environmental features in the study area from Stage 2 - Environmental Sensitivity (see Section 3.2.1 in main report) to identify the environmental risk of the drought order / permit.

Although the DPG informs the hydrometric data to be used as part of environmental features for consideration within the environmental assessment (see Box 1 Appendix H of the DPG), it does not provide a methodology for identifying the hydrological impact.

Cascade has developed a flexible approach[2] to identifying the spatial extent of the study area from hydrological information and characterising the hydrological impact within the study area, in terms of the scale, nature, duration and timing of impacts, although this is only appropriate to apply to reaches that do not dry naturally. A hydrological methodology for watercourses that naturally dry for part of the year is also presented that characterises the hydrological impact within the study area, in terms of the scale, nature, duration and timing of impacts. These are presented below.

Perennially flowing watercourse hydrological methodology

This methodology is applied to watercourses that flow throughout the year and that are potentially impacted on by the drought order / permit.

Core to this approach is the use of relevant long term flow statistics to inform the scale of hydrological impact and thereby delimit the zone of influence in the downstream river system. To determine these, potential reductions in flow resulting from implementation of the drought order / permit are compared with flows without the drought order / permit in place (i.e. the additional abstraction advocated by the drought order / permit over and above the existing abstraction). This helps to determine the scale of potential impact at any particular site/ feature using the matrix in **Figure A.1** or **Figure A.2** depending on the altitude of the waterbody and whether it is classified as lowland or upland[3]. Where possible, the hydrological assessments presented in previous EMPs and EARs of the drought options have been used to

1 Welsh Government / Defra / NRW / Environment Agency (2011). Water Company Drought Plan Guideline. June 2011.
2 Hydrological impact approach used in previous drought plan environmental assessments for water companies including Thames Water, Yorkshire Water and United Utilities
3 The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.
The Directions set out the principles of classification of surface water and groundwater bodies, including the use of 80m above Ordnance Datum as the altitude that differentiates water quality requirements for upland and lowland biology. Where there are ambiguities, or thresholds are crossed, upland is assumed to apply to ensure a precautionary assessment.

help identify the spatial extent of the study area from hydrological information and characterising the hydrological impact within the study area.

Figure A.1 Hydrological Assessment Matrix (Upland)

		Summer Q99		
	% reduction in flow	<10%	10-25%	>25%
Summer Q95	<10%	Negligible	Minor	Moderate
	10-25%	Minor	Moderate	Major
	>25%	Moderate	Major	Major

Figure A.2 Hydrological Assessment Matrix (Lowland)

		Summer Q99		
	% reduction in flow	<10%	10-25%	>25%
Summer Q95	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

Figure A.1 illustrates that at the time of implementation of a drought order / permit, upland river systems of relevance to each of these proposed options will exhibit high sensitivity to changes in low flow (represented by Q_{95}, summer[4]) and very high sensitivity to changes in extreme low flow (represented by Q_{99}, summer). As illustrated by **Figure A.2**, lowland rivers of relevance to each of these proposed options are considered to be less sensitive to reductions in summer low flows (summer Q_{95}), but similarly sensitive to reductions in extreme summer low flows (summer Q_{99}).

Figures A.1 and **A.2** are appropriate for the assessment of hydrological impacts on low flow regimes in watercourses during the spring, summer and autumn. However, in some cases there is a need to assess the impacts of drought order schemes on watercourses during the winter. For example, a reduction in compensation release may remain in force during the winter high flow period, to increase the probability of reservoir refill prior to the following year's spring/summer drawdown period. During the winter season, watercourses have relatively lower sensitivity to changes in low flow, and moderate sensitivity to changes in moderate flow. This can be reflected by the use of the matrices in **Figures A.3** and **A.4** for the assessment of drought order / permit schemes which are only likely to impact on a watercourse during the winter. The categorisation of impacts as negligible, minor, moderate or major is based on the percentage reduction in year round low flow (Q95) and year round median flow (Q50).

Figure A.3 Hydrological Assessment Matrix (Upland / Winter)

		Year round Q95		
	% reduction in flow	<10%	10-25%	>25%
Year round Q50	<10%	Negligible	Minor	Moderate
	10-25%	Minor	Moderate	Major
	>25%	Moderate	Major	Major

[4] Flow statistics indicate the proportion of days a flow is equalled or exceeded. Therefore Q95 indicates flow equalled or exceeded on 95% of days in the measured record (equivalent to an average of 347 days per year)

Figure A.4 Hydrological Assessment Matrix (Lowland / Winter)

		Year round Q95		
	% reduction in flow	<10%	10-25%	>25%
Year round Q50	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

The matrices are used to identify 1) the overall study area – which extends downstream of the abstraction until the hydrological impact has reduced to negligible; 2) reaches with similar scales of impact within the overall study area; and 3) the scale of hydrological impact within each reach. Typically reaches have been delimited by the addition of flow from a significant tributary or discharge; although the similarity of geomorphological characteristics of the reach may also be important in reach specification. The matrices can be applied to a variety of upland or lowland catchments respectively including those dominated by groundwater, and can be applied until the tidal limit.

In addition to the information provided by summary flow statistics in the matrix, information on the timing, duration and relevant seasons of the drought order / permit impacts have been informed by licence details and river gauging data have also been used to characterise the likely nature of the drought order / permit impacts.

If the drought order / permit does not impact on the magnitude of low flows in a watercourse, but does cause changes in the duration of low flow periods (which can be quantified), then the matrix in **Figure A.5** may be appropriate. The assessment is based on the percentage increase in the number of days for which flow is at or below the low flow (Q95) value. Typically this would be the case when the low flow regime in a watercourse downstream of a reservoir is protected by a statutory compensation release from the reservoir, but the reservoir may be drawn down below top water level for longer periods due to increased direct abstraction under the drought order / permit conditions.

If low flows in a watercourse are adversely affected in both magnitude and duration, then the impacts on magnitude are always used to determine the significance of hydrological impacts, using the appropriate matrix from **Figures A.1** to **A.4** inclusive. **Figure A.5** is only used when the impacts on low flows are on duration only.

Figure A.5 Hydrological Assessment Matrix (Low Flow Duration)

Percentage increase in low flow duration	Significance
<5%	Negligible
5-10%	Minor
10-25%	Moderate
>25%	Major

Intermittently flowing watercourse hydrological methodology

This methodology is applied to watercourses, potentially impacted on by the drought order / permit, that flow for most of the time but seasonally or occasionally ceasing to flow in response to decreased water availability e.g. due to increased evapotranspiration or bed seepage. . Such watercourses are identified from previous investigations and available data. Examples of watercourses where this methodology would be applied include winter bournes or watercourses that dry along their route due to losses to underlying aquifers. The impact classification of this methodology is as follows:

- Major - If the drought order / permit resulted in sections drying that did not dry up anyway
- Moderate - If the drought order / permit resulted in sections drying earlier (by more than a week) and / or recovering later (by more than a week) and hence flow reduction occurring in the channel for more than a week
- Minor - If the drought order / permit resulted in sections drying earlier (up to a week) and/or recovering later (by up to a week) and hence flow reduction occurring in the channel for up to a week OR if the drought order / permit were a secondary flow driver (e.g. flow through gravels being primary cause of flow losses rather than the drought order / permit)
- Negligible - No significant impact

In addition to the derived classifications, information on the timing, duration and relevant seasons of the drought order / permit impacts have been informed by licence details, available data and findings of previous investigations. These have been used to characterise the likely nature of the drought order / permit impacts.

Reservoir hydrological methodology

More recently Cascade has developed a similar approach to categorise the significance of hydrological impacts of drought order / permit operations on reservoirs. The assessment requires an estimate of the relative change in duration of reservoir drawdown (i.e. the period for which water in the reservoir is below top water level), and the percentage decrease in the minimum reservoir level reached during the drawdown period. These two parameters are then compared against the reservoir impacts hydrological assessment matrix in **Figure A.6**.

This approach would be a suitable method to assess the impacts of a drought order / permit which involves significant changes to the reservoir water level regime (that would not normally be experienced during a drought without any additional measures implemented). For example, a drought order / permit may involve increasing daily or annual licensed abstraction limits to allow an increased rate of direct abstraction from the reservoir. This may enable some or all of a reservoir's emergency storage volume to be utilised, but is likely to lead to both lower water levels and increased periods of time below top water level.

Figure A.6 Hydrological Assessment Matrix (Reservoir Impacts)

	% Increase in duration of reservoir drawdown			
% Decrease in minimum reservoir level	<5%	5-10%	10-25%	>25%
<5%	Negligible	Negligible	Minor	Moderate
5-10%	Negligible	Minor	Moderate	Major
10-25%	Minor	Moderate	Major	Major
>25%	Moderate	Major	Major	Major

Additional Considerations

For groundwater schemes, hydrogeological data, where available, has been reviewed to inform the study area and duration of any impacts (noting impacts on groundwater may extend beyond the six month period of drought order / permit implementation - see below). An increase in groundwater abstractions would lead to an increased cone of depression in groundwater levels for groundwater abstraction. This impact can affect other non-surface water receptors such as other wells, springs or groundwater dependent ecosystems. It could also mean that surface water impacts would extend upstream of the abstraction point or, in significant instances, to other watercourses some distance from the abstraction.

For groundwater abstractions, the impact of a drought order / permit could extend beyond the six month period (time limited) of abstraction depending on the local hydrogeology of the area. During drought situations, where there is limited recharge to the aquifer system, the abstraction can be mainly at the expense of groundwater stored in the aquifer. This can, in the long run, delay groundwater level recovery and have a knock on effect on baseflow contributions to watercourses. Flows could, therefore, be reduced for longer than the six month period during which the drought order / permit could be implemented and, as such, has been considered as part of the assessment described in this report.

APPENDIX B
HYDROLOGY AND PHYSICAL ENVIRONMENT ASSESSMENT

B1 INTRODUCTION

This appendix assesses the potential impacts on the physical environment of the Llys-y-Fran Reservoir and its downstream catchment, consisting of the Afon Syfynwy and the Eastern Cleddau River, during the period of implementation of the drought order.

For the purposes of this assessment, the "without drought order" baseline includes the continuation of abstraction from Llys-y-Fran Reservoir and Canaston Intake on the Eastern Cleddau River and releases from Llys-y-Fran Reservoir in accordance with the licensed arrangements described below, including occasional freshet releases as directed by Natural Resources Wales. The assessed drought order involves the use of a proportion of the freshet bank (part of the Llys-y-Fran Reservoir storage volume) for public water supply, so that freshet releases would be limited to three occurrences during the implementation period of the drought order.

B.1.1 Welsh Water's Existing Operations

Welsh Water owns and operates Llys-y-Fran Reservoir. The company is permitted to abstract up to 5.0Ml/d each day and 765Ml/year from the reservoir (as per licence number 22/61/4/38). There are further restrictions on the abstraction linked to an upstream abstraction at Preseli Reservoir (also known as Rosebush Reservoir) (licence number 22/61/4/1) and a downstream abstraction at Canaston Intake on the Eastern Cleddau river (licence number 22/61/4/10) as set out below:

- The aggregate quantity of water abstracted from Llys-y-Fran and Preseli Reservoirs shall not exceed 5,909.8Ml/year
- The aggregate quantity of water abstracted from Llys-y-Fran Reservoir and at Canaston shall not exceed 25,000Ml/year
- The aggregate maximum daily quantity abstracted from Llys-y-Fran Reservoir and at Canaston shall not exceed a quantity determined from the volume of water available in Llys-y-Fran Reservoir in accordance with operating rules that have been agreed with Natural Resources Wales (NRW).

There are a number of additional conditions relating to the abstraction, as follows:

- Provision of a uniform statutory compensation water release to the Afon Syfynwy of 13.64Ml/d at all times (when regulation releases are not occurring)
- At the request of NRW, release up to 955Ml into the downstream watercourse (at a daily rate no greater than 68Ml/d) for the benefit of fisheries
- Release water into the Afon Syfynwy to support the abstractions at Canaston (authorised under licence number 22/61/4/10, described below); in effect this is

a regulation release which cannot be greater than 71.36Ml/d.

Welsh Water may release water from the reservoir into the downstream Afon Syfynwy in order to support flows in the Eastern Cleddau River so that it can continue to abstract a routine amount of water at the downstream Canaston intake. The timing of such regulation releases are described below with reference to the Canaston abstraction licence, as follows:

- Welsh Water may abstract up to 85Ml/d and 25,000Ml/year at Canaston intake, downstream of Canaston Bridge.
- Abstraction may not occur if it were to cause the rate of flow in the river downstream of the abstraction to be reduced to less than 2.84Ml/hour (68.2Ml/d) as a hands off flow (HoF) condition.
- As described above, Welsh Water may release water from Llys-y-Fran Reservoir (regulation releases) to support river flow during periods of low flow, so that routine abstractions are achieved without breach of the HoF.
- From April to June (inclusive) and October to December (inclusive), the maximum daily abstraction rate shall not exceed the values set out in **Table B1.1** if unsupported flow in the River Eastern Cleddau at the Canaston Bridge Gauging Station (gauged flow minus Llys-y-Fran reservoir releases plus abstractions at Pont Hywel) is within the specified ranges. Any abstraction in excess of these rates must be supported by regulation releases from Llys-y-Fran reservoir equating to the excess amounts.

Table B1.1 Flow-related seasonal daily abstraction limits

Unsupported flow in the Eastern Cleddau at Canaston Bridge Gauging Station (Ml/d)	Maximum daily abstraction (Ml/d)
Below 110.592	12.96
110.592 – 194.376	38.016
194.377 – 270.408	63.072

- At any time, the maximum hourly rate of abstraction and corresponding rate of discharge from Llys-y-Fran Reservoir shall be determined from the volume of water available in the reservoir in accordance with the reservoir operating rules.
- The aggregate quantity of water abstracted from Canaston, Llys-y-Fran Reservoir and Pont Hywel (licence number 22/61/4/3) shall not exceed 85Ml/d.

The Canaston licence conditions have been amended following a review of Welsh Water's abstractions by NRW under the environmental requirements of the EU Habitats Directive ("Review of Consents" process). The new licence conditions come into force on 31 March 2019 and therefore the drought option has been assessed relative to these new licence conditions, subject to the availability of hydrological data sets which currently do not include any periods with the new licence conditions in force.

B.1.2 Welsh Water's Proposed Drought Order Operations

In accordance with the Llys-y-Fran Reservoir Section 158 operating agreement, a total of 955Ml of the storage volume within Llys-y-Fran Reservoir is allocated to the freshet bank, to be released for fisheries management purposes at the direction of Natural Resources Wales (NRW). This volume allows for up to five releases of 190 Ml each to be made. The drought order involves using 385Ml (approximately 40%) of this volume of storage for public water supply, so that only a limited number (three) of freshet releases could take place during the period of implementation.

Retaining part of the freshet bank volume within the reservoir for public supply, rather than releasing it to the downstream watercourse, will conserve the longevity of reservoir storage and improve the probability of reservoir winter refill. The drought order scheme will influence the Afon Syfynwy downstream of Llys-y-Fran Reservoir outfall and its continuation as the Eastern Cleddau River until the tidal limit.

Welsh Water has determined through water resources modelling that the drought order would only be required during the months of August to November inclusive. However, the impact of the drought order will only occur at times when freshet releases for fisheries purposes would normally be made. Information available at the time of this assessment indicates that releases are typically requested for a short period (around 4-5 days) during the early autumn. It is assumed that this relates to the need to ensure spate flows during the key fish migration period of October to December. The assessment has therefore considered potential impacts during the autumn/early winter period of October to December inclusive.

The assessment includes the Llys-y-Fran Reservoir and the downstream reaches of the Afon Syfynwy. The study area is shown on **Figure B1.1**. The Afon Syfynwy, a large tributary, joins the Eastern Cleddau approximately 6km upstream of the tidal limit.

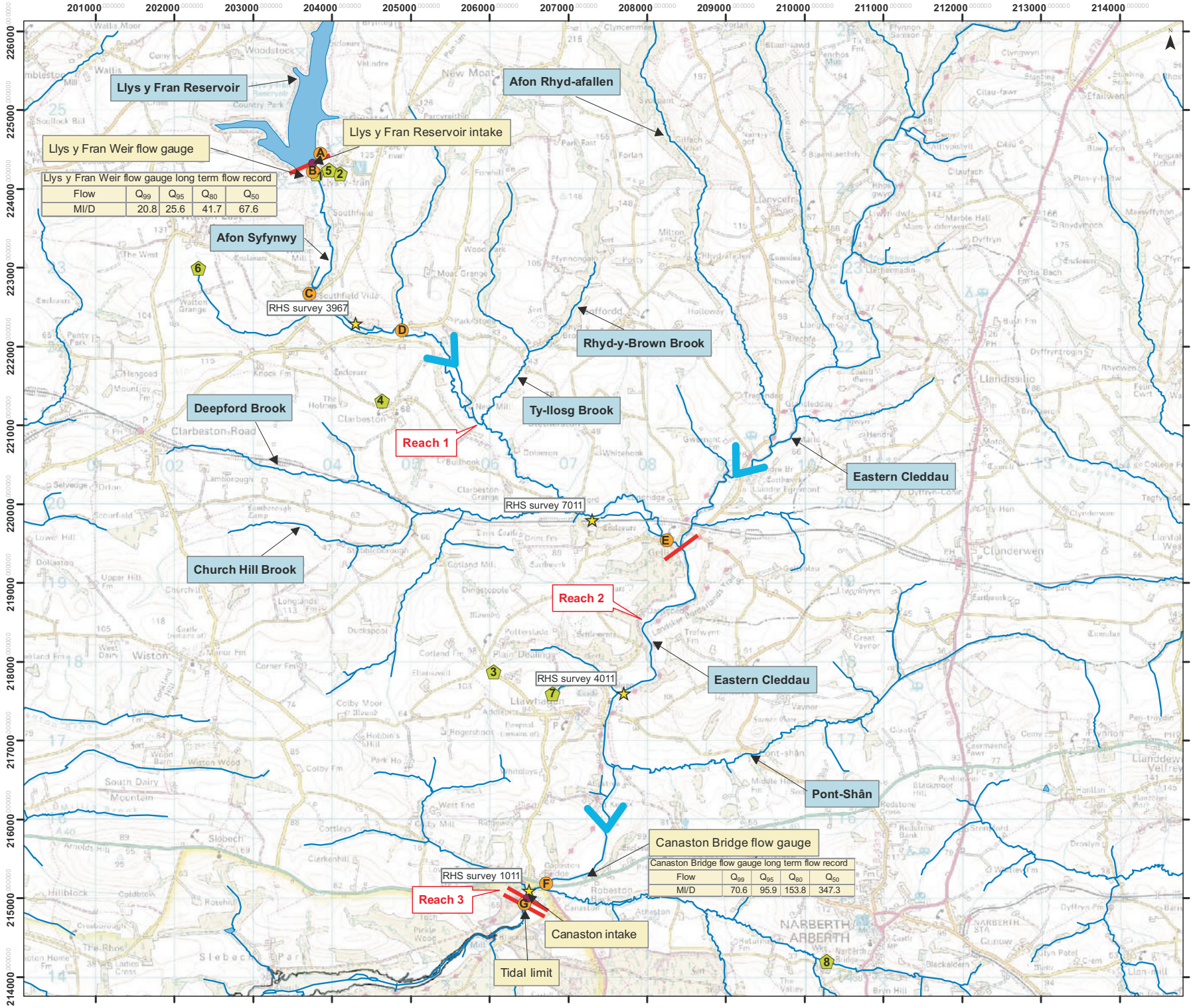
The physical environment includes consideration of hydrology and hydrodynamics, geomorphology, and water quality. The assessment has three principle objectives:

1. It is used to "list the likely impacts (low, moderate or high) to the flow/level regime due to supply-side drought management actions" as required by the DPG[1] and set out in Figure 5 of the DPG
2. It is used to support the screening and assessment of sensitive features (including ecological features and designated sites) as required by the DPG and set out in Section 5 of this report
3. Where sensitive features are the physical environment itself, it provides supporting technical information for their screening and assessment.

1 Welsh Ministers / Defra / NRW / Environment Agency (2011). Water Company Drought Plan Guideline. June 2011.

This appendix is set out in the following sections:

Section B.2 Hydrological Impact
Section B.3 Physical Environment Assessment
Section B.4 Physical Environment Impact Summary
Section B.5 Cumulative Impacts.



Legend

- Water Courses
- Reservoir
- Hydrological Reach
- Llysyfran Reservoir Intake
- Canaston Intake
- Direction of Flow
- River Habitat Surveys (RHS)

Water Quality Monitoring Sites

- A: 32688: Llys y Fran Reservoir at boathouse
- B: 32402: Afon Syfynwy at Llys y Fran
- C: 86046: Syfynwy below Walton Mill Fish Farm
- D: 73775: Syfynwy at Stepaside Bridge Sample U/S of Bridge
- E: 32406: Gelli
- F: 88181: E.Cleddau at Canaston RB
- G: 120010: Eastern Cleddau Source

Discharges

- 1: Llys y Fran (Fish Farm)
- 2: Ivy House, Clarbeston Road
- 3: ST at Caffle Brewery
- 4: Clarebeston STW
- 5: Llys y Fran STW
- 6: Walton East STW
- 7: Llawhaden STW
- 8: Narberth West STW

RICARDO

Dŵr Cymru Welsh Water

1:45,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Hydrological Overview: 8206-7 Llys y Fran Freshet Bank

Figure Number: Figure B1.1

Date: February 2019

B2 HYDROLOGICAL AND HYDROGEOLOGICAL IMPACT

B.2.1 Reference Conditions

B.2.1.1 Catchment Overview

The Afon Syfynwy is located in south west Wales, with its source in the Preseli Hills, Pembrokeshire at ~300m above sea level. The Afon Syfynwy is a tributary of the Eastern Cleddau, with the confluence at Gelli ~21km downstream from the source of the Syfynwy. Two on-line impounding reservoirs are situated along the Afon Syfynwy, the lowest and most significant being Llys-y-Fran Reservoir. The Eastern Cleddau flows into the far eastern end of Milford Haven at Canaston Bridge and drains an area of ~208km^2. Downstream of Llys-y-Fran Reservoir, the Afon Syfynwy generally flows through improved grassland and other mixed agricultural land with significant tree coverage between Llys-y-Fran Reservoir and Stepaside Brook. Downstream of its confluence with the Afon Syfynwy, the Eastern Cleddau flows through improved grassland and some heavily wooded areas. There is little urbanisation in the catchment.

B.2.1.2 Baseline Data Availability

Continuous monitoring of Afon Syfynwy flow is undertaken by Welsh Water at the Llys-y-Fran weir flow gauge located immediately downstream of the Llys-y-Fran Reservoir outflow. NRW monitors river flow at the Eastern Cleddau River at Canaston Bridge (0.9km upstream of the Canaston intake). Welsh Water monitors the rate of abstraction at Canaston.

Data are available for:

- Llys-y-Fran weir flow gauge: daily river flow record from 1994 to present (weekly data available for 1993 to 1994)
- Llys-y-Fran weir flow gauge: intermittent spot gauging data (level, velocity and wetted parameters such as wetted width and cross sectional area)
- Measurement of the managed outflows made by Welsh Water from Llys-y-Fran Reservoir into the Afon Syfynwy: daily metered flow from 2004 to present
- Canaston Bridge flow gauge: daily river flow record from 1960 to present
- Canaston intake abstraction: daily metered flow from 1995 to present
- Intermittent spot gauging data (flow, level, velocity and wetted parameters such as wetted width and cross sectional area) at a number of locations on the Afon Syfynwy and Eastern Cleddau River (locations indicated in **Figure B1.1**), although the availability of the parameters varies dependent upon location.

A summary of recorded flow in the Afon Syfynwy is presented in **Table B2.1**.

Table B2.1 Summary of Recorded Mean, Maximum and Minimum Daily Flow in the Afon Syfynwy at Llys-y-Fran weir flow gauging station (1993 - 2018)

Percentage of time river flow equalled or exceeded	Mean daily flow Ml/d, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum flow	763	697	611	369	594	526	724	554	500	763	763	763	763
10% (high flow)	294	226	171	135	88	83	93	112	130	167	287	299	195
50%	131	101	71	54	48	57	64	67	63	60	115	119	68
80%	64	57	42	33	32	34	45	57	51	39	36	67	42
90%	41	46	33	28	26	26	35	47	36	26	26	37	31
95% (low flow)	36	39	27	26	22	23	30	40	30	23	23	25	26
99% (extreme low flow)	21	25	23	21	21	22	27	33	24	21	21	20	21
Minimum flow	18	20	18	20	19	17	23	22	20	17	21	18	17

The low flow statistics for the winter period (1st October to 31 March inclusive) are: Q_{95} = 25.0 Ml/d; Q_{99} = 20.8 Ml/d. The summer low flow and extreme low flow statistics (1st April to 30th September inclusive) are Q_{95}=26.3Ml/d and Q_{99}=21.4Ml/d. Low flows at this location are strongly influenced by the statutory compensation flow rate of 13.64 Ml/d from Llys-y-Fran Reservoir.

A summary of recorded flow in the Eastern Cleddau River at Canaston Bridge is presented in **Table B2.2**. The HoF condition at this location means that Welsh Water may not abstract such a volume at Canaston intake (0.9km downstream) as may cause the flow at this location to drop below 2.84 Ml/hr (68Ml/d). Recent additional licence conditions limiting abstraction in certain flow ranges (as shown in **Table B1.1**) are not yet reflected in the recorded data.

Table B2.2 Summary of Recorded Mean, Maximum and Minimum Daily Flow in the Eastern Cleddau River at Canaston Bridge gauging station (1960 - 2018)

Percentage of time river flow equalled or exceeded	Mean daily flow Ml/d, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum flow	5279	5970	5391	4009	2393	3309	4311	9850	4553	8320	6903	9331	9850
10% (high flow)	1771	1400	1041	769	508	414	344	550	620	1280	1772	1871	1166
50%	739	544	438	318	222	159	135	170	199	404	695	750	347
80%	432	345	269	200	148	114	98	102	116	203	388	435	154
90%	315	287	223	163	128	98	85	90	92	134	289	340	114
95% (low flow)	242	239	193	141	113	89	75	75	79	98	202	288	96
99% (extreme low flow)	171	162	159	122	94	69	60	62	67	75	114	208	71
Minimum flow	128	129	137	110	75	58	51	55	63	65	84	132	51

The low flow statistics for the winter period (1st October to 31st March inclusive) are: Q_{95} = 185 Ml/d; Q_{99} = 99 Ml/d. The summer low flow and extreme low flow statistics (1st April to

30th September inclusive) are Q_{95}=84.3Ml/d and Q_{99}=65.8Ml/d.

Limited data on historic freshet releases is available, however formal correspondence has been reviewed requesting a fisheries management release of up to 68Ml/d over a five-day period from 6 October 2014 to 10 October 2014. For the purposes of this assessment it is assumed that the timing, duration and flow rate of the requested fisheries release in 2014 is typical of the pattern of freshet releases in those years when it is required.

B.2.1.3 Hydrology

Afon Syfynwy

Hydrological Reach 1 (Afon Syfynwy) is characterised by irregular meanders in a very shallow vee-shaped valley. Channel widths vary slightly throughout the reach between 7-10m. Channel depth is typically shallow at approximately 0.35m. Riparian tree cover along the reach is dense and is characterised by semi-continuous to continuous tree cover. In Reach 1, flows are dominated by Llys-y-Fran Reservoir outflows, with flow accretion downstream arising from the remainder of the Afon Syfynwy catchment.

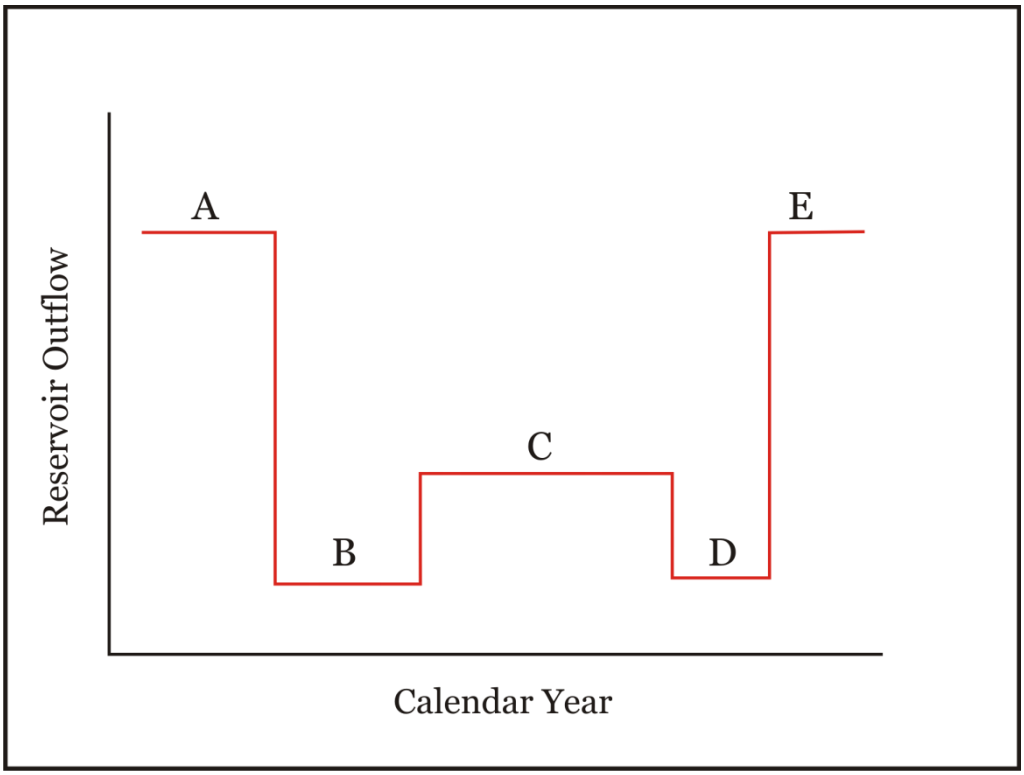
Outflows from Llys-y-Fran Reservoir to Afon Syfynwy follow a seasonal pattern, as illustrated in **Figure B2.1** below. The following describes the typical stages of flow, applicable to the data records up to and including 2018:

A. Reservoir overflows ("spills") occur regularly and extensively every winter (typically ranging from over 100Ml/d to 300Ml/d, although peak flows of up to 763Ml/d do occur in some years).
B. When the reservoir level drops below the spillway crest, outflows from the reservoir comprise just the compensation flow releases. This is most likely during the spring.
C. If river flow at Canaston becomes insufficient to maintain the required river abstraction rate (according to the terms of the HoF), then regulation releases are made from the reservoir in addition to compensation releases. This occurs in most, but not all summers. In an environmental drought, this period would likely extend into the autumn.
D. When river flows at Canaston recover, regulation ceases and reservoir outflow reverts to just the compensation flow release. This period is typically from late summer / autumn. In an environmental drought, this period would likely be delayed to later in the autumn. Typically, freshet releases would be required during period D if flow recovery is delayed, to provide spate flows during a key fish migration period.
E. Wetter weather in late autumn / winter will refill the reservoir until it starts spilling again. This period of overflow extends from early / mid-winter to spring.

Under the new licence conditions in force from 31 March 2019, additional regulation releases will be required during the periods April to June and October to December when unsupported flow is below 270Ml/d. At the time of this assessment, there is no data available

reflecting the revised mode of operation. The assessment is based on the available hydrological and operational data sets (up to 2018), but consideration has been given to the potential effects of additional seasonal regulation releases on the estimated hydrological impacts.

Figure B2.1 Llys-y-Fran Reservoir Outflow Pattern Over a Calendar Year



Eastern Cleddau River

Reaches 2 and 3 (Eastern Cleddau River) are characterised by irregular meanders in a very shallow vee-shaped valley. Channel widths are predominantly between 12-14m through most of the reach, increasing towards the end of the reach to 18-23m. Riparian tree cover along the reach is dense and is characterised by semi-continuous to continuous tree cover in the upper portion of the reach, decreasing to isolated / scattered in the lower portion of the reach.

In Reach 2, flows from the Eastern Cleddau River add considerable flow to that of the Afon Syfynwy. The Eastern Cleddau River is not impounded and, although subject to abstractions and discharges, retains a degree of natural flow variability. In most summers and in periods of environmental drought, flows in Reach 2 are elevated by regulation releases from Llys-y-Fran Reservoir (period C on **Figure B2.1**). Flows in the lower part of Reach 2 are characterised by the Canaston Bridge flow gauge records.

In Reach 3, flows are reduced from those in Reach 2. Under the lowest flow conditions, including those of environmental drought, (and only at period C on **Figure B2.1**), the flow in Reach 3 is not protected by the HoF and a semi-natural flow regime is present. At low

flows, when regulation releases are not being made (only during periods B and D on **Figure B2.5**), flow in Reach 3 is maintained at the HoF value - albeit such occasions are rare. Under the new licence conditions, low flows occurring during the spring and autumn are more likely to require regulation releases to be made to support abstraction.

Hydrometric Parameters

Spot gauging records on the Afon Syfynwy provide relatively limited water level and flow data. Additional cross section monitoring was undertaken for Welsh Water at representative natural river sections on 4 August 2011 and 21 September 2011. Two locations (one on the Afon Syfynwy (SN048222) and another on the Eastern Cleddau River (SN074166) were surveyed on the first date whilst one was surveyed on the second date, for health and safety reasons (river was too fast and high to safely enter). On the dates of survey, the flows at the Llys-y-Fran weir were 56.0Ml/d (4 August - regulation releases being made) and 20.6Ml/d (21 September - compensation releases only being made). On 4 August 2011 the gauged flow at Canaston Bridge was 241Ml/d, which corresponds with the full year Q_{63} of the site. Although no formal spot flow sampling was undertaken, a number of velocity measurements were made. Results from the sampling are provided in **Table B2.3**.

Table B2.3 2011 Hydrometric Parameters Obtained from Cross Section Survey of the Afon Syfynwy and Eastern Cleddau River

Hydrometric Parameter	Afon Syfynwy Cross Section		Eastern Cleddau River Cross Section
	4.8.2011	21.9.2011	4.8.2011
Wetted Width (m)	8.5	8.5	16.0
Wetted width with depth greater than 0.1m (m)	7.0	7.0	12.3
Maximum Depth (m)	0.9	0.68	0.65
Mean Depth (m)	0.33	0.37	0.33
Mean Velocity (m/s)	0.30	0.22	0.48

At the Afon Syfynwy survey site, there was no recorded difference in wetted width or mean velocity corresponding to regulation releases (4 August) and compensation flow releases (21 September). Reductions in maximum wetted depth are apparent, but not in wetted usable depth (width with depths greater than 0.1m). With only the one survey at the Eastern Cleddau River site it is not possible to determine how wetted parameters vary with flow.

Drought Order Assessment

The timing of the impact of the drought order is most likely to occur during short periods of up to 5 days during October to December inclusive, when freshet releases would typically be occurring at the request of NRW. This is based on formal correspondence from NRW to Welsh Water in 2014 requesting freshet releases for fisheries management purposes. However, the proposed drought order leaves a total of 570Ml still available in the freshet bank to be used for such purposes. Inspection of NRW's request for a freshet release in October 2014 indicates that a total volume of about 190Ml would be required to be taken from the freshet bank, to make the freshet releases at the requested rates and steps specified

by NRW. The remaining volume of 570Ml in the freshet bank would therefore be sufficient to provide three such releases during the period of implementation of drought order. The impact of the drought order would therefore be that a fourth, or subsequent, freshet release could not take place during the winter refill period. However, it is assumed that this would be required only in rare circumstances, and as the downstream watercourse could still benefit from freshet releases on three separate occasions during the autumn/winter, the hydrological impact of the drought order may be considered to be **negligible**.

B.2.2 Hydrological Impact

B.2.2.1 Hydrological Zone of Influence

A review of the flows and physical habitat characteristics of the river network downstream of the Llys-y-Fran Reservoir has identified the areas where the proposed drought order impacts upon hydrology. The study area includes the Llys-y-Fran reservoir, the Afon Syfynwy downstream of the reservoir and the Eastern Cleddau down to its tidal limit; it comprises three distinct hydrological reaches as listed in **Table B2.4** and identified on **Figure B1.1**.

The potential hydrological impact of the drought order has been reviewed for each hydrological reach and is discussed below. Note that the impact on Llys-y-Fran Reservoir itself would be a potential increase in water levels / storage volume, relative to the position without the drought order, by retaining part of the freshet bank (385Ml) within storage. This would be considered as a minor beneficial impact and has not been assessed further.

B.2.2.2 Hydrological Impact Assessment

Reach 1 – Afon Syfnwy, Llys-y-Fran Reservoir to Eastern Cleddau Confluence

The drought order involves retaining approximately 40% of the total volume of the freshet bank, 385Ml, within storage in Llys-y-Fran reservoir and making this additional volume available for public supply. Implementation of the drought order would mean that freshet releases to the downstream watercourse, for example for fisheries management, could still take place on up to three separate occasions during the duration of the drought order. The hydrological impact of the temporary reduction in the freshet bank volume would therefore be assessed as having a **negligible** hydrological impact.

Reach 2 – Eastern Cleddau, Afon Syfynwy confluence to Canaston Intake

As for Reach 1, implementation of the drought order would still leave sufficient volume in the freshet bank for stepped freshet releases of around 4-5 days to occur on up to 3 separate occasions. The hydrological impact of the drought order on Reach 2 is therefore assessed as **negligible**.

Reach 3 – Eastern Cleddau from Canaston Intake to the tidal limit

In Reach 3, flow is reduced by the Welsh Water abstraction intake at Canaston. Again, as for Reaches 1 and 2, the effect of the drought order is to limit the number of occurrences of

typical 4-5 day freshet release events to three separate occurrences and so a fourth or subsequent release could not be made. This is assessed as a **negligible** hydrological impact on Reach 3.

B.2.2.3 Hydrological Impact Summary

Three reaches have been considered, all of which are assessed as having a **negligible** hydrological impact as a result of the drought order.

The three impacted reaches are shown in **Table B2.4** and establish the full in-channel zone of influence of the drought order for environmental sensitivity screening (see **Figure B1.1**).

Table B2.4 Hydrological Reaches Identified in the Study Area – Winter (October to December) Impact

Hydrological Reach		Reach Boundary		Reach Length (km)	% flow reduction		Hydrological Impact - Winter
					Year round Q_{50}	Year round Q_{95}	
1	Afon Syfynwy	Llys-y-Fran Reservoir	Confluence with the Eastern Cleddau River	10km	0%	0%	**Negligible**
2	Eastern Cleddau	Confluence with the Afon Syfynwy	Canaston Intake	6.5km	0%	0%	**Negligible**
3	Eastern Cleddau	Canaston Intake	Tidal limit	0.1km	0%	0%	**Negligible**

B3 PHYSICAL ENVIRONMENT ASSESSMENT

B.3.1 Geomorphology

Geomorphology information for the Afon Syfynwy and Eastern Cleddau catchment has been obtained from the results of walkover surveys undertaken for Welsh Water during summer 2011. In addition, there are two NRW River Habitat Survey (RHS) sites located in Reach 1 (Survey ID 3967 and 5083) and two located in Reach 2 (Survey ID 1011 and 4011). There are no RHS sites in Reach 3 (see **Figure B1.1**).

Reach 1 - Afon Syfnwy, Llys-y-Fran Reservoir to Eastern Cleddau Confluence

Reach 1 is characterised by irregular meanders in a very shallow vee-shaped valley. Channel widths vary slightly throughout the reach although are between 7-10m. Riparian tree cover along the reach is dense and is characterised by semi-continuous to continuous tree cover.

A review of the walkover survey data shows that the reach is predominantly a mixture of gravel / pebble and cobble sized particles, with some silt noted towards the end of the reach. Riffles are noted as occurring extensively in the reach. Silt is also noted as being present at

the margins of the river in this reach.

The flow type in Reach 1 was recorded as predominantly rippled with broken and unbroken standing waves. This reflects the extensive nature of riffles within the reach and interactions between flow depth and the channel substrate. Smooth flow was also noted throughout the reach, likely representing pools between riffles.

The walkover survey has identified that the reach is characterised predominantly by erosional features, although depositional features are present, particularly in the initial 2.7km of the reach. The erosional features are linked to erosion of the earth banks and are characterised by active eroding cliffs and slumping and poaching. However, no significant areas of bank collapse or signs of channel avulsion have been noted. Depositional features are characterised by channel bars. These data highlight that the reach is predominantly erosional but appears to be responding to the current flow and sediment regime.

Surrounding land use is predominantly rough pasture and improved grassland with some areas of broadleaf woodland towards the start of the reach.

Reach 2 – Eastern Cleddau

Reach 2 is characterised by irregular meanders in a very shallow vee-shaped valley. Channel widths are predominantly between 12-14m through most of the reach, increasing towards the end of the reach to 18-23m. Riparian tree cover along the reach is dense and is characterised by semi-continuous to continuous tree cover in the upper portion of the reach, decreasing to isolated / scattered in the lower portion of the reach.

A review of the walkover survey data shows that the reach is predominantly a mixture of gravel / pebble and cobble sized particles. Riffles are noted as occurring frequently and extensively in the reach. Sand forms the bed substrate towards the middle of the reach ~3.0km downstream with bedrock also noted here.

The flow type in Reach 2 was recorded as predominantly rippled with broken and unbroken standing wave. This reflects the extensive nature of riffles within the reach and interactions between flow depth and the channel substrate. Smooth flow was also noted throughout the reach, likely representing pools between riffles. A single area of upwelling was also noted towards the end of the reach.

The walkover survey has identified that the reach is characterised predominantly by erosional features, although depositional features are present, particularly in the initial 3.0km of the reach. The erosional features are linked to erosion of the earth banks and erosion is characterised by active eroding cliffs and slumping and poaching. However, no significant areas of bank collapse or signs of channel avulsion have been noted. Depositional features are characterised by channel bars. These data highlight that the reach is dominantly erosional but appears to be responding to the current flow and sediment regime.

Surrounding land use is predominantly improved grassland with some areas of broadleaf

woodland towards the start of the reach.

Reach 3 – Eastern Cleddau

Reach 3 is very short and is slightly sinuous and is surrounded by floodplains. Channel width is approximately 25m. Riparian tree cover along the reach is limited and is characterised by isolated/scattered trees on the right bank and semi-continuous to continuous on the left bank.

A review of the walkover survey data shows that in the initial 0.6km of Reach 2 bed substrate is predominantly gravel / pebble sized particles, although some bedrock was noted around the margins during a field visit in July 2011.

The flow type in Reach 3 was recorded as wholly smooth with no other flow types identified.

The walkover survey has identified no erosional or depositional features in the reach.

Surrounding land use is predominantly improved grassland on the right bank with broadleaf woodland on the left bank.

B.3.1.1 Anthropogenic Features

Reach 1 - Afon Syfnwy, Llys-y-Fran Reservoir to Eastern Cleddau Confluence

The walkover survey has identified three barriers in Reach 1. The existing RHS sites within this reach indicate low anthropogenic influence in the upper section of the reach with only poaching noted. The RHS data notes a significant increase in anthropogenic features towards the end of the reach with fords, outfalls, reinforced banks and bridges contributing to a Habitat Modification Score of 365.

Reach 2 – Eastern Cleddau

No barriers have been identified by the walkover survey in Reach 2. The existing RHS sites within this reach indicate low anthropogenic influence in the upper section of the reach, with only poaching and reinforced banks noted. The RHS data in the lower reach records a significant increase in anthropogenic features, particularly from reinforced banks and the presence of bridges, which contribute to a Habitat Modification Score of 690.

Reach 3 – Eastern Cleddau

A weir is present at both the upstream and downstream boundaries of Reach 3.

B.3.1.2 Conclusions

In drought conditions, it is assumed that no significant geomorphological activity (i.e. erosion or transport or depositional processes) will be occurring within the catchment or river and sediment supply to the river is likely to be negligible (given the nature of the catchment described above and the presence of the reservoir in controlling sediment

movement). The existing data show that total suspended solid concentrations in the river are generally very low (see Section 3.2 below). Therefore, it is concluded that the impact of the drought order on sediment dynamics in all three reaches is **negligible**.

During the operation of a drought order, flows would be reduced significantly in Reach 1. These decreases in flow may result in changes in flow depth and increased exposure of channel banks. This could potentially lead to desiccation of earth banks during drought conditions, increasing the risk of bank collapse due to gravity and increasing the potential for erosion of dry earth as normal flows resume post the drought order. Furthermore, as the drought order is operating during the winter months, there is an increased risk of erosion of the banks due to freeze-thaw action. However, given the dominantly erosive nature of all reaches in the study area (as set out above), and the fact that the features all suggest that the Afon Syfynwy and Eastern Cleddau are responding to the current flow and sediment regime and variations therein, the influence and impact of bank erosion caused by reducing flows is taken to be **negligible**.

The change in flow depth may also expose sections of the channel bed, particularly in Reach 1. This could lead to increased exposure of any in channel features such as riffles (which were noted as being extensive throughout Reach 1) and bars. In addition, the reduction in flow depth may impact on flow velocity due to increasing friction between the bed surface and flow, possibly leading to protrusion of the coarser bed particles through the flow surface. The reduction in velocities could impact on particle dynamics. However, given the very low total suspended solid concentrations and, where visible, the general gravel / pebble nature of the channel bed, the impacts of reductions in flow are concluded to be **negligible**.

B.3.2 Water Quality

This section sets out the baseline water quality and examines changes over time and with respect to river flows. Environmental pressures on river water quality (such as discharges from wastewater/sewage treatment works), which may cause increased deterioration in water quality with the drought order in place, are discussed separately in Section B.3.3.

To support the assessment of potentially sensitive environmental features (see Section 5 of the main report), an understanding has been developed of the water quality of the rivers within the zone of influence of the drought order, including trends over time and with respect to river flow. For Water Framework Directive(WFD) classification, NRW has set out[2] (following UK Technical Advisory Group (UKTAG) evidence[3]) what pressures, including water quality pressures, each biological quality element is capable of responding to. For the purposes of assessment here, the supporting water quality parameters are set out: for fish and macroinvertebrates (where identified as sensitive features) as dissolved oxygen saturation and total ammonia concentration; and for macrophytes and algae (phytobenthos / diatoms) (where identified as sensitive features) as soluble reactive phosphorus (SRP). Specifically, for macrophytes, if the hydrological impacts of drought permit implementation have been identified within the main macrophyte growing season (April to September), an assessment of SRP has been undertaken.

Potential impacts on other water quality parameters, such as temperature, have been considered where appropriate (e.g. temperature influences dissolved oxygen and if sufficient information is available on dissolved oxygen it may not be necessary to undertake a separate temperature assessment).

Ten years of NRW routine water quality monitoring data were reviewed to provide an overview of water quality in the zone of hydrological impact. On the Afon Syfynwy, within the extent of influence of the drought order (Reach 1), there are five NRW water quality sampling sites. On the Eastern Cleddau (Reaches 2 and 3), there are two NRW water quality sampling sites (**Table B3.1** and **Figure B1.1**). Data are available for these sites (2006 to 2015) and include measurements of a suite of parameters.

Where data are lacking the assessment has been undertaken using professional judgement. Values at the limit of detection have been halved in line with standard NRW / Environment Agency practice.

[2] Environment Agency (2011) Method statement for the classification of surface water bodies v2.0 (external release) Monitoring Strategy v2.0 July 2011 Table 2
[3] UK Technical Advisory Group on the Water Framework Directive (2008) Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive December 2007 (alien species list updated – Oct 2008 and Nov 2008). Appendix 1

Table B3.1 Details of NRW Water Quality Sampling Points on the Afon Syfynwy

Reach	Site Name	NRW Site Code	Grid reference	Location
1	Llys-y-Fran Reservoir at boathouse	32688	SN0385024450	Llys-y-Fran Reservoir at boathouse
	Afon Syfynwy at Llys-y-Fran	32402	SN0375824226	Afon Syfynwy D/S of Llys-y-Fran Reservoir
	Syfynwy below Walton Mill Fish Farm	86046	SN0371222674	Upstream of Slade Brook
	Syfynwy at Stepaside Bridge Sample U/S of Bridge	73775	SN0488722211	Afon Syfynwy at Stepaside Bridge
	Gelli	32406	SN0825019540	Afon Syfynwy U/S of confluence with Eastern Cleddau
2	E.Cleddau at Canaston RB	88181	SN0671715186	Eastern Cleddau U/S of confluence with Narbeth Brook
3	Eastern Cleddau Source	120010	SN0644514931	Eastern Cleddau near tidal limit D/S of confluence with Narbeth Brook

Reach 1 (Afon Syfnwy, Llys-y-Fran Reservoir to Eastern Cleddau confluence)

Water quality data are available for five NRW monitoring points on Reach 1 (major hydrological impact). Data are available for: Llys-y-Fran Reservoir at boathouse (site 32688); Afon Syfynwy at Llysyfran (site 32402); Syfynwy below Walton Mill Fish Farm (site 86046); Syfynwy at Stepaside Bridge Sample U/S of Bridge (site 73775) and Gelli (site 32406).

The average pH at Llys-y-Fran Reservoir at boathouse over the ten year review period was 7.4 and the maximum water temperature was 20.5 ^{o}C. The average pH at Afon Syfynwy at Llysyfran over the ten year review period was 7.4 and the maximum water temperature was 19.2 ^{o}C. The average pH at Syfynwy below Walton Mill Fish Farm over the ten year review period was 18.5^{o}C and the maximum water temperature was 7.2 ^{o}C. The average pH at Syfynwy at Stepaside Bridge Sample U/S of Bridge over the ten year review period was 16.3 and the maximum water temperature was 7.5 ^{o}C. The average pH at Gelli over the ten year review period was 7.3 and the maximum water temperature was 18.0 ^{o}C.

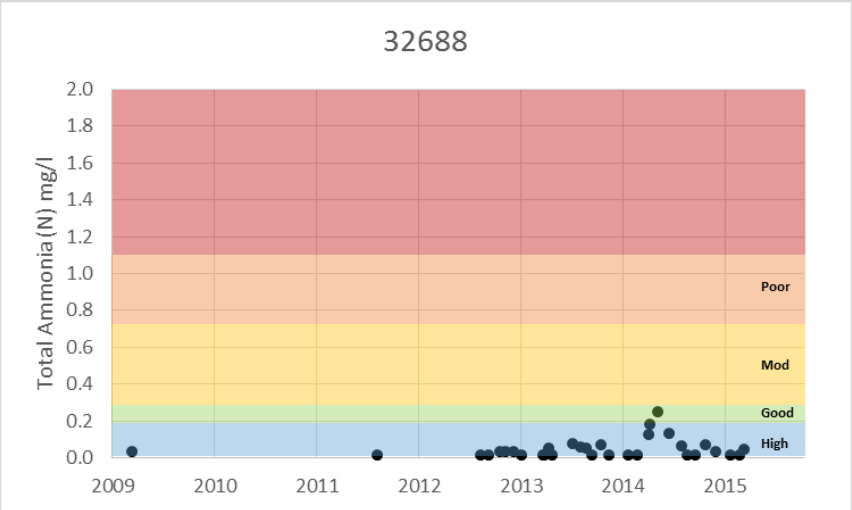
Sites on the Afon Syfynwy show low concentrations of total suspended solids. Afon Syfynwy at Llysyfran has a maximum total suspended solids of 7.4mg/l and a median of 1.5mg/l, suggesting total suspended solids are low for most of the available monitoring period. At the Gelli site, the maximum total suspended solids values was 108mg/l, with median total suspended solids of 4.15mg/l. Values above 20mg/l are the response to storm events in the catchment.

Total ammonia concentration

Total ammonia concentration for the Llys-y-Fran Reservoir at boathouse was reviewed and data presented in **Figure B3.1** against the relevant WFD standards for an upland low

alkalinity river[4].

Figure B3.1 Total Ammonia in the Llys-y-Fran Reservoir at boathouse, Incorporating Appropriate WFD Status Bands

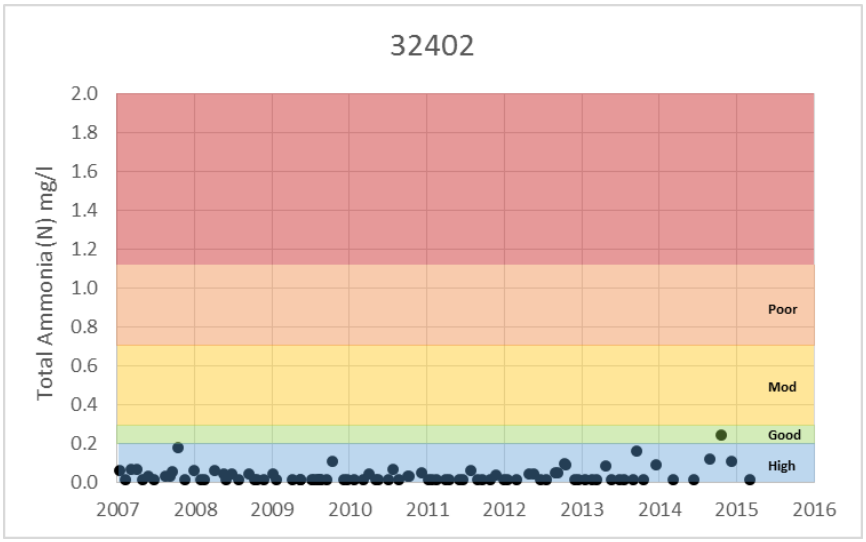


Total ammonia (N) concentrations at the Llys-y-Fran Reservoir at boathouse (see **Figure B3.1**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l). One instance of Good status is observed on 02/12/2014 with 0.25 mg/l suggesting an isolated incident.

Total ammonia concentration for the Afon Syfynwy at Llys-y-Fran was reviewed and data presented in **Figure B3.2** against the relevant WFD standards for an upland low alkalinity river[5].

[4] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.
[5] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

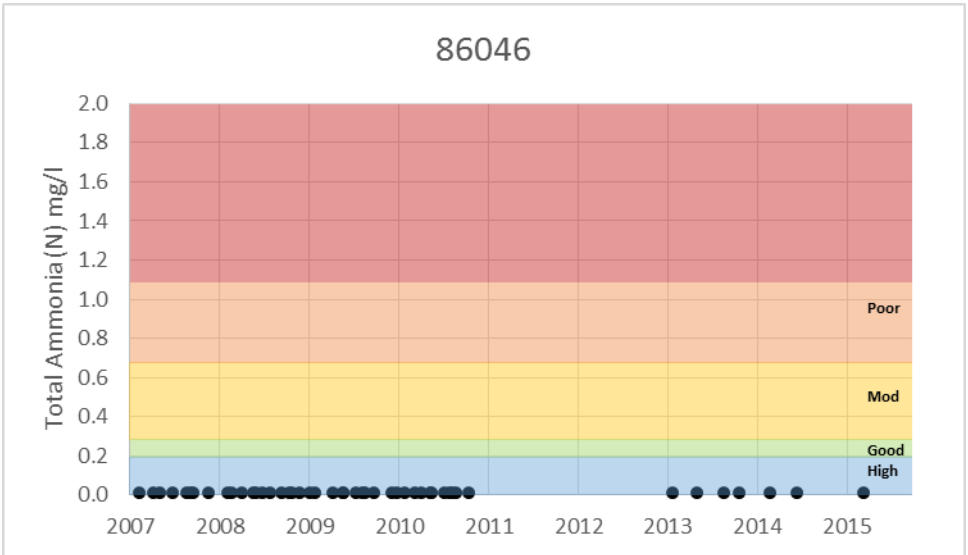
Figure B3.2 Total Ammonia in the Afon Syfynwy at Llys-y-Fran, Incorporating Appropriate WFD Status Bands



Total ammonia concentrations on the Afon Syfynwy at Llys-y-Fran (see **Figure B3.2**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l). One exception is noted on 04/12/2014 with 0.24 mg/l. Consequently good WFD status is achieved on this date.

Total ammonia concentration for the Syfynwy below Walton Mill Fish Farm, above Slade Brook was reviewed and data presented in **Figure B3.3** against the relevant WFD standards for an upland low alkalinity river[6].

Figure B3.3 Total Ammonia in the Syfynwy below Walton Mill Fish Farm, above Slade Brook, Incorporating Appropriate WFD Status Bands

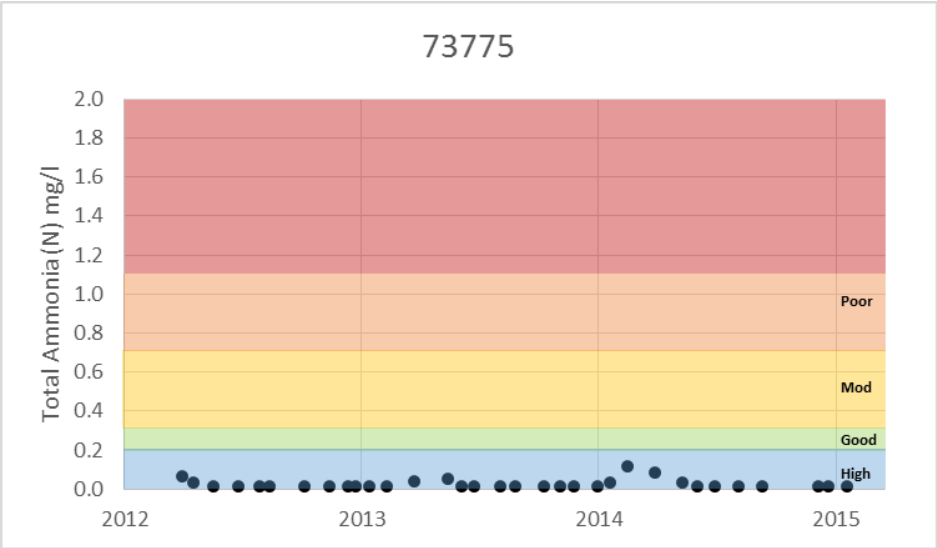


[6] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

Total ammonia concentrations on the Syfynwy below Walton Mill Fish Farm, above Slade Brook (see **Figure B3.3**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l).

Total ammonia concentration for the Afon Syfynwy at Stepaside Bridge was reviewed and data presented in **Figure B3.4** against the relevant WFD standards for an upland low alkalinity river[7].

Figure B3.4 Total Ammonia in the Afon Syfynwy at Stepaside Bridge, above Slade Brook, Incorporating Appropriate WFD Status Bands

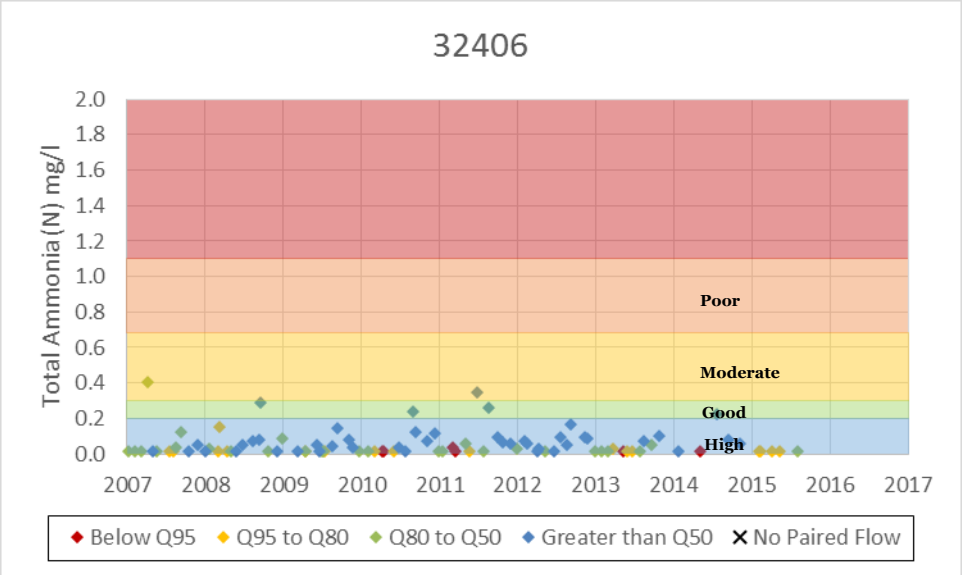


Total ammonia concentrations on the Afon Syfynwy at Stepaside Bridge (see **Figure B3.4**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l).

Total ammonia concentration for the Afon Syfynwy at Gelli was reviewed and data presented in **Figure B3.5** against the relevant WFD standards for an upland low alkalinity river[8].

[7] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.
[8] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

Figure B3.5 Total Ammonia in the Afon Syfynwy at Gelli, above Slade Brook, Incorporating Appropriate WFD Status Bands



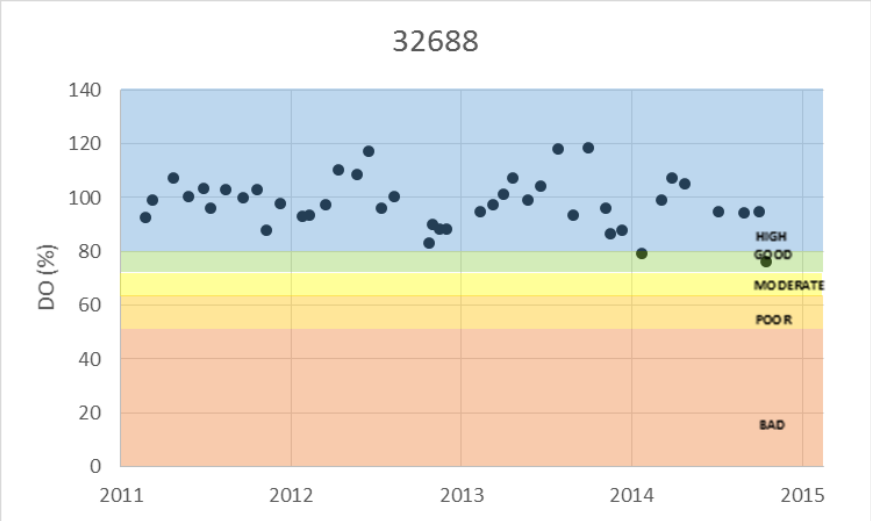
Total ammonia concentrations on the Afon Syfynwy at Gelli (see **Figure B3.5**) were predominantly consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l). Good status is observed on five occasions: 07/01/2005 at 0.21 mg/l; 04/12/2008 at 0.29 mg/l; 17/11/2010 at 0.24 mg/l; 03/11/2011 at 0.26 mg/l and 06/10/2014 at 0.22 mg/l. Moderate status is also noted twice with 0.40 mg/l on 26/06/2007 and 0.34 mg/l on 12/09/2011.

Dissolved oxygen saturation

Dissolved oxygen saturation for monitoring site 32688 on the Llys-y-Fran Reservoir at Boathouse was reviewed and data are presented in **Figure B3.6** against the relevant WFD standards for an upland low alkalinity river[9].

[9] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

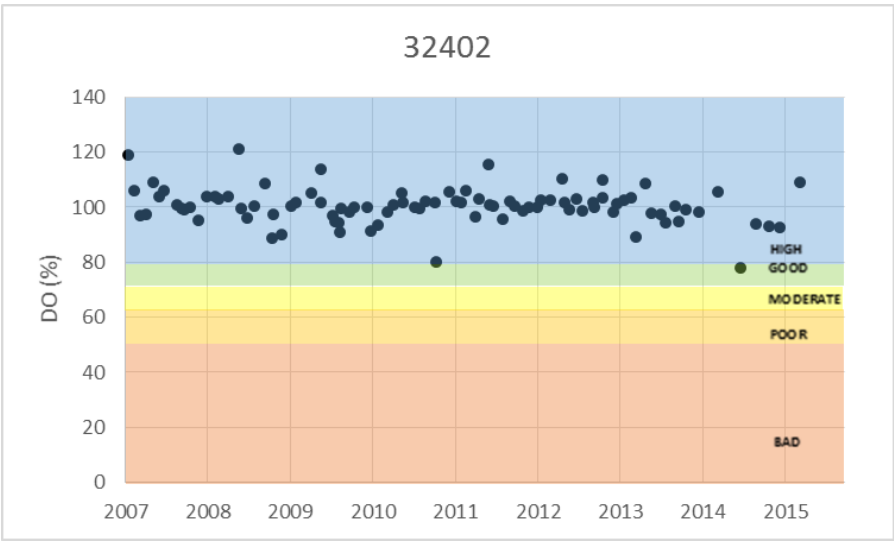
Figure B3.6 Dissolved Oxygen Concentrations on the Llys-y-Fran Reservoir at Boathouse, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements for Llys-y-Fran Reservoir at Boathouse (see **Figure B3.6**) were mostly consistent with the WFD standard to support high status for fish and invertebrates (80%). One exception is notable on 06.10.2015 with 76.1% resulting in Good WFD status. This appears to be an isolated incident.

Dissolved oxygen saturation at the Afon Syfynwy at Llys-y-Fran was reviewed and data are presented in **Figure B3.7** against the relevant WFD standards for an upland low alkalinity river[10].

Figure B3.7 Dissolved Oxygen Concentrations on the Afon Syfynwy at Llys-y-Fran, Incorporating Appropriate WFD Status Bands

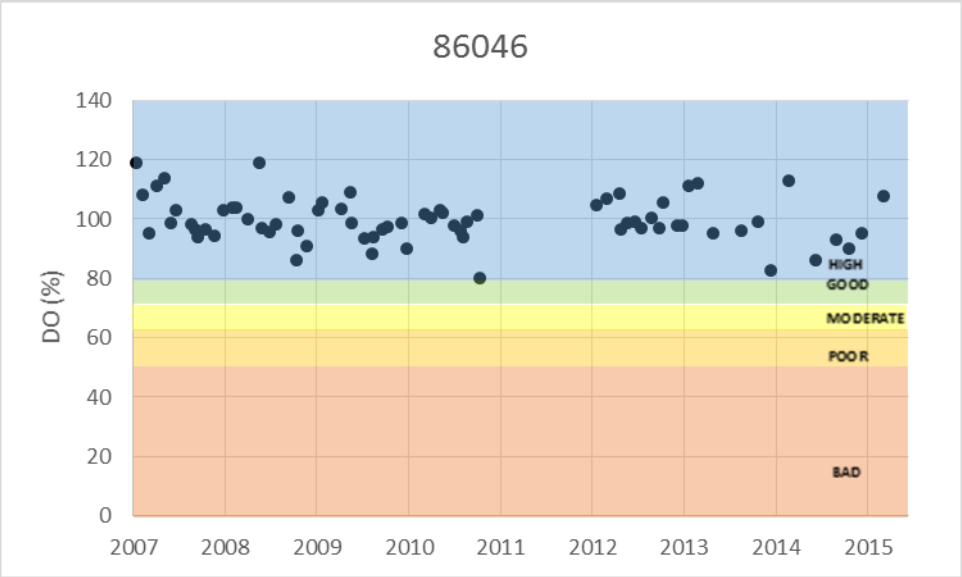


[10] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

Dissolved oxygen saturation measurements at the Afon Syfynwy at Llys-y-Fran (see **Figure B3.7**) were mostly consistent with the WFD standard to support high status for fish and invertebrates (80%). In one instance Good WFD status is achieved on 30/07/2014 with 78% suggesting an isolated incident.

Dissolved oxygen saturation at the Afon Syfynwy at below Walton Mill Fish Farm was reviewed and data are presented in **Figure B3.8** against the relevant WFD standards for an upland low alkalinity river[11].

Figure B3.8 Dissolved Oxygen Concentrations on the Afon Syfynwy at below Walton Mill Fish Farm, Incorporating Appropriate WFD Status Bands

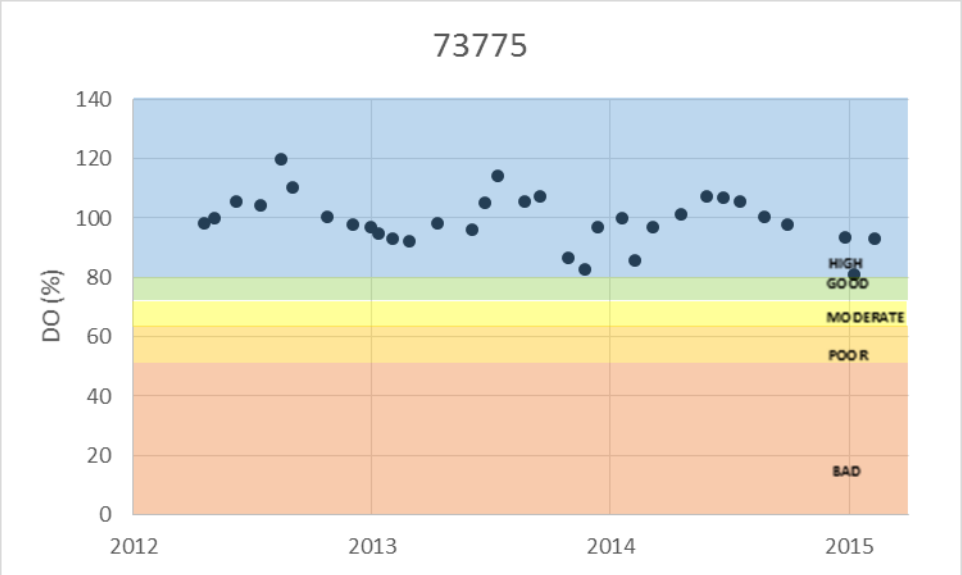


Dissolved oxygen saturation measurements at the Afon Syfynwy below Walton Mill fish farm, above Slade Brook (see **Figure B3.8**) were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Dissolved oxygen saturation at the Afon Syfynwy at Stepaside Bridge was reviewed and data are presented in **Figure B3.9** against the relevant WFD standards for an upland low alkalinity river[12].

[11] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.
[12] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

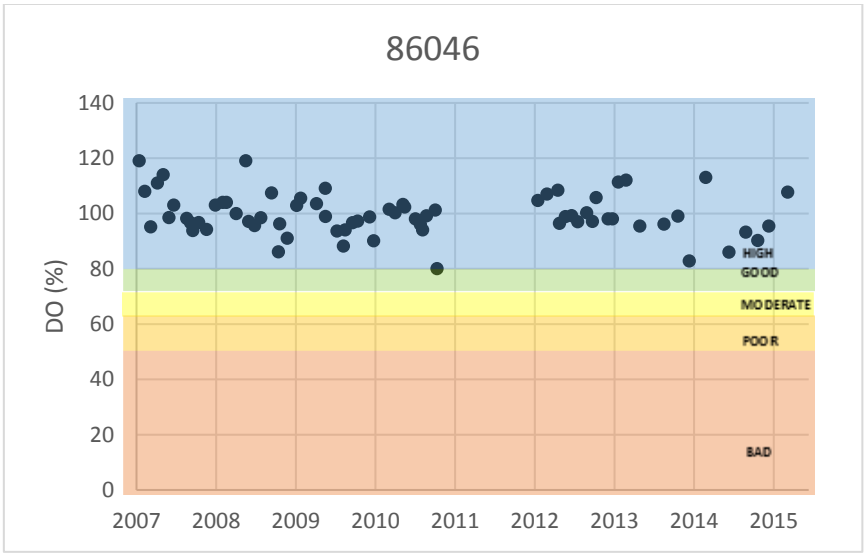
Figure B3.9 Dissolved Oxygen Concentrations on the Afon Syfynwy at Stepaside Bridge, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements at the Afon Syfynwy at Stepaside Bridge (see **Figure B3.9**) were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Dissolved oxygen saturation on the Afon Syfynwy at Gelli was reviewed and data are presented in **Figure B3.10** against the relevant WFD standards for an upland low alkalinity river[13].

Figure B3.10 Dissolved Oxygen Concentrations on the Afon Syfynwy at Gelli, Incorporating Appropriate WFD Status Bands



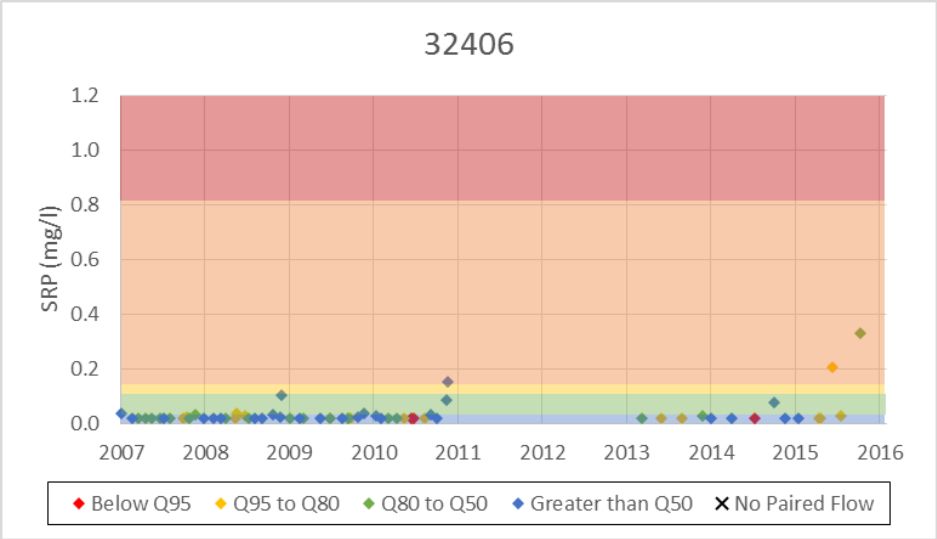
[13] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

Dissolved oxygen saturation measurements on the Afon Syfynwy at Gelli (see **Figure B3.10**) were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Soluble Reactive Phosphorus Concentration

Soluble Reactive Phosphorus (SRP) concentration for monitoring on the Afon Syfynwy at Gelli was reviewed and data are presented in **Figure B3.11** against the relevant site specific WFD standards[14].

Figure B3.11 Soluble Reactive Phosphorus on the Afon Syfynwy at Gelli, Incorporating Appropriate WFD Status Bands



Soluble Reactive Phosphorus concentrations at Afon Syfynwy at Gelli (see **Figure B3.11**) were mostly consistent with the WFD standard to support good status for diatoms and macrophytes (0.04mgP/l). Poor status is noted on three instances on the 25/11/2010, 08/06/2015 and 16/10/2015 with 0.15 mg/l, 0.21 mg/l and 0.33 mg/l respectively.

Reach 2 (Eastern Cleddau)

Water quality data are available for one NRW monitoring point on Reach 2 (negligible hydrological impact). Data are available for Eastern Cleddau at Canaston Road Bridge (site 88181) and represents the downstream section of Reach 2.

The average pH at Eastern Cleddau at Canaston Road Bridge over the ten year review period was 7.6 and the maximum water temperature was 17.7 ^{o}C.

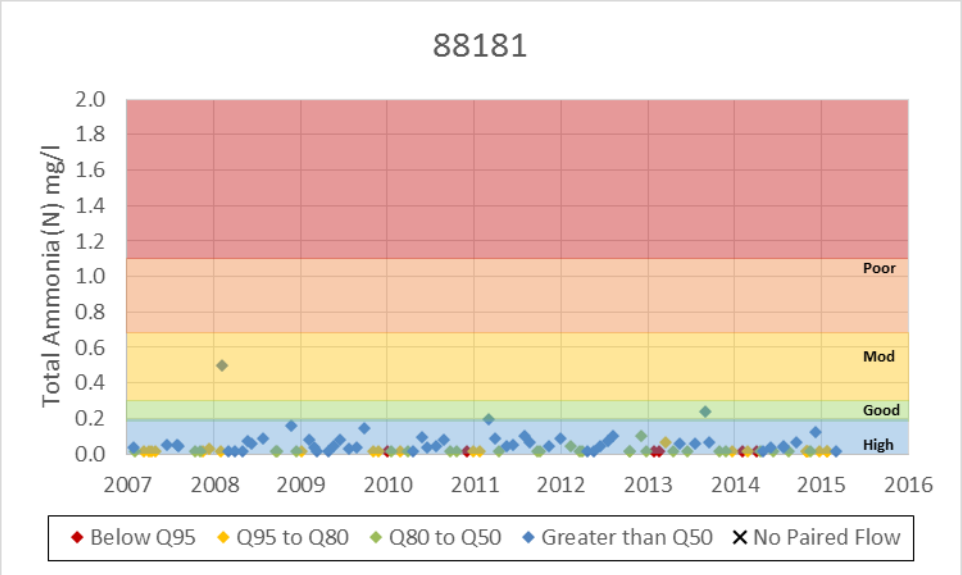
Total ammonia concentration

Total ammonia concentration for the Eastern Cleddau at Canaston Road Bridge was

[14] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

reviewed and data presented in **Figure B3.12** against the relevant WFD standards for an upland low alkalinity river[15].

Figure B3.12 Total Ammonia in the Eastern Cleddau at Canaston Road Bridge, Incorporating Appropriate WFD Status Bands



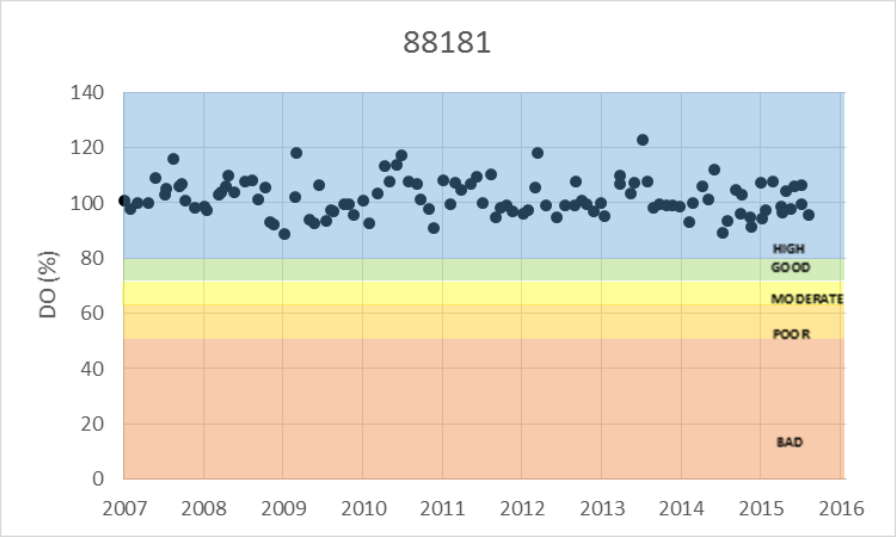
Total ammonia concentrations on the Eastern Cleddau at Canaston Road Bridge (see **Figure B3.12**) were predominantly consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l). Two exceptions are noted: Good WFD status is noted on 24/02/2014 with 0.23 mg/l while Moderate WFD status was observed on 30/07/2008 measuring 0.5 mg/l.

Dissolved oxygen saturation

Dissolved oxygen saturation on the Eastern Cleddau at Canaston Road Bridge was reviewed and data are presented in **Figure B3.13** against the relevant WFD standards for an upland low alkalinity river[16].

[15] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.
[16] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

Figure B.13 Dissolved Oxygen Concentrations on the Eastern Cleddau at Canaston Road Bridge, Incorporating Appropriate WFD Status Bands

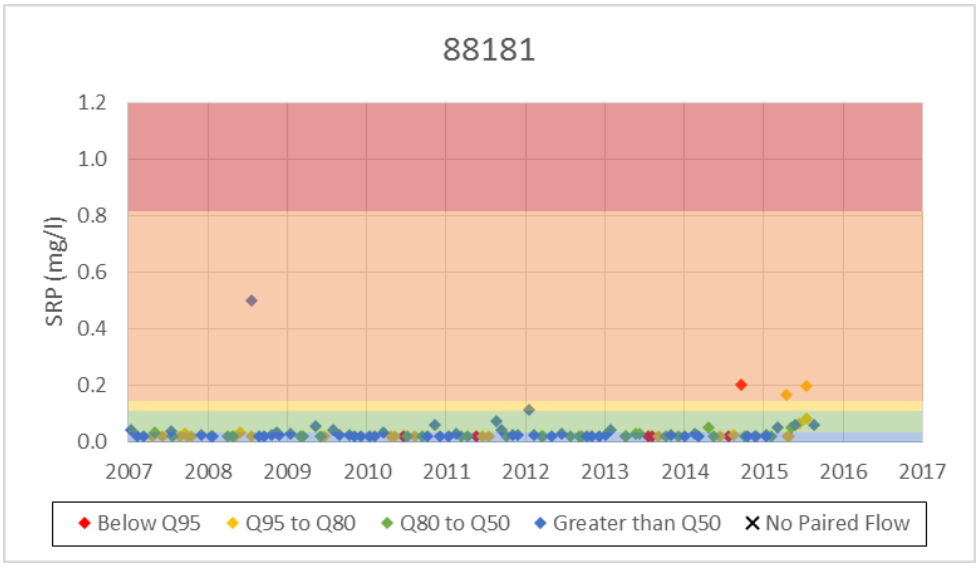


Dissolved oxygen saturation measurements at the Eastern Cleddau at Canaston Road Bridge (see **Figure B3.13**) were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Soluble Reactive Phosphorus Concentration

Soluble Reactive Phosphorus concentration for monitoring on the Eastern Cleddau at Canaston Road Bridge was reviewed and data are presented in **Figure B3.14** against the relevant site specific WFD standards[17].

Figure B3.14 Soluble Reactive Phosphorus on the Eastern Cleddau at Canaston Road Bridge, Incorporating Appropriate WFD Status Bands



[17] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

Soluble Reactive Phosphorus concentrations at Eastern Cleddau at Canaston Road Bridge (see **Figure B3.14**) were mostly consistent with the WFD standard to support good status for diatoms and macrophytes (0.04mg/l). Poor status is noted on four instances: 30/07/2008 with 0.5 mg/l; 24/09/2014 with 0.2 mg/l; 22/04/2015 with 0.16 mg/l and 22/07/2015 with 0.2 mg/l.

Reach 3 (Eastern Cleddau)

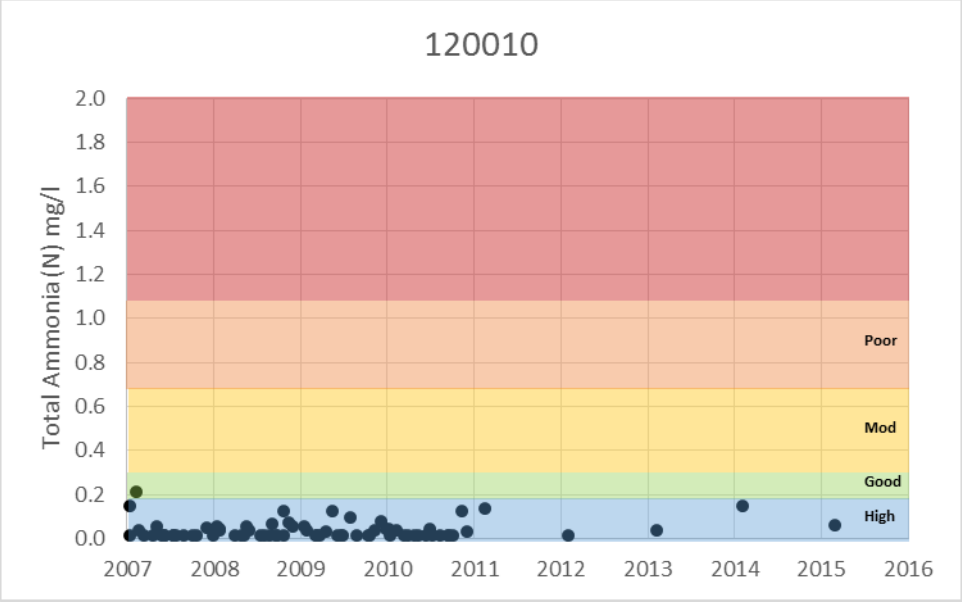
Water quality data are available for one NRW monitoring point on Reach 3 of the Eastern Cleddau (negligible hydrological impact) at Source (site 120010) and represents the downstream section of Reach 3.

The average pH for the Eastern Cleddau site at Source over the ten year review period was 7.5 and the maximum water temperature was 19 ^{o}C.

Total ammonia concentration

Total ammonia concentration for the Eastern Cleddau at Source was reviewed and data presented in **Figure B3.15** against the relevant WFD standards for an upland low alkalinity river[18].

Figure B3.15 Total Ammonia in the Eastern Cleddau at Source, Incorporating Appropriate WFD Status Bands



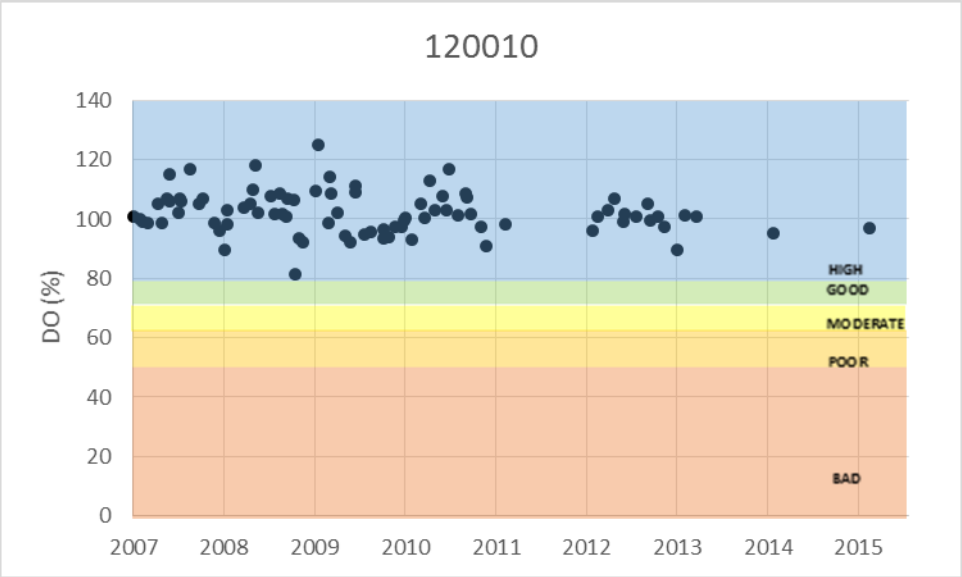
Total ammonia concentrations for the Eastern Cleddau at Source (see **Figure B3.15**) were predominantly consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l). One exception is noted on 17/02/2007 with 0.22mg/l.

[18] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

Dissolved oxygen saturation

Dissolved oxygen saturation for the Eastern Cleddau at Source was reviewed and data are presented in **Figure B3.16** against the relevant WFD standards for an upland low alkalinity river[19].

Figure B3.16 Dissolved Oxygen Concentrations on the Eastern Cleddau at Source, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements for the Eastern Cleddau at Source (see **Figure B3.16**) were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Water Quality Summary

Assessment of risk to water quality as a result of the Llys-y-Fran drought order is limited by the spatial and temporal extent of the data available. Data received from NRW cover the period January 2007 to December 2015.

Total ammonia concentrations were mostly consistent with the standard to support high status for fish and invertebrates throughout the zone of influence of the Llys-y-Fran drought order. Seasonal variability in total ammonia concentration was low. The risk of the drought order to total ammonia concentration levels within the zone of influence is therefore assessed as **minor** in Reach 1, **negligible** in Reach 2 and **negligible** in Reach 3.

Dissolved oxygen saturation values were mostly consistent with the standard to support High status for fish and invertebrates throughout the zone of influence of the Llys-y-Fran drought order. The risk of the drought order to dissolved oxygen saturation levels within the

[19] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

zone of influence is therefore assessed as **minor** in Reach 1, **negligible** in Reach 2 and **negligible** in Reach 3.

Soluble Reactive Phosphorus concentration values were mostly consistent with the standard to support High status for fish and invertebrates throughout the zone of influence of the Llys-y-Fran drought order. The risk of the drought order to dissolved oxygen saturation levels within the zone of influence is therefore assessed as **minor** in Reach 1, **negligible** in Reach 2 and **negligible** in Reach 3.

B.3.3 Environmental Pressures

B.3.3.1 Flow Pressures

No significant abstractions other than the Welsh Water abstraction at Canaston are located within the zone of influence of the drought order.

B.3.3.2 Water Quality Pressures

Two consented discharges have been identified as having a negligible or higher water quality pressure. A summary of these impacts are identified in **Table B3.2**.

Table B3.2 Summary of Water Quality Pressures

Discharge Name	Flow: Daily total (Ml/day)	Flow: DWF (Ml/day)	BOD: 5 Day ATU (mg/l)	Ammoniacal Nitrogen as N (mg/l)	Suspended Solids at 105 C (mg/l)	Water Quality Pressure
Llys y Fan (Fish Farm)	0.003	Not specified	Not specified	Not specified	Not specified	Negligible
Llys-y-Fran STW	0.01	Not specified	Not specified	Not specified	Not specified	Minor
Walton East STW	Not specified	0.016	5	Not specified	Not specified	Minor
ST at Caffle Brewery	0.0044	Not specified	Not specified	Not specified	Not specified	Negligible
Clarebeston STW	0.005	Not specified	Not specified	Not specified	Not specified	Negligible
Llawhaden STW	0.005	Not specified	40	Not specified	Not specified	Negligible
Narberth West STW	2.39	1.1	50	25	Not specified	Minor (the discharge is close to tidal limit)
Ivy House, Llys-y-Fran, Clarbeston Road	0.0016	Not specified	20	Not specified	30	Negligible

B4 PHYSICAL ENVIRONMENT IMPACT SUMMARY

Potential impacts on the physical environment associated with the Llys-y-Fran Reservoir drought order are summarised in **Table B4.1**

Table B4.1 Summary of Potential Changes to the Physical Environment of the Impacted Reaches from Implementation of the Llys-y-Fran Reservoir Drought Order

Issue	Identified Impact
Afon Syfynwy (Reach 1)	
Flows in the Afon Syfynwy *Negligible impacts during October to December*	• Impacts to river flow (hydrology) in the reach downstream of Llys-y-Fran Reservoir have been assessed as negligible, as up to three freshet releases could still be made.
Water quality in the River Afon Syfynwy *Minor risk at any time of year*	• Impacts to water quality in the reach downstream of Llys-y-Fran Reservoir have been assessed as minor for ammonia, dissolved oxygen and soluble reactive phosphorous.
Consented discharges *Negligible risk at any time of year*	• These discharges are considered to have negligible pressure on the water environment during implementation of the drought order.
Eastern Cleddau (Reach 2)	
Flows in the Eastern Cleddau *Negligible impacts during October to December*	• Impacts to river flow (hydrology) in the reach downstream of the Afon Syfynwy confluence have been assessed as negligible, as up to three freshet releases could still be made.
Water quality in the River Eastern Cleddau *Negligible risk at any time of year*	• Impacts to water quality in the reach downstream of Llys-y-Fran Reservoir have been assessed as negligible for ammonia, dissolved oxygen and soluble reactive phosphorous.
Consented discharges *Minor risk at any time of year*	• The Narberth West STW discharges are considered to exert a minor pressure on the water environment during implementation of the drought order.
Eastern Cleddau (Reach 3)	
Flows in the Eastern Cleddau *Negligible impacts during October to December*	• Impacts to river flow (hydrology) in the reach downstream of the Canaston abstraction intake have been assessed as negligible, as up to three freshet releases could still be made.
Water quality in the River Eastern Cleddau *Negligible risk at any time of year*	• Impacts to water quality in the reach downstream of Llys-y-Fran Reservoir have been assessed as negligible for ammonia, dissolved oxygen and soluble reactive phosphorous.

B5 CUMULATIVE IMPACTS

The focus of this EAR is the Llys-y-Fran drought order. The assessment, as described in previous sections, has considered how the proposed drought order may affect the environment in combination with the effects of existing licences and consents. In accordance with the DPG the assessment also considers the potential cumulative effects of Welsh Water implementing other drought permits / orders within a similar timeframe. The potential for options to act in combination is set out in **Table B5.1**.

Consideration has also been given to the potential for cumulative impacts of drought options implemented by neighbouring water companies (see **Table B5.1**). The assessment of the potential for cumulative impacts of Welsh Water's supply side and drought permit / order options with drought options listed in neighbouring water companies' drought plans has also been undertaken as part of the Strategic Environmental Assessment (SEA) of Welsh Water's Draft Statutory Drought Plan. The SEA was informed by the most recent information available on the neighbouring water companies' drought plans.

Table B5.1 Cumulative Impacts of the Llys-y-Fran Drought Order with other Drought Options

Organisation	Potential In-combination Impacts	Further Consideration Required (Yes/No)
Welsh Water - other drought options in the Pembrokeshire WRZ	N/A	N/A
Welsh Water - other drought options in the Eastern Cleddau catchment	8206-2 (Preseli) –the extent of any impact of the Preseli drought order extends until the upper end of Llys-y-Fran Reservoir. As the impacts of the Llys-y-Fran drought order extends from the outlet of the reservoir, the impacted areas of the two schemes would be mutually exclusive. There are no cumulative effects of these two drought orders on the downstream water environment.	No
Natural Resources Wales - Drought options in the Eastern Cleddau catchment	No previous drought order applications have been made in the South West Wales region.	No