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Energy & Environment

Dŵr Cymru Welsh Water

Environmental Assessment of Afon Dwyfor Drought Permit (8034-1)

Final

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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 the Afon Dwyfor drought permit, over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

The Afon Dwyfor is located in Welsh Water's Lleyn / Harlech WRZ which covers the entire Lleyn Peninsula and the coastal strip south to Harlech.

The assessment also considers how the proposed drought permit 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 Natural Resources Wales (NRW) for a drought permit at Llyn Cwmystradllyn, which may be required by Welsh Water in the future.

PROPOSED DROUGHT PERMIT DETAILS

In order to protect essential public water supplies within Welsh Water's Lleyn / Harlech WRZ in the event of a future severe drought, Welsh Water may need to make an application to NRW for a drought permit to vary the conditions of its abstraction licence from Afon Dwyfor at the Garndolbenmaen intake.

If granted, the drought permit would involve an increase of 1Ml/d to the daily abstraction rate at Welsh Water's Garndolbenmaen intake on the Afon Dwyfor, without a corresponding increase in the rate of daily regulation release required from Llyn Cwmystradllyn at times when measured flow at Dolbenmaen weir is below the seasonal flow constraint value. This would enable Welsh Water to reduce their direct abstraction from Llyn Cwmystradllyn by 1Ml/d and thus conserve reservoir storage for use in river regulation and/or direct supply during a drought. To implement this

drought permit, an amendment to abstraction licence 23/65/8/16 is required. This drought permit will potentially influence the Afon Dwyfor downstream to the tidal limit.

The revised abstraction arrangements under the drought permit would be authorised for a maximum of five months (September-January), but would be removed sooner if the water resources situation within the Llyn / Harlech WRZ returns to adequate levels to safeguard essential water supplies, as agreed with NRW.

NEED FOR THE DROUGHT PERMIT

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

The justification for the drought permit 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 permit application.

ALTERNATIVE SOURCES CONSIDERED

Details of alternative sources considered by Welsh Water will be completed at the time of application for the Afon Dwyfor drought permit. This will demonstrate justification for the proposed drought permit details applied for.

POTENTIAL IMPACTS OF DROUGHT PERMIT IMPLEMENTATION

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

Summary of the Hydrological Assessment for the Afon Henwy and Afon Dwyfor

The assessment has concluded that there is **no** impact on river flows on the Afon Henwy from immediately downstream of Llyn Cwmystradllyn to the confluence with the Afon Dwyfor, and **no** impacts on the Afon Dwyfor downstream as far as the Garndolbenmaen Welsh Water abstraction intake. Impacts on the Afon Dwyfor are assessed as being **negligible** downstream of the intake. There are **negligible** impacts on the physical environment of the river, including water quality.

Summary of the Environmental Features Screening for the Afon Henwy and Afon Dwyfor

In accordance with national drought planning guidance, environmental assessment is neither required nor included for features where screening has identified a minor or negligible hydrological 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 with existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for a drought permit at the Afon Dwyfor.

MITIGATION AND MONITORING

The environmental assessment has identified negligible environmental impacts arising from implementation of the drought permit at the Afon Dywfor. This has included consideration and assessment of impacts on sites designated for their environmental importance. No mitigation measures are currently proposed as a consequence.

CONCLUSIONS

In summary, it has been concluded that the environmental effects on river flows, water quality and ecology of implementing a drought permit at the Afon Dywfor, 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**.

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Appendix A – Hydrology and Hydrogeological Methodology

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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 permit by Dŵr Cymru Welsh Water (Welsh Water) to temporarily modify the abstraction conditions to allow an increase of 1Ml/d in the river abstraction at the Afon Dwyfor Garndolbenmaen intake, without a corresponding increase in the regulation release rate from Llyn Cwmystradllyn reservoir at times when measured flow at Dolbenmaen weir is below the seasonal flow constraint value. Water abstracted at Llyn Cwmystradllyn is used to provide public water supplies to Welsh Water's Lleyn / Harlech 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 permit at the Afon Dwyfor. A drought permit 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 permit 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 permit over a maximum period of six months. The purpose of the assessment is to determine the environmental impacts of the drought permit over and above any effects arising from natural drought conditions.

The study area and focus of this environmental assessment of the Afon Dwyfor drought permit, covers the following waterbodies:

- Llyn Cwmystradllyn (GB31034490)
- Cwmystradllyn (GB110065053690)
- Dwyfawr – lower (GB110065053660)

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 permit (**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 permit monitoring requirements (**see Section 9 of this report**).

The environmental assessment has been conducted in accordance with Government regulations – and using the Welsh Government / Natural Resource Wales Drought Plan Guideline¹ (DPG); specifically Section 5 and Appendices I and J, and Welsh Government / Defra / NRW / Environment Agency guidance on drought permits and drought orders².

Consideration has been given to the potential impacts of drought permit 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 permit 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.

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 an 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 permits / orders 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

¹ NRW (2017) *Water Company Drought Plan Guideline*.

² Welsh Government / Defra / NRW / 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.

permit). 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 permit at the Afon Dwyfor, 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 permit.

1.4 STRUCTURE AND CONTENT OF THE REPORT

This EAR comprises the following sections:

Section 1: Introduction

Section 2: Background to the Drought Permit

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: Environmental Monitoring Plan (EMP)

Section 10: Conclusions

2 BACKGROUND TO THE DROUGHT PERMIT

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 WRZs

(see **Figure 2.1**).

The Lley / Harlech WRZ covers the entire Lley Peninsula and the coastal strip south to Harlech. The WRZ can be divided into two systems: the northern ‘Lley’ system of Llyn Cwmystradllyn, Llyn Cwm Dulyn and Afon Dwyfor; and the southerly ‘Cilfor – Harlech’ system of Llyn Eiddew Mawr and Llyn Tecwyn Uchaf.

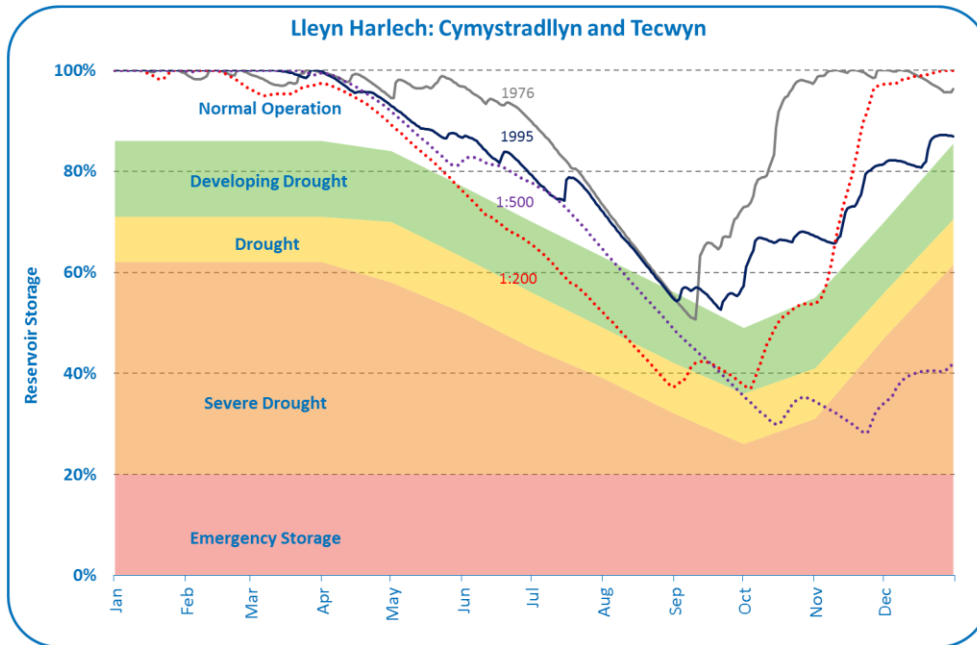
Figure 2.1 Welsh Water Water Resource Zones



The Afon Dwyfor is located in the Lley Harlech region of north-west Wales. The trigger levels for applying for a drought permit at the Afon Dwyfor are based on storage in Llyn Cwmystradllyn falling below a defined level³; this is shown in **Figure 2.2** (orange shading labelled as ‘severe drought’). There is also the possibility of a drought permit being triggered should two of the three other reservoirs in the WRZ enter a state of ‘severe drought’. Welsh Water’s assessment in its 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 draft Drought Plan 2020.

³ Based on the combined storage of Cwmystadllyn and Tecwyn Uchaf.

Figure 2.2 Llyn Cwmystradllyn Drought Action Zones and Historic Droughts



2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT THE AFON DWYFOR

The Dwyfor Regulation Scheme comprises two abstraction sources; Llyn Cwmystradllyn and the Afon Dwyfor. Welsh Water’s licence (number 23/63/8/16) to abstract water under the Water Resources Act 1991 from the Afon Dwyfor at the Garndolbenmaen intake includes the following conditions:

- 2,310 million litres (Ml) authorised to be abstracted per annum
- At an abstraction rate not exceeding 8.4Ml per day (Ml/d)
- Abstraction is subject to flow constraints in the Afon Dwyfor measured at NRW Dolbenmaen weir flow gauge located downstream of the Garndolbenmaen intake:
 - No abstraction at river flows less than or equal to 29.5Ml/d during the period 1 September-22 May unless regulation releases are being made from Llyn Cwmystradllyn
 - No abstraction at river flows less than or equal to 59.1Ml/d during the period 23 May-31 August unless regulation releases are being made from Llyn Cwmystradllyn
 - Regulation releases from Llyn Cwmystradllyn can be abstracted as a “put-and-take” arrangement from the Afon Dwyfor intake, i.e. any water released from the reservoir as a regulation flow release over and above the compensation flow release can be re-abstracted downstream from the Garndolbenmaen river intake.

The abstraction is made directly from the river intake and piped under gravity to nearby Dolbenmaen Water Treatment Works (WTW) where water is treated and put into supply. Treatment capacity at the old Dolbenmaen WTW was until recently 5.5Ml/d and consequently recorded river intake flows do not exceed this value. The new Dolbenmaen WTW has a treatment capacity of 18 Ml/d which also accommodates the Llyn Cwmystradllyn direct abstraction (see below). Inspection of the recorded data for the works raw water inlet indicates that daily river abstractions are generally around 3Ml/d or less, and occur during the summer period of around March to October. Although it is possible to abstract the full licensed rate of 8.4Ml/d, in practice the abstraction, and hence the regulation release rate, is unlikely to exceed 6Ml/d.

River regulation of the Afon Henwy and the Afon Dwyfor using Llyn Cwmystradllyn is also subject to an operating agreement made under Section 20 of the Water Resources Act 1991, and a river regulation scheme for the benefit of fisheries. The Section 20 operating manual is being updated to include a description of the measure in the context of the scheme and the sequence of actions that would result in an application for the drought permit.

There are clauses in Welsh Water's abstraction licence number 23/65/8/19 which are relevant to the management of flows in the Dwyfor catchment and comprise part of the Dwyfor Regulation Scheme, as follows:

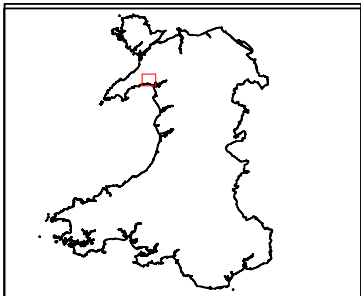
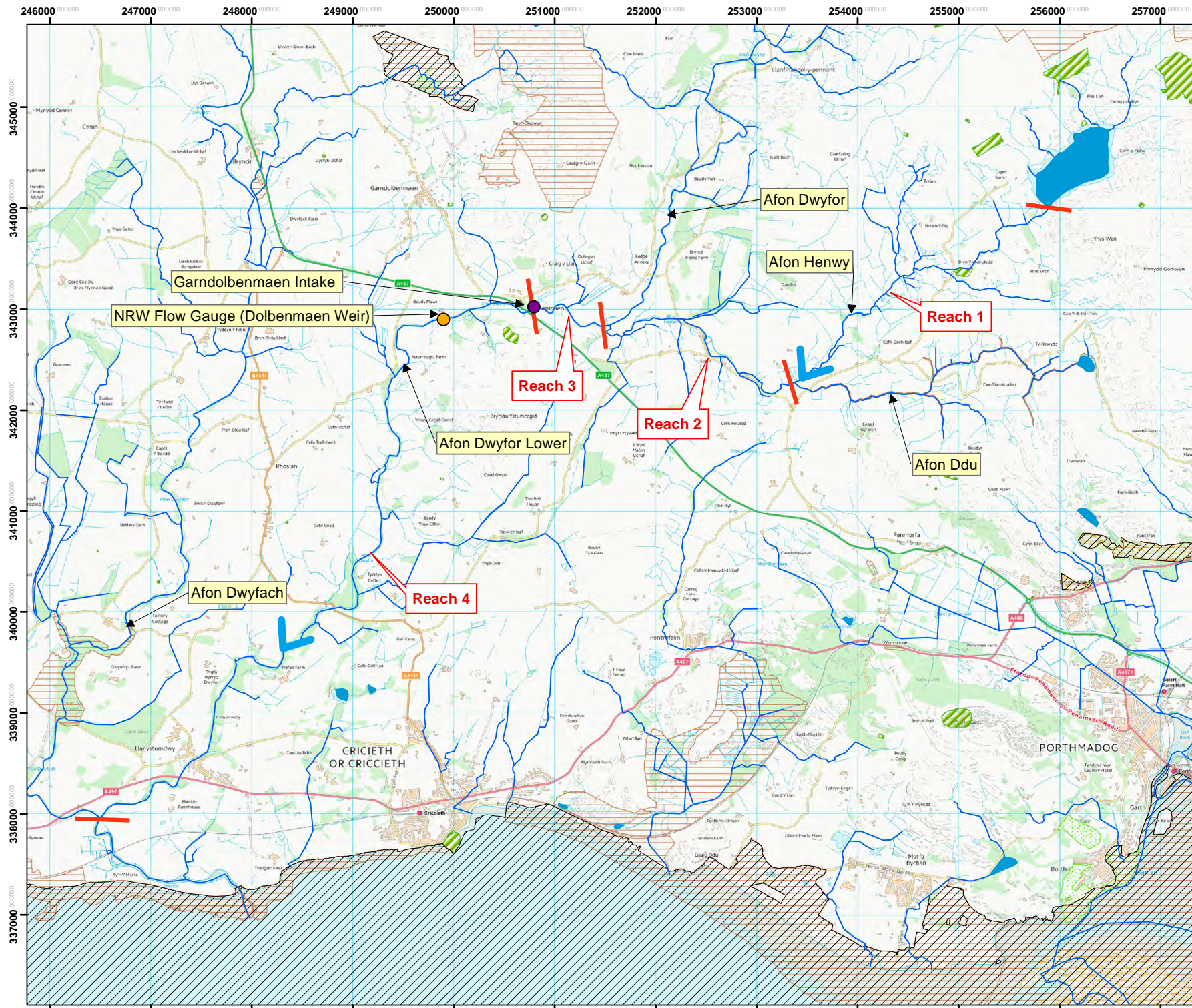
- A compensation flow release of 3.01 Ml/d is required from Llyn Cwmystradllyn to the Afon Henwy (a tributary of the Afon Dwyfor)
- Fisheries management and angling flow releases from Llyn Cwmystradllyn up to a total volume of 159Ml for release during the period 1 April to 1 November (of which 136Ml can be released between 1 August and 30 September, subject to various conditions⁴).
- Intermittent flow release from Llyn Cwmystradllyn of either 16.1 or 17.45Ml per week (depending on reservoir level) for the specific benefit of, and at the written request of, the Brynkir woollen mill (located on the Afon Henwy), at a rate not exceeding 145l per second⁵.

The abstraction licence includes for the abstraction of water directly from Llyn Cwmystradllyn which is piped to Dolbenmaen WTW where water is treated and put into supply. This drought permit would not seek to amend clauses in the licence relating to this abstraction, which in the interests of clarity have not been discussed further.

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

⁴ This is an additional quantity if the reservoir is in zone E.

⁵ Or 0.477 Ml/hour



Legend

- Flow Gauge
- Abstractions
- Hydrological Reach
- ▭ Reservoir
- Water Courses
- Direction of Flow
- Local Nature Reserve
- National Nature Reserve
- Special Area of Conservation
- Sites of Special Scientific Interest
- Scheduled Ancient Monuments





1:35,321
 Note: All locations are approximate
 This drawing incorporates Ordnance Survey Information
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Project Title: **Welsh Water Drought Plan Environmental Assessment**

Figure Title: **Study area: 8034-1 Reduce the compensation release at Llyn Cwmystadrllyn**

Figure Number: Figure 2.3	Date: February 2019
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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 PERMIT

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

2.5 DROUGHT PERMIT – 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 permit, setting out the alternative options to the drought permit that Welsh Water has considered in addressing the risks to essential public water supplies due to drought.

2.7 PROPOSED DROUGHT PERMIT DETAILS

In order to protect essential public water supplies within Welsh Water's Llyn / Harlech WRZ in the event of a future severe drought, Welsh Water may need to make an application to NRW for a drought permit to vary the conditions of its abstraction licence relating to the Afon Dwyfor.

If granted, the drought permit would involve a proposed increase of 1Ml/d in the river abstraction at Welsh Water's Garndolbenmaen intake on the Afon Dwyfor, without a corresponding increase in the regulation release rate from Llyn Cwmystradllyn at times when the measured flow at Dolbenmaen weir is below the seasonal flow constraint limit. Water resources modelling undertaken by Welsh Water indicates that the drought permit is most likely to be implemented during the period September to January inclusive. This would enable Welsh Water to reduce their direct abstraction from Llyn Cwmystradllyn by 1Ml/d and thus conserve reservoir storage for later use for river regulation and/or direct supply during a drought. This drought permit will potentially influence the Afon Henwy from Llyn Cwmystradllyn to the Afon Dwyfor confluence, and the Afon Dwyfor downstream to the tidal limit.

Details of the existing and proposed drought permit abstraction at Afon Dwyfor are presented in **Table 2.1**.

Table 2.1 Existing and Proposed Drought Permit Abstraction

Abstraction Water Source	NGR	Normal Abstraction	Proposed Drought Permit Abstraction	Benefit ML/d
Afon Dwyfor	SH 559 00 44 000	<p>Welsh Water’s licence (23/63/8/16) to abstract water under the Water Resources Act 1991 from the Afon Dwyfor at the Garndolbenmaen intake includes the following conditions:</p> <ul style="list-style-type: none"> • 2,310 million litres (ML) authorised to be abstracted per annum • At an abstraction rate not exceeding 8.4ML/d • Subject to flow constraints in the Afon Dwyfor measured at the NRW Dolbenmaen weir flow gauge on the downstream of the Garndolbenmaen intake: <ul style="list-style-type: none"> • No abstraction at river flows less than or equal to 29.5ML/d during the period 1 September-22 May unless regulation releases are being made from Llyn Cwmystradllyn • No abstraction at river flows less than or equal to 59.1ML/d during the period 23 May-31 August unless regulation releases are being made from Llyn Cwmystradllyn • Regulation releases from Llyn Cwmystradllyn can be abstracted as put-and-take from the downstream Afon Dwyfor, i.e. any water released from the reservoir (as a regulation release over and above the compensation release) can be re-abstracted from the river downstream at the Garndolbenmaen intake. 	<p>Proposed increase in the daily river abstraction at Garndolbenmaen intake of 1 ML/d, without a corresponding increase in the daily regulation release rate from Llyn Cwmystradllyn at times when measured flow at Dolbenmaen weir is below the seasonal flow constraint value.</p>	1.00

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

2.8 DROUGHT PERMIT PROGRAMME

Drought actions and any future application for a drought permit would be managed by the Dwyfor Consultative Group. Decisions around which permit to apply for in the Lley Harlech WRZ will be made in liaison with the Section 20 consultative groups to ensure the best option for the environment and water resource situation is chosen.

Drought permits can be granted 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 permit is restricted to September to January, as confirmed by water resources modelling carried out by Welsh Water.

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

2.9 DROUGHT PERMIT 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 permit being implemented. For the purposes of this assessment, the "without drought permit" baseline includes the continuation of abstraction from the Afon Dwyfor at the Garndolbenmaen intake under the existing abstraction licence conditions, and the continuation of the existing rates of abstraction, compensation and regulation flow releases from Llyn Cwmystradlyn. This represents normal operating arrangements during a typical summer / autumn period. The assessed drought permit would enable a temporary increase of 1Ml/d in the river abstraction at Garndolbenmaen, without a corresponding increase in the regulation release rate from Llyn Cwmystradlyn at times when the measured flow at Dolbenmaen weir is below the seasonal flow constraint value. This would enable Welsh Water to reduce their direct abstraction from Llyn Cwmystradlyn by 1Ml/d to conserve storage in the reservoir.

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 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 for the drought permit assessment 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.

To set the context of the studies, it should be noted that EAR considers the environmental impacts of implementing a drought permit 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 permit 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 permit 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 revised Drought Plan (i.e. before 2025)
 - Drought options from other neighbouring water company Drought Plans, NRW

Drought Plans

- National Policy Statements for Wastewater and Renewable Energy Infrastructure.

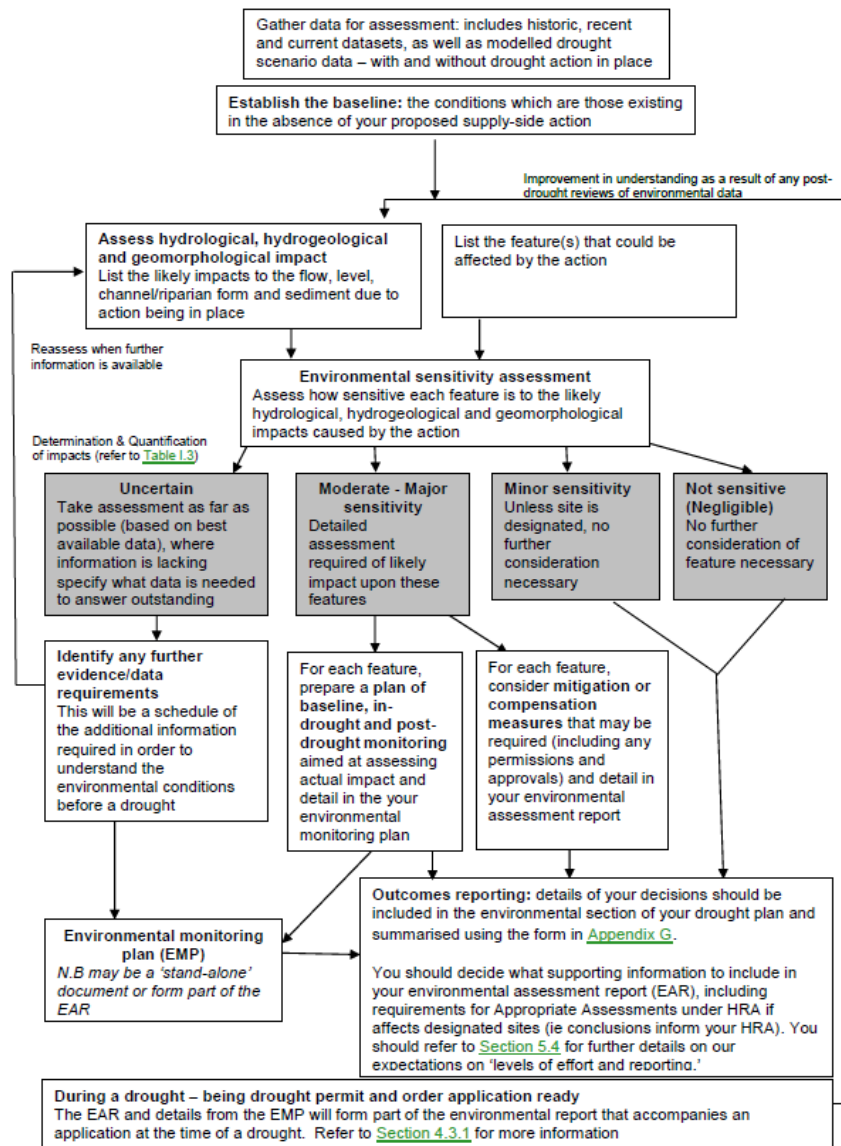
This is discussed further in Section 7.

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 permit implementation should be considered in the context of what would occur without drought permit 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 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 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 permit. 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 permit with subsequent applications for a drought permit required to consider cumulative effects of multiple drought permits / orders.
- **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 permit at the Afon Dwyfor.

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 & archaeological 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 permit.

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 Afon Dwyfor drought permit together with identification of relevant, sensitive environmental features within those study areas (based on the risk of them being impacted by the drought permit during the period of its operation).

As set out in **Figure 3.1**, the environmental sensitivity screening identifies the outcome for each listed feature. DPG Figure 5 categorises four outcomes 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.

For each feature identified, the assessment methodology used in the EAR to identify the magnitude and significance of impact has been defined (see Section 3.3 below).

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.

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 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 Ireland⁶
- 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
- Conservation of Habitats and Species Regulations 2017
- The Countryside and Rights of Way Act 2000.

⁶ CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. September 2018.

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

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 permit.

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 permit.

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 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 and 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 AFON DWYFOR DROUGHT PERMIT - 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 permit. **Appendix B** sets out an assessment of the potential impacts on the physical environment of the Afon Dwyfor drought permit during the period of implementation of the drought permit. The “without drought permit” 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 permit impacts, identifying the likely changes in flow/ level regime due to implementing the drought permit. The specific requirements of the DPG are summarised as:

- identify any changes that the drought permit 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 permit;
- describe how the likely conditions would differ with the drought permit 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 Llyn Cwmystradllyn Reservoir, Afon Henwy and Afon Dwyfor to tidal limit.

2. The nature and duration of the potential impact:

A description of the likely conditions with the drought permit 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 permit, the key areas for the assessment of the physical environment have been identified as:

- changes in water level of Llyn Cwmystradllyn Reservoir
- changes in flow in Afon Henwy
- changes in flow in Afon Dwyfor

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 permit is most likely to occur during the autumn and winter period, considered to not extend outside the period September to January.

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 permit 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 Permit

Afon Henwy (Reach 1)	
Flows in the Afon Henwy <i>No impacts</i>	<ul style="list-style-type: none"> No hydrological changes anticipated
Afon Henwy (Reach 2)	
Flows in the River Henwy <i>No impacts</i>	<ul style="list-style-type: none"> No hydrological changes anticipated
Afon Dwyfor (Reach 3)	
Flows in the River Dwyfor <i>Minor impacts for up to six months during the summer / autumn period</i>	<ul style="list-style-type: none"> No hydrological changes anticipated
Afon Dwyfor (Reach 4)	
Flows in the River Dwyfor <i>Negligible impacts for up to five months during period September to January inclusive.</i>	<ul style="list-style-type: none"> Impacts have been assessed as negligible

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 permit impacts and the baseline condition without a drought permit 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 AFON DWYFOR DROUGHT PERMIT ENVIRONMENTAL FEATURES ASSESSMENT

5.1 INTRODUCTION

In compliance with the DPG, environmental sensitivity screening has been undertaken within the zone of hydrological influence. As set out in **Box 1** above, further 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.

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 permit. Susceptibility to the flow / level impacts resulting from the drought permit (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 Afon Dwyfor Drought Permit

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)
Reach 1 – Afon Henwy (Llyn Cwmystradllyn Outflow to Afon Ddu confluence)				
Notable species - Fish Atlantic salmon <i>Salmo salar</i> Brown trout <i>Salmo trutta</i> Bullhead <i>Cottus gobio</i> Brook lamprey ⁷ <i>Lampetra planeri</i> River lamprey <i>Lampetra fluviatilis</i> Sea lamprey <i>Petromyzon marinus</i> European eel <i>Anguilla anguilla</i>	None	A number of notable species occur within the reach. Reductions in flow is anticipated to reduce the availability of habitat for fish, and increase the risk of predation. Changes to wetted depth and wetted width may restrict the access of migratory fish to spawning habitat or to dry out spawning gravels.	Negligible	No
Notable species – Invertebrates White-clawed crayfish <i>Austropotamobius pallipes</i>	None	The changes to river flow following initial onset of environmental drought is anticipated to reduce the availability of habitats and significantly alter habitat availability and quality for white-clawed crayfish	Negligible	No
Notable species – Mammals Otter <i>Lutra lutra</i>	None	These species are not expected to be significantly impacted by drought permit implementation as habitat and availability and quality is not anticipated to be significantly altered. The reduction in river level may even be beneficial to otter with prey more easily accessible	Negligible	No
Benthic macroinvertebrate communities	None	The communities in this reach potentially includes the Nationally Scarce caddisfly <i>Rhyacophila septentrionis</i> and the Red Data Book crane fly <i>Limonia omisineris</i> . The major hydrological impact is anticipated to reduce the availability of habitats or lead to exposure of benthic macroinvertebrate habitats.	Negligible	No
Macrophyte communities	None	The communities in this reach are likely to include <i>Ranunculus</i> communities (<i>Ranunculon fluitantis</i> and <i>Callitricho-Batrachion</i>), and possibly the Nationally Scarce liverwort <i>Porella pinnata</i> and the Nationally Scarce moss <i>Platyhypnidium lusitanicum</i> . The major hydrological impact is anticipated to reduce the availability of habitats or reduce water quality with consequent impacts on macrophyte communities.	Negligible	No
Invasive fauna and flora, including the invasive non-native flatworm species <i>Dugesia tigrina</i>	None	Invasive species may use the change in flow of the watercourse to aid its dispersal and/or competition with native species.	Negligible	No

⁷ Although not currently identified as a Environment (Wales) Act Section 7 species, Brook lamprey are included as an Annex II species, and thus are considered to be of importance for conservation

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)
Landscape and visual amenity	None	Llyn Cwmystradlyn and the majority of the Afon Henwy are located within Snowdonia National Park, in the Llyn Peninsula. In its lower reaches, the Henwy leaves the National Park and flows through an Environmentally Sensitive Area (ESA) to discharge out to the sea near Criccieth. The impact on flows will only be temporary and will be ameliorated once the drought has passed.	Negligible	No
Recreation	None	Recreational activities in the area include walking, climbing, angling and fishing. Any reduction in wetted width and depth may influence water-dependent activities such as angling and fishing. There is potential for all of these activities to be impacted by the drought permit. The impact on flows will only be temporary and will be ameliorated once the drought has passed.	Negligible	No
Scheduled Ancient Monuments	None	A hillfort designated as an ancient monument can be found within 500m of the reach. This has no water dependant features.	Negligible	No
Reach 2 – Afon Henwy (Afon Ddu confluence to Afon Dwyfor confluence)				
Notable species - Fish Atlantic salmon <i>Salmo salar</i> Brown trout <i>Salmo trutta</i> Bullhead <i>Cottus gobio</i> Brook lamprey <i>Lampetra planeri</i> River lamprey <i>Lampetra fluviatilis</i> Sea lamprey <i>Petromyzon marinus</i> European eel <i>Anguilla anguilla</i>	None	A number of notable species occur within the reach. Reductions in flow is anticipated to reduce the availability of habitat for fish, and increase the risk of predation. Changes to wetted depth and wetted width may restrict the access of migratory fish to spawning habitat or to dry out spawning gravels.	Negligible	No
Notable species – Invertebrates White-clawed crayfish <i>Austropotamobius pallipes</i> Freshwater pearl mussel <i>Margaritifera margaritifera</i>	None	The changes to river flow following initial onset of environmental drought is anticipated to reduce the availability of habitats and significantly alter habitat availability and quality for white-clawed crayfish and freshwater pearl mussel	Negligible	No
Notable species – Mammals Otter <i>Lutra lutra</i>	None	These species are not expected to be significantly impacted by drought permit implementation as habitat and availability and quality is not anticipated to be significantly altered. The reduction in river level may even be beneficial to otter with prey more easily accessible	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)
Benthic macroinvertebrate communities	None	The communities in this reach potentially includes the Nationally Scarce caddisfly <i>Rhyacophila septentrionis</i> and the Red Data Book crane fly <i>Limonia omissinervis</i> . The moderate hydrological impact is anticipated to reduce the availability of habitats or lead to exposure of benthic macroinvertebrate habitats.	Negligible	No
Macrophyte communities	None	The communities in this reach are likely to include <i>Ranunculus</i> communities (<i>Ranunculon fluitantis</i> and <i>Callitricho-Batrachion</i>), and possibly the Nationally Scarce liverwort <i>Porella pinnata</i> and the Nationally Scarce moss <i>Platyhypnidium lusitanicum</i> . The moderate hydrological impact is anticipated to reduce the availability of habitats or reduce water quality with consequent impacts on macrophyte communities.	Negligible	No
Invasive fauna and flora, including the invasive non-native flatworm species <i>Dugesia tigrina</i>	None	Invasive species may use the change in flow of the watercourse to aid its dispersal and/or competition with native species.	Negligible	No
Landscape and visual amenity	None	Llyn Cwmystradlyn and the majority of the Afon Henwy are located within Snowdonia National Park, in the Llyn Peninsula. In its lower reaches, the Henwy leaves the National Park and flows through an Environmentally Sensitive Area (ESA) to discharge out to the sea near Criccieth. The impact on flows will only be temporary and will be ameliorated once the drought has passed.	Negligible	No
Recreation	None	Recreational activities in the area include walking, climbing, angling and fishing. Any reduction in wetted width and depth may influence water-dependent activities such as angling and fishing. There is potential for all of these activities to be impacted by the drought permit. The impact on flows will only be temporary and will be ameliorated once the drought has passed.	Negligible	No
Scheduled Ancient Monuments	None	Two chambered long cairns designated as ancient monuments can be found within 500m of the reach. These have no water dependant features.	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)
Reach 3 – Afon Dwyfor (Afon Henwy confluence to Garndolbenmaen intake)				
Notable species - Fish Atlantic salmon <i>Salmo salar</i> Brown trout <i>Salmo trutta</i> Bullhead <i>Cottus gobio</i> Brook lamprey <i>Lampetra planeri</i> River lamprey <i>Lampetra fluviatilis</i> Sea lamprey <i>Petromyzon marinus</i> European eel <i>Anguilla anguilla</i>	None	A number of notable species occur within the reach. Reductions in flow is anticipated to reduce the availability of habitat for fish, and increase the risk of predation. Changes to wetted depth and wetted width may restrict the access of migratory fish to spawning habitat or to dry out spawning gravels.	Negligible	No
Notable species – Invertebrates White-clawed crayfish <i>Austropotamobius pallipes</i> Freshwater pearl mussel <i>Margaritifera margaritifera</i>	None	The changes to river flow following initial onset of environmental drought is anticipated to reduce the availability of habitats and significantly alter habitat availability and quality for white-clawed crayfish and freshwater pearl mussel	Negligible	No
Notable species – Mammals Otter <i>Lutra lutra</i>	None	These species are not expected to be significantly impacted by drought permit implementation as habitat and availability and quality is not anticipated to be significantly altered. The reduction in river level may even be beneficial to otter with prey more easily accessible	Negligible	No
Benthic macroinvertebrate communities	None	The communities in this reach potentially includes the Nationally Scarce caddisfly <i>Rhyacophila septentrionis</i> and the Red Data Book crane fly <i>Limonia omissinervis</i> . The minor hydrological impact is anticipated to reduce the availability of habitats or lead to exposure of benthic macroinvertebrate habitats.	Negligible	No
Invasive fauna and flora, including the invasive non-native flatworm species <i>Dugesia tigrina</i>	None	Invasive species may use the change in flow of the watercourse to aid its dispersal and/or competition with native species.	Negligible	No
Landscape and visual amenity	None	The Afon Dwyfor flows through an Environmentally Sensitive Area (ESA) to discharge out to the sea near Criccieth. The impact on flows will only be temporary and will be ameliorated once the drought has passed.	Negligible	No
Recreation	None	Recreational activities in the area include walking, climbing, angling and fishing. Any reduction in wetted width and depth may influence water-dependent activities such as angling and fishing. There is potential for all of these activities to be impacted by the drought permit. The impact on flows will only be temporary and will be ameliorated once the drought has passed.	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)
Scheduled Ancient Monuments	None	A burial chamber designated as ancient monuments can be found within 500m of the reach. This has no water dependant features.	Negligible	No
Reach 4 – Afon Dwyfor (Garndolbenmaen intake to tidal limit)				
Notable species - Fish Atlantic salmon <i>Salmo salar</i> Brown trout <i>Salmo trutta</i> Bullhead <i>Cottus gobio</i> Brook lamprey <i>Lampetra planeri</i> River lamprey <i>Lampetra fluviatilis</i> Sea lamprey <i>Petromyzon marinus</i> European eel <i>Anguilla anguilla</i>	Negligible	A number of notable species occur within the reach. Reductions in flow is anticipated to reduce the availability of habitat for fish, and increase the risk of predation. Changes to wetted depth and wetted width may restrict the access of migratory fish to spawning habitat or to dry out spawning gravels.	Negligible	No
Notable species – Invertebrates White-clawed crayfish <i>Austropotamobius pallipes</i> Freshwater pearl mussel <i>Margaritifera margaritifera</i>	Negligible	The changes to river flow following initial onset of environmental drought is anticipated to reduce the availability of habitats and significantly alter habitat availability and quality for white-clawed crayfish and freshwater pearl mussel	Negligible	No
Notable species – Mammals Otter <i>Lutra lutra</i>	Negligible	These species are not expected to be significantly impacted by drought permit implementation as habitat and availability and quality is not anticipated to be significantly altered. The reduction in river level may even be beneficial to otter with prey more easily accessible	Negligible	No
Benthic macroinvertebrate communities	Negligible	The Negligible hydrological impact is anticipated to reduce the availability of habitats or lead to exposure of benthic macroinvertebrate habitats.	Negligible	No
Macrophyte communities	Negligible	The negligible hydrological impact is not anticipated to materially reduce the availability of habitats or lead to greater than negligible adverse effects on macrophyte communities.	Negligible	No
Invasive fauna and flora, including the invasive non-native flatworm species <i>Dugesia tigrina</i>	Negligible	Invasive species may use the change in flow of the watercourse to aid its dispersal and/or competition with native species.	Negligible	No
Landscape and visual amenity	Negligible	The Afon Dwyfor flows through an Environmentally Sensitive Area (ESA) to discharge out to the sea near Criccieth. The impact on flows will only be temporary and will be ameliorated once the drought has passed.	Negligible	No
Scheduled Ancient monuments	Negligible	A burial chamber designated as ancient monuments can be found within 500m of the reach. This has no water dependant features.	Negligible	No

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 permit. 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	Llyn Cwmystradllyn (GB31034490)		Cwmystradllyn (GB110065053690)		Dwyfawr – lower (GB110065053660)	
	RBMP2 (2015) ⁸	2018 Cycle 2 Interim Classification ⁹	RBMP2 (2015) ⁸	2018 Cycle 2 Interim Classification ⁹	RBMP2 (2015) ⁸	2018 Cycle 2 Interim Classification ⁹
Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Minor Beneficial		None		None / Negligible	
Heavily Modified Waterbody (Y/N)	Yes		Yes		No	
Overall Biological	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Fish	Not assessed	Not assessed	High	High	Good	High
Macrophytes / Phytobenthos Combined	N/A	N/A	Good	Good	Good	Good
Macrophytes	N/A	N/A	Not assessed	Not assessed	Not assessed	Not assessed
Phytobenthos	N/A	N/A	Good	Good	Good	Good
Macro-invertebrates	N/A	N/A	High	High	High	Not assessed
Phytoplankton	Good	Good	N/A	N/A	N/A	NA
Total P/ Phosphate	Good	High	Good	High	High	High
Ammonia	Not assessed	Not assessed	High	High	High	High
Dissolved Oxygen	Not assessed	Not assessed	High	High	High	High
pH	Not assessed	Not assessed	High	High	High	Moderate
Sensitivity (Uncertain, Moderate/Major, Minor, Not sensitive)	Not sensitive		Not sensitive		Not sensitive	
Further Consideration Required (Y/N)	No		No		No	

⁸ NRW (2017) <https://drive.google.com/file/d/0B2hsDbbdxztZHItRU9lNkg1YWw/view>

⁹ NRW (2018) https://drive.google.com/file/d/14w17jLo5sNuToVELqMCK_yc6DdHU7STb/view

5.3 FEATURES ASSESSMENT

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

6 AFON DWYFOR DROUGHT PERMIT – MITIGATION

The hydrological impact of the drought permit 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 permit implementation.

7 CUMULATIVE IMPACTS

In accordance with the DPG and the Habitats Regulations, consideration has been given to how the proposed drought permit 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 permit with other Welsh Water supply-side and drought order / permit 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 other neighbouring water company Drought Plans and NRW Drought Plans
 - National Policy Statements for Wastewater and Renewable Energy Infrastructure
- Environmental monitoring before, during and after drought permit implementation (see Section 9).

If a drought permit 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 permit specified in the application.

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

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 Afon Dwyfor drought permit with other drought order / permit schemes have been identified.

Welsh Water WRMP schemes

No WRMP schemes identified with cumulative impacts.

Drought options from other neighbouring water company Drought Plans and NRW Drought Plans

No cumulative impacts of options in NRW Drought Plans or neighbouring water company drought plans with a drought permit at Afon Dwyfor are anticipated (see Section B5 in **Appendix B**). However, this should be reviewed at time of future application for a drought permit.

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 permit implementation have been made in the EMP which is presented in Section 9 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 AFON DWYFOR DROUGHT PERMIT - 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.

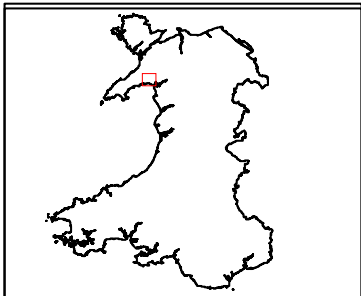
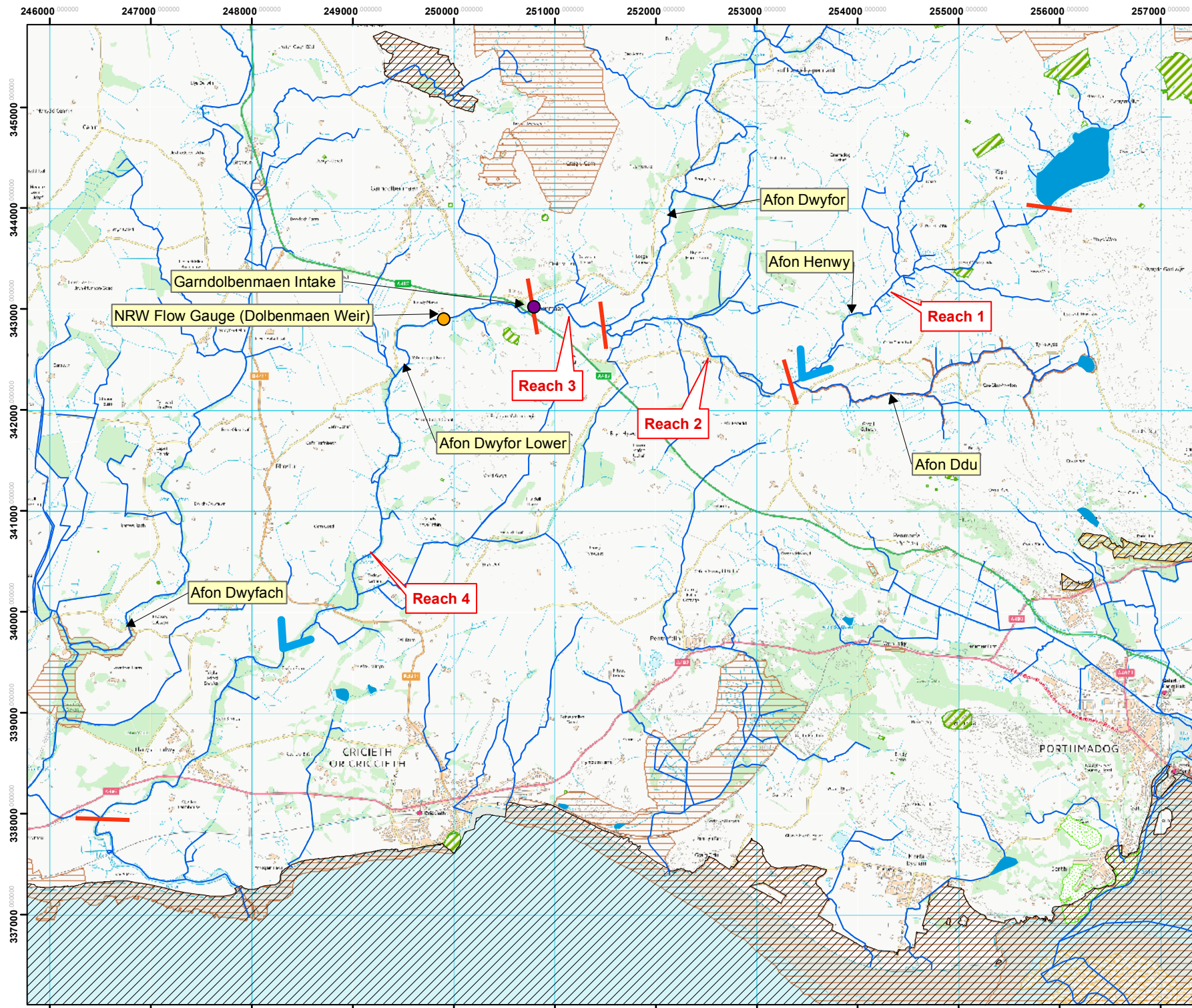
At this stage, no mitigation measures have been identified as required as the hydrological influence of the drought permit has been assessed as negligible (see Section 4).

9 ENVIRONMENTAL MONITORING PLAN (EMP)

The hydrological impact of the Afon Dwyfor drought permit 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 permit, 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 9.1**, and should include:

- Daily Llyn Cwmystradllyn water level;
- Daily Llyn Cwmystradllyn compensation weir flow gauge;
- Daily Garndolbenmaen intake abstraction flows.



Legend

- Flow Gauge
- Abstractions
- Hydrological Reach
- Reservoir
- Water Courses
- Direction of Flow
- Local Nature Reserve
- National Nature Reserve
- Special Area of Conservation
- Sites of Special Scientific Interest
- Scheduled Ancient Monuments





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▲ Note: All locations are approximate
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Project Title: **Welsh Water Drought Plan Environmental Assessment**

Figure Title: **Environmental Monitoring: 8034-1 Reduce the compensation release at Llyn Cwmystradlyn**

Figure Number: Figure 10.1	Date: February 2019
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10 CONCLUSIONS

This EAR provides an assessment of the potential environmental impacts relating to the implementation of the Afon Dwyfor drought permit. If granted and implemented, the drought permit would authorise a temporary increase of 1Ml/d in the river abstraction from Garndolbenmaen intake, without a corresponding increase in the rate of regulation release from Llyn Cwmystradllyn reservoir at times when measured flow at Dolbenmaen weir is below the seasonal flow constraint value. This would enable Welsh Water to reduce the regulation releases from Llyn Cwmystradllyn and thus would help to conserve storage in the reservoir.

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 permit (Stage 2).

The hydrological impact assessment is identified as no impact on the Afon Dwyfor, with **negligible** impacts on the physical environment of the river, including water quality.

The DPG states that 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 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 permit, 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 with existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for a drought permit at the Afon Dwyfor.

The environmental assessment has identified negligible environmental impacts of implementing the Afon Dwyfor drought permit. Consequently, in line with regulatory Guidance for drought permit assessments, mitigation measures have been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.

In summary, it has been concluded that the environmental effects on river flows, water quality and ecology of implementing the Afon Dwyfor drought permit, 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**.



APPENDIX A HYDROLOGY AND HYDROGEOLOGY METHODOLOGY

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

Consideration is required (by the DPG¹) 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 approach² 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 upland³. 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		
		<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		
		<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 Q₉₅, summer⁴) and very high sensitivity to changes in extreme low flow (represented by Q₉₉, 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 Q₉₅), but similarly sensitive to reductions in extreme summer low flows (summer Q₉₉).

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		
		<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		
		<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 Llyn Cwmystradllyn reservoir and the Afon Henwy / Afon Dwyfor river catchment during the period of implementation of the drought permit and subsequent reservoir level recovery.

For the purposes of this assessment, the “without drought permit” baseline includes the continuation of abstraction from the Afon Dwyfor at the Garndolbenmaen intake under the existing abstraction licence conditions, and the continuation of the existing rates of abstraction and regulation releases from Llyn Cwmystradllyn. This represents normal operating arrangements during a typical summer / autumn period. The assessed drought permit would enable a temporary increase in the abstraction rate at Garndolbenmaen of 1Ml/d (without a corresponding increase in the regulation release rate), to conserve storage in Llyn Cwmystradllyn by reducing regulation releases from the reservoir by 1Ml/d.

B.1.1 Welsh Water’s Existing Operations

Welsh Water’s licence (number 23/65/8/16) to abstract water under the Water Resources Act 1991 from the Afon Dwyfor at the Garndolbenmaen intake (see **Figure B1.1**) includes the following conditions:

- 2,310 million litres (Ml) authorised to be abstracted per annum
- At an abstraction rate not exceeding 8.4Ml per day (Ml/d)
- Abstraction is subject to flow constraints in the Afon Dwyfor measured at the NRW Dolbenmaen weir flow gauge located downstream of the Garndolbenmaen intake:
 - No abstraction at river flows less than or equal to 29.5Ml/d during the period 1 September-22 May unless regulation releases are being made from Llyn Cwmystradllyn
 - No abstraction at river flows less than or equal to 59.1Ml/d during the period 23 May-31 August unless regulation releases are being made from Llyn Cwmystradllyn
 - Regulation releases from Llyn Cwmystradllyn can be abstracted as a “put-and-take” arrangement from the Afon Dwyfor intake, i.e. any water released from the reservoir as a regulation flow release over and above the compensation flow release can be re-abstracted from the river.

The abstraction is made directly from a river intake and piped under gravity to the nearby Dolbenmaen Water Treatment Works (WTW) where water is treated and put into supply. Current treatment capacity at the old Dolbenmaen WTW was until recently 5.5Ml/d and consequently recorded river intake flows do not exceed this value. The new Dolbenmaen WTW

has a treatment capacity of 18 Ml/d, however, inspection of the recorded data for the works raw water inlet indicates that daily abstractions are generally around 3Ml/d or less, and occur during the summer period of around March to October. Although it is possible to abstract the full licensed rate of 8.4Ml/d, in practice the abstraction, and hence the regulation release rate, is unlikely to exceed 6Ml/d. There are clauses in Welsh Water's abstraction licence number 23/65/8/19 which are relevant to the management of flows in the Dwyfor catchment, as follows:

- A compensation flow release of 3.01 Ml/d is required from Llyn Cwmystradllyn to the Afon Henwy (a tributary of the Afon Dwyfor)
- Fisheries management and angling releases from Llyn Cwmystradllyn up to a total volume of 159Ml for release during the period 1 April to 1 November (of which 136Ml can be released between 1 August and 30 September, subject to various conditions¹).
- Intermittent release from Llyn Cwmystradllyn of 16.1 or 17.45Ml per week for the specific benefit of, and at the written request of, the Brynkir woollen mill (located on the Afon Henwy), at a rate not exceeding 145 l per second.

The abstraction licence includes for the abstraction of water directly from Llyn Cwmystradllyn which is piped to the new Dolbenmaen WTW where water is treated and put into supply. This drought permit would not seek to amend clauses in the licence relating to this abstraction, which in the interests of clarity have not been discussed further.

River regulation of the Afon Henwy and the Afon Dwyfor using Llyn Cwmystradllyn is also subject to an operating agreement made under Section 20 of the Water Resources Act 1991. The Section 20 operating manual is being updated to include a description of the measure in the context of the scheme and the sequence of actions that would result in an application for the drought permit.

B.1.2 Welsh Water's Proposed Drought Permit

Welsh Water's proposed drought permit involves a temporary increase of 1Ml/d in the daily abstraction rate at the Garndolbenmaen intake, without a corresponding increase in the daily regulation release rate from Llyn Cwmystradllyn when flow at Dolbenmaen weir is below the seasonal flow constraint limit. Water resources modelling undertaken by Welsh Water indicates that the drought permit is most likely to be implemented during the period September to January inclusive. This would conserve reservoir storage for use in river regulation and/or direct supply during a drought, by enabling Welsh Water to reduce their direct abstraction from Llyn Cwmystradllyn by 1Ml/d. This drought permit will potentially influence the Afon Henwy from Llyn Cwmystradllyn to the Afon Dwyfor confluence, and the Afon Dwyfor downstream to the tidal limit. The study area is shown on **Figure B1.1**.

The physical environment includes consideration of hydrology and hydrodynamics,

¹ An additional quantity if reservoir is in Zone E.

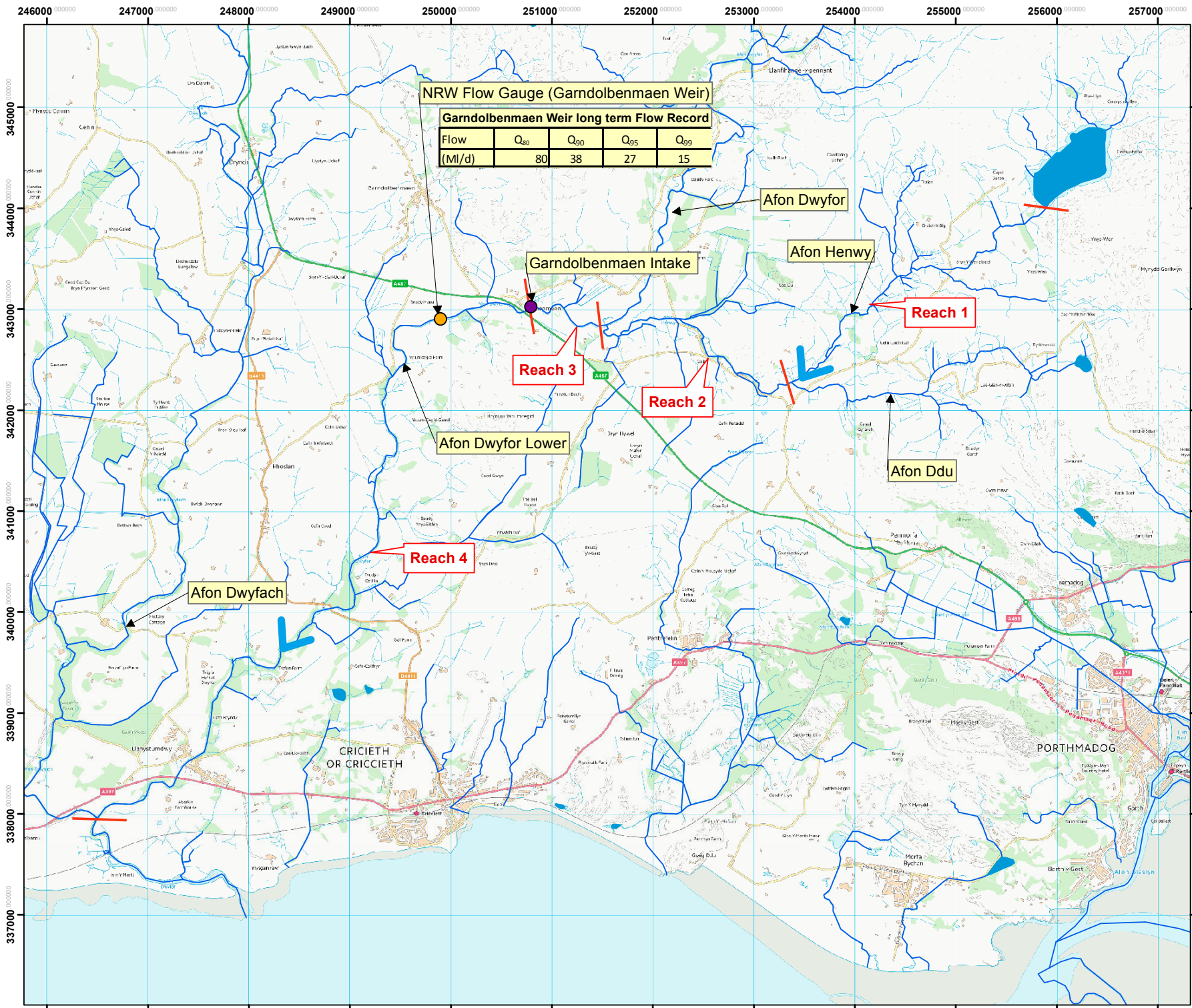
geomorphology and water quality. The assessment has three key objectives:

1. To “list the likely impacts to the flow, level, channel/riparian form and sediment due to action being in place” as required by the DPG² 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.

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.

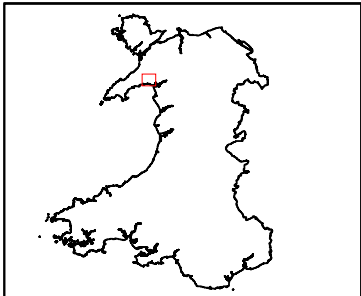
² Natural Resources Wales (2017) *Water Company Drought Plan Technical Guideline*. Available at <https://cdn.naturalresources.wales/media/684414/final-wc-drought-plan-guidance-2017.pdf?mode=pad&rnd=131656713580000000>, Accessed 04 February 2019.



NRW Flow Gauge (Garndolbenmaen Weir)

Garndolbenmaen Weir long term Flow Record

Flow (Ml/d)	Q ₈₀	Q ₉₀	Q ₉₅	Q ₉₉
	80	38	27	15



- Legend**
- Flow Gauge
 - Abstractions
 - Hydrological Reach
 - Water Courses
 - Reservoir
 - Direction of Flow



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 Note: All locations are approximate
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Project Title: **Welsh Water Drought Plan Environmental Assessment**

Figure Title: **Reduce the regulation release at Llyn Cwmystadlyn**

Figure Number: **Figure B1.1** Date: **February 2019**

B2 HYDROLOGICAL IMPACT

B.2.1 Reference Conditions

B.2.1.1 Catchment Overview

Llyn Cwmystradllyn

The remote natural lake of Llyn Cwmystradllyn was dammed in the 1960s to increase the water storage volume. The embankment holds back a maximum usable storage of 2,910Ml with a surface area of 40ha (at top water level) at an altitude of 205m. The 5km² catchment draining into the reservoir has high rainfall on rough grazing land in a mountainous area.

The compensation flow release of 3.01 Ml/d from Llyn Cwmystradllyn helps to sustain flow in the downstream Afon Henwy and Afon Dwyfor all year round. Additionally, regulation releases are made concurrently when abstraction at the Garndolbenmaen river intake is taking place and river flows are below the hands-off flow requirement, together with any fisheries releases required. Daily abstractions rates, and therefore regulation releases, are generally around 3Ml/d or less, and occur during the summer period of around March to October. Although it is possible to abstract the full licensed rate of 8.4Ml/d, in practice the abstraction, and hence the regulation release rate, is unlikely to exceed 3Ml/d. However, in a drought levels would be taken up to 6Ml/d to conserve stocks in the reservoir. These controlled releases from Llyn Cwmystradllyn represent a significant proportion of the flow in the downstream river system during drought and in periods without significant rainfall across the catchment.

Afon Henwy / Afon Dwyfor

The Afon Dwyfor catchment (64km² total drainage area to the tidal limit) includes the major tributary of the Afon Henwy. Both the Afon Dwyfor and Afon Henwy originate in the Moel Hebog / Nantlle ridge group of mountains in the Snowdonia National Park. At their confluence, the Afon Dwyfor is the larger river, draining an area twice the size of the area drained by the Afon Henwy. Flow in the Afon Dwyfor is natural whilst flows in the Afon Henwy are influenced by the Llyn Cwmystradllyn impoundment and flow release regime.

B.2.1.2 Baseline Data Availability

Continuous monitoring is undertaken by Welsh Water to monitor its operations at Llyn Cwmystradllyn and the Garndolbenmaen intake, including:

- Daily Llyn Cwmystradllyn water level data from 1983 to present.
- Daily Llyn Cwmystradllyn compensation weir flow gauge data from 1988 to present (data missing for the period 2001 to 2005). Weir flow measurement includes all controlled releases from the reservoir combined with any overflow (spill).
- Daily Garndolbenmaen intake abstraction flows from 1988 to present.

In addition, Natural Resources Wales operates a river flow gauge at Garndolbenmaen weir, downstream of the Garndolbenmaen intake for which daily river flow data are available from 1975 to 2014.

Some limited flow data are available from a gauge at Cwmystradllyn, as well as several flow values from spot flow gauging undertaken during September 2011³ and during April and July 2012⁴. The spot flow gauging results are discussed further in Section B.2.2.2.

Other available data includes catchment areas at different locations in the study area⁵.

The reference conditions of Llyn Cwmystradllyn reservoir and the Afon Henwy / Afon Dwyfor catchments are summarised below, based on the available hydrological data as set out above.

B.2.1.3 Hydrology

Llyn Cwmystradllyn Reservoir

Typically, reservoir levels range from about 12m to about 15m above local datum in Llyn Cwmystradllyn, although in the drought of 1984 levels dropped to around 8.8m. The maximum recorded reservoir level is at 15.3m above datum and when the reservoir is at full capacity, any overflows pass over the spillway into the Afon Henwy. A summary of mean reservoir levels is given in **Table B2.1** for the period 1983 to 2015.

Table B2.1 Summary of Recorded Mean, Maximum and Minimum Daily Reservoir Level in Llyn Cwmystradllyn Reservoir (1983 - 2015)

Percentage of time lake level equalled or exceeded	Mean daily reservoir level, metres, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum reservoir level	15.3	15.3	15.3	15.3	15.2	15.2	15.3	15.3	15.2	15.4	15.3	15.4	15.4
10% (high level)	15.1	15.1	15.1	15.0	15.0	15.0	15.0	15.0	15.1	15.1	15.1	15.1	15.1
50%	15.0	15.0	14.9	14.9	14.8	14.5	14.4	14.5	14.6	14.9	15.0	15.0	14.9
80%	14.9	14.8	14.8	14.5	14.4	14.0	13.7	13.1	13.3	13.8	14.9	14.9	14.3
90%	14.7	14.7	14.7	14.4	14.0	13.5	13.4	12.5	12.4	13.1	14.6	14.5	13.7
95%	14.5	14.5	14.6	14.2	13.9	13.3	13.3	12.3	11.9	12.6	13.6	14.3	13.2
99% (low level)	14.2	14.1	14.5	14.0	13.6	12.8	12.6	11.8	11.7	12.0	13.1	14.0	12.0
Minimum reservoir level	13.6	13.2	13.5	12.5	10.9	10.1	9.2	8.8	8.9	11.3	12.2	12.2	8.8

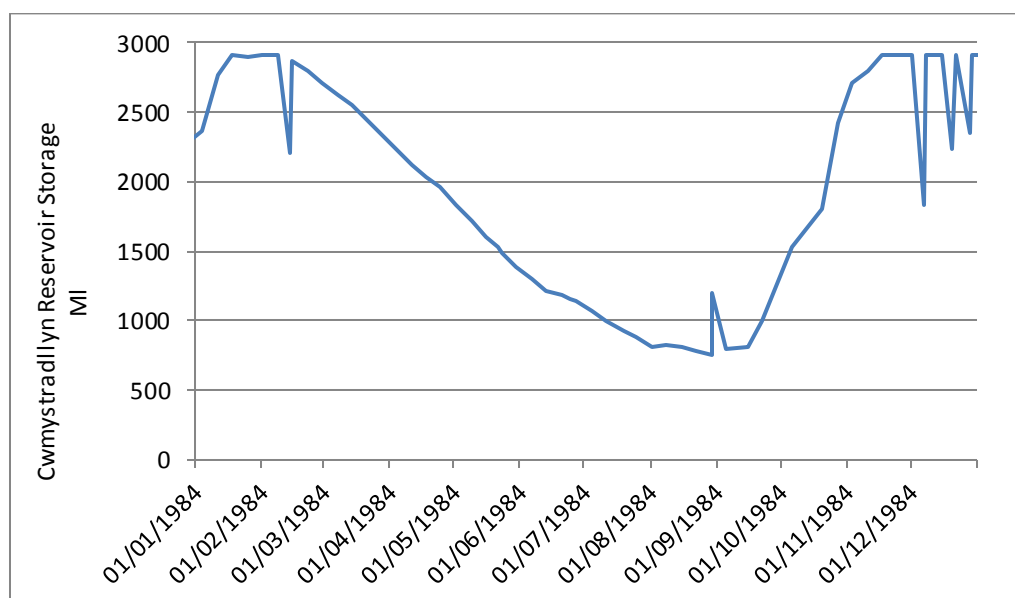
Figure B2.1 illustrates the drawdown pattern in Llyn Cwmystradllyn during the drought of 1984.

³ Amec (2012) Environmental Assessment of the Afon Dwyfor Drought Permit, Report Prepared for Welsh Water

⁴ Cascade Consulting (2013) Environmental Monitoring Studies for the Afon Dwyfor (N3) Drought Permit, Report Prepared for Welsh Water

⁵ Cascade Consulting (2007) Environmental Monitoring Plan for Afon Dwyfor (below the Cwmystradllyn Regulation Discharge) (N3), Report Prepared for Welsh Water

Figure B2.1 Llyn Cwmystradllyn Reservoir Storage 1984 (based on weekly manual readings)



Afon Henwy at Cwmystradllyn

The Afon Henwy is 6km long, with a catchment area of 47.9km² at its confluence with Afon Dwyfor. At the Llyn Cwmystradllyn reservoir spillway weir, the catchment area is 5.1km². The outflow from the reservoir is measured (including compensation releases, regulation releases and overflows) and a summary of the outflow data is given in **Table B2.2** below.

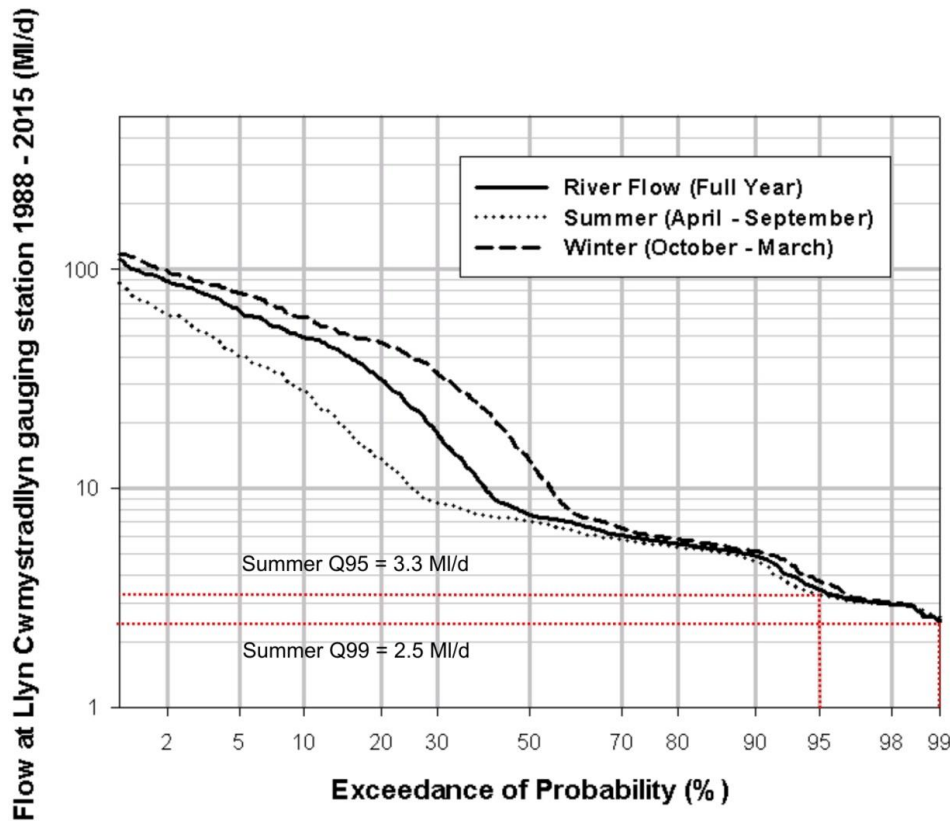
Table B2.2 Summary of Recorded Mean, Maximum and Minimum Daily Reservoir Outflow from Llyn Cwmystradllyn to the Afon Henwy (1988 - 2015)

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	129.3	119.7	1333.3	105.4	97.6	110.8	136.0	1293.9	450.3	450.3	134.3	134.3	1333.3
10% (high flow)	58.9	50.9	48.2	35.7	10.3	17.4	14.4	28.2	36.6	61.6	70.0	70.4	48.6
50%	24.3	10.7	7.3	6.8	5.9	7.0	7.3	8.1	7.3	8.1	17.0	23.0	7.6
80%	6.2	5.6	5.3	5.0	5.0	5.2	5.6	6.0	5.7	6.0	6.3	6.3	5.6
90%	5.5	4.1	3.9	3.5	3.3	4.2	5.3	5.5	5.0	5.3	5.9	5.2	4.9
95% (low flow)	4.5	3.1	3.1	3.0	3.1	3.3	5.0	4.9	3.5	4.9	5.2	3.6	3.5
99% (extreme low flow)	3.2	2.2	2.2	2.8	2.9	2.7	3.0	3.2	1.3	2.0	3.0	2.6	2.6
Minimum flow	0.9	0.7	0.7	1.5	1.5	1.7	1.9	1.3	0.2	0.0	1.6	1.7	0.0

The low flow statistics for the summer period (1st April to 30th September inclusive) are: Summer Q₉₅ = 3.3Ml/d; Summer Q₉₉ = 2.5Ml/d. The flow duration curve for the reservoir outflow to the Afon Henwy is shown in **Figure B2.3**. The extreme low flow (Q₉₉) statistic is lower than the statutory compensation release of 3.01Ml/d. However, since late 2007 flows

have always been around 3Ml/d or higher, so for the purposes of the drought permit assessment it is assumed that a minimum compensation release of 3.01Ml/d will be representative of future extreme low flows at the upstream end of Afon Henwy

Figure B2.3 Afon Henwy Mean Daily Flow at Llyn Cwmystradllyn (1988 – 2015)



Afon Dwyfor at Garndolbenmaen

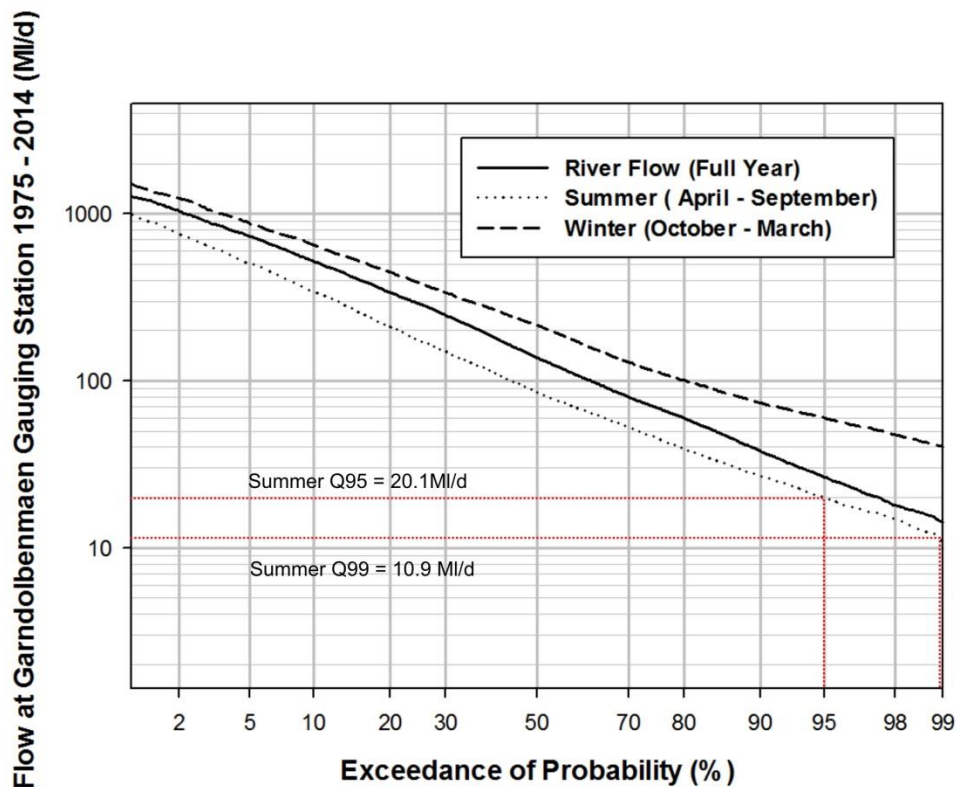
Natural Resources Wales continuously monitors river flow on the Afon Dwyfor at the Garndolbenmaen flow gauging station which is 6.8km downstream of Llyn Cwmystradllyn Reservoir, and just downstream of the Garndolbenmaen abstraction intake, at an altitude of 85.5m AOD. The available flow record extends from 1975 to 2014 and is summarised in **Table B2.3** below.

Table B2.3 Summary of Recorded Mean, Maximum and Minimum Daily Flow in the Afon Dwyfor at Garndolbenmaen Gauging Station (1975 - 2014)

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	2316	2238	3171	2894	1598	1780	3076	2454	1616	2972	2497	2436	3171
10% (high flow)	662	559	496	358	246	254	313	414	453	656	744	740	519
50%	243	181	154	112	76	65	65	98	119	204	272	254	137
80%	117	90	84	56	36	30	31	40	54	97	126	114	60
90%	84	69	66	39	26	21	23	22	38	68	92	82	38
95% (low flow)	67.7	57.1	54.4	31.9	19.4	16.8	17.9	16.1	30.7	53.2	65.1	69.2	26.5
99% (extreme low flow)	51.18	37.85	44.68	26.26	13.42	13.81	7.08	4.30	20.99	32.52	37.27	50.44	14.60
Minimum flow	38.79	17.54	32.49	21.95	10.97	11.40	3.37	2.07	4.15	22.90	30.24	34.39	2.07

The low flow statistics for the summer period (1st April to 30th September inclusive) are: Summer Q₉₅ = 20.1Ml/d; Summer Q₉₉ = 10.9Ml/d. The flow duration curve for the Afon Dwyfor at Garndolbenmaen is shown in **Figure B2.4**.

Figure B2.4 Afon Dwyfor Mean Daily Flow at Dolbenmaen (1975 – 2014)



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

Llyn Cwmystradllyn Reservoir has identified the likely hydrological zone of influence of the drought permit which has been used to define the study area. The study area includes the Afon Henwy and the Afon Dwyfor, comprising four distinct hydrological reaches, as shown on **Figure B1.1**:

- Reach 1 is the Afon Henwy, from the Llyn Cwmystradllyn outflow to the confluence with the Afon Ddu.
- Reach 2 is the Afon Henwy, from the confluence with the Afon Ddu to the confluence with the Afon Dwyfor.
- Reach 3 is the Afon Dwyfor from the confluence with the Afon Henwy to the Garndolbenmaen abstraction intake.
- Reach 4 is the Afon Dwyfor from the Garndolbenmaen abstraction intake to the tidal limit at the confluence with the Afon Dwyfach.

The potential hydrological impacts of the drought permit options have been assessed for Llyn Cwmystradllyn Reservoir and the four separately identified river reaches, as summarised in **Table B2.9** and **Table B2.10** at the end of this section.

The details of the assessment for each reach are presented below.

B.2.2.2 Hydrological Impact Assessment

Llyn Cwmystradllyn Reservoir

The impact of the drought permit on Llyn Cwmystradllyn Reservoir would be a marginal increase in water level / storage, relative to the position without the drought permit, due to the 1Ml/d reduction in direct abstraction from the reservoir which would help to conserve reservoir storage. The length of time of shoreline exposure would be slightly shorter compared to the baseline drought scenario, as the reservoir would be at low levels for slightly less time and reach top water level slightly earlier during the winter refill period. This is considered a **minor beneficial** impact of the drought permit and has not been assessed further.

River Reach Assessment

In order to categorise the significance of flow reductions in the four relevant river reaches, flow statistics at the upstream limit of each reach have been calculated, either from the available data record (Reaches 1 and 4) or by a comparison of spot flow gauging results from summer 2011 and spring / summer 2012, and using the catchment areas to scale flows using the corresponding daily flow values and catchment area of the Afon Dwyfor at the Garndolbenmaen flow gauge.

The locations of the spot flow gauging sites are shown in **Table B2.4**, whilst the spot flow gauging results, and corresponding percentages of gauged flow, are shown in **Table B2.5**

below. Catchment areas for key sites within the study area, together with the assessed contributing percentage of Afon Dwyfor flow at the Garndolbenmaen gauge, are shown in **Table B2.6**.

For Reach 2, it is assumed that the Afon Ddu and Afon Henwy catchment downstream of the reservoir, contribute a further 7.3% and 10.0% respectively of the Garndolbenmaen low flow statistics, to the minimum reservoir compensation flow of 3.01Ml/d in Reach 1 (see details under Reach 1 below). For Reach 3, the low flow statistics were estimated as 92.1% of the Garndolbenmaen values. These estimates were based on relative catchment areas, as the spot flow locations were not located exactly at the ends of the reaches and the gauging dates did not correspond to low or extreme low flow percentiles of the Garndolbenmaen flow record. However, comparison of the spot flow values with gauged flows at Garndolbenmaen indicates that the proportions of flow are of a similar magnitude for the relevant locations.

Table B2.4 Spot Flow Sampling Locations

Site	River	NGR
Site 3	Afon Henwy	SH5383642718
Site 4	Afon Ddu	SH5353542194
Site 6	Afon Henwy	SH5223342916
Site 7	Afon Dwyfor	SH5195543280
Site 12	Afon Dwyfor	SH4758238695

Table B2.5 Results of Spot Flow Gaugings on the Afon Henwy and Afon Dwyfor Compared to Gauged Flow at Garndolbenmaen (m³/s)

Spot flow gauging results (Ml/d)	Afon Henwy d/s of Afon Ddu confluence		Afon Dwyfor d/s of Afon Henwy confluence		Garndolbenmaen gauged flow for comparison	Approximate equivalent flow percentile of Garndolbenmaen gauged flow				
	Site 3	Site 4	Site 6	Site 7			Site 3 flow + Site 4 flow	% of gauged flow (Garn.)	Site 6 flow + Site 7 flow	% of gauged flow (Garn.)
1/9/2011	12.4	3.7	18.2	55.4	16.1	21.4	73.6	97.7	75.3	Q75
15/9/2011	16.0	13.9	46.8	92.1	29.9	21.6	138.9	100.5	138.2	Q50
29/9/2011	21.9	9.7	43.4	94.3	31.6	22.4	137.7	97.8	140.8	Q50
13/4/2012	15.4	4.8	31.6	46.6	20.2	23.5	78.2	90.8	86.1	Q65
26/7/2012	24.5	6.4	33.1	53.2	30.9	33.7	86.3	94.2	91.6	Q65

Source: AMEC 2012 (2011 values), Cascade 2013 (2012 values)

Table B2.6 Contributing River Catchment Areas in the Study Area and Area-Flow Proportion at Garndolbenmaen Flow Gauge for Estimation of Baseline Low Flows

Area / Location	Catchment Area	Area-flow proportion at Dolbenmaen Weir flow gauge*
Llyn Cwmystradllyn reservoir outlet	5.1 km ²	9.8% of gauged flow
Afon Henwy prior to the Afon Ddu confluence	10.3 km ²	19.8% of gauged flow
End of Reach 1	14.6 km ²	28.1% of gauged flow
Afon Ddu (to the end of Reach 1)	3.8 km ²	7.3% of gauged flow
End of Reach 2	47.9 km ²	92.1% of gauged flow
Afon Dwyfor (to the confluence with Afon Henwy)	30.0 km ²	57.7% of gauged flow
End of Reach 3	49.9 km ²	96.0% of gauged flow
Dolbenmaen Weir flow gauge	52.0 km ²	100.0% of gauged flow
End of Reach 4	63.7 km ²	122.5% of gauged flow

*Area-flow proportioning also includes allowances for the controlled releases from Llyn Cwmystradllyn, not listed here. Source: Cascade 2007

The resulting flow statistics for the summer period 1 April to 30 September inclusive and the percentage reduction in these flows due to the proposed drought permit are shown in **Table B2.7**. **Table B2.8** shows the year round flow statistics and corresponding percentage reductions.

Table B2.7 Summer Flow Statistics and Impact of Drought Permit by Reach

Reach	Baseline Flow Statistics MI/d		Increase of 1 MI/d in abstraction rate at Garndolbenmaen intake		
	Summer Q ₉₅	Summer Q ₉₉	Reduction in flow relative to baseline drought	% of summer Q ₉₅	% of summer Q ₉₉
1	3.3	3.01	0 MI/d	0.0%	0.0%
2	7.0	4.9	0 MI/d	0.0%	0.0%
3	18.5	10.0	0 MI/d	0.0%	0.0%
4	20.1	10.9	1 MI/d	5.0%	9.2%

Table B2.8 Year Round Flow Statistics and Impact of Drought Permit by Reach

Reach	Baseline Flow Statistics MI/d		Increase of 1 MI/d in abstraction rate at Garndolbenmaen intake		
	Year Round Q ₉₅	Year Round Q ₉₉	Reduction in flow relative to baseline drought	% of year round Q ₉₅	% of year round Q ₉₉
1	3.5	7.6	0 MI/d	0.0%	0.0%
2	8.1	31.4	0 MI/d	0.0%	0.0%
3	24.4	126.2	0 MI/d	0.0%	0.0%
4	26.5	137.4	1 MI/d	3.8%	0.7%

Reach 1 – Afon Henwy (Llyn Cwmystradllyn Outflow to Afon Ddu confluence)

The summer low flow and extreme low flow statistics for the Llyn Cwmystradllyn outflow long term data record (Q₉₅ and Q₉₉) are 3.3MI/d and 2.5MI/d respectively. As explained earlier, the measured extreme low flow statistic (Q₉₉) is lower than the statutory compensation release of 3.01MI/d. However, since late 2007 flows have always been around 3.01MI/d or higher, so for the purposes of this assessment it is assumed that a minimum compensation release of

3.01Ml/d will be representative of future extreme low flows at the upstream end of Afon Henwy. Reservoir outflows of up to 9.01Ml/d will occur regularly, when regulation releases of up to 6Ml/d are taking place, however the long term data record indicates that outflows do regularly drop to the compensation flow release rate of 3.01Ml/d and so the low flow statistics are considered representative of the low flow regime at the top of Reach 1.

During the implementation of this drought option, there will be no reduction in either the compensation release rate or the regulation release rate, relative to the “without drought permit” baseline. There is therefore **no** hydrological impact of this drought option on Reach 1 at any time of year.

Reach 2 – Afon Henwy (Afon Ddu confluence to Afon Dwyfor confluence)

As there is no change to the compensation and regulation release regime from Llyn Cwmystradllyn, there is no flow reduction anticipated in Reach 2. There is therefore **no** hydrological impact of this drought option on Reach 2 at any time of year.

Reach 3 – Afon Dwyfor (Afon Henwy confluence to Garndolbenmaen intake)

As there is no change to the compensation and regulation release regime from Llyn Cwmystradllyn, there is no flow reduction anticipated in Reach 3. There is therefore **no** hydrological impact of this drought option on Reach 3 at any time of year.

Reach 4 – Afon Dwyfor (Garndolbenmaen intake to tidal limit)

Although much of this river reach would be classified as lowland, the upstream boundary of the reach (being the Garndolbenmaen intake) is at 85.5m AOD and therefore the reach crosses the upland threshold at the upstream end. A precautionary approach has therefore been taken and the hydrological assessment matrix applicable to upland sites has been used to assess the impacts on this reach.

The low flow regime downstream of the Garndolbenmaen gauging station is protected by the seasonal hands-off flow conditions relating to Welsh Water’s abstraction from the Afon Dwyfor. However, the increase of 1Ml/d in the daily abstraction rate at the Garndolbenmaen intake would not be supported by a corresponding increase in the regulation release rate from Llyn Cwmystradllyn when flows at Dolbenmaen weir are below the seasonal flow constraint limits. The increased abstraction therefore represents a flow reduction of 1Ml/d in Reach 4 at times of low flow. This is equivalent to a reduction of 5% in the summer low flow (Q_{95}) and of 9.2% in the summer extreme low flow (Q_{99}), as shown in **Table B2.7**. The equivalent reductions in the year round low flow (Q_{95}) and median flow (Q_{50}) are 3.8% and 0.7% respectively, as shown in **Table B2.8**.

The hydrological impact of the drought permit on Reach 4 is therefore considered to be **negligible** at any time of year.

Cross-sectional surveys undertaken at the spot flow gauging sites in 2012 (**Table B2.4**)

indicated that changes in flow were associated with a change in wetted river channel depth but not any significant change in flow velocity. Overall, the reductions in channel width, depth and velocity are likely to be minor in magnitude. The duration of any notable change in channel dynamics would be less than the duration of the drought permit, since high flows would be contributed from the rest of the catchment even before the reservoir has refilled.

B.2.2.3 Hydrological Impact Summary

Four reaches have been considered for which the assessed hydrological impacts range from **none** to **negligible** at any time of year. The impacted reaches are shown in **Table B2.9** and **Table B2.10** and establish the full in-channel zone of influence of the drought permit for environmental sensitivity screening (see **Figure B1.1**).

Table B2.9 Hydrological and Monitoring Reaches identified in the Study Area – Summer Impact (September)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact - summer
		Upstream	Downstream		Summer Q ₉₅	Summer Q ₉₉	
Llyn Cwmystradllyn Reservoir		n/a	n/a	n/a	n/a	n/a	Minor Beneficial
1	Afon Henwy	Llyn Cwmystradllyn Reservoir Outflow	Afon Ddu confluence	3.6km	0.0%	0.0%	None
2	Afon Henwy	Afon Ddu confluence	Afon Dwyfor confluence	2.4km	0.0%	0.0%	None
3	Afon Dwyfor	Afon Henwy confluence	Garndolbenmaen intake	0.8km	0.0%	0.0%	None
4	Afon Dwyfor	Garndolbenmaen intake	Tidal limit located at the Afon Dwyfach confluence	8.6km	5.0%	9.2%	Negligible

Table B2.10 Hydrological and Monitoring Reaches identified in the Study Area – Winter Impact (October – January)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact - winter
		Upstream	Downstream		Year round Q ₅₀	Year round Q ₉₅	
Llyn Cwmystradllyn Reservoir		n/a	n/a	n/a	n/a	n/a	Minor Beneficial
1	Afon Henwy	Llyn Cwmystradllyn Reservoir Outflow	Afon Ddu confluence	3.6km	0.0%	0.0%	None
2	Afon Henwy	Afon Ddu confluence	Afon Dwyfor confluence	2.4km	0.0%	0.0%	None
3	Afon Dwyfor	Afon Henwy confluence	Garndolbenmaen intake	0.8km	0.0%	0.0%	None
4	Afon Dwyfor	Garndolbenmaen intake	Tidal limit located at the Afon Dwyfach confluence	8.6km	0.7%	3.8%	Negligible

B3 PHYSICAL ENVIRONMENT ASSESSMENT

Given that there is no adverse hydrological impact associated with the drought permit, effects on geomorphology and water quality are equally assessed as negligible. Similarly, there would be no flow pressures or water quality pressures that would pose an increased risk to any water-dependent environmental features within the vicinity of the Afon Henwy and Afon Dwyfor.

B4 PHYSICAL ENVIRONMENT IMPACT SUMMARY

Potential impacts on the physical environment associated with the Afon Dwyfor drought permit 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 Afon Dwyfor Drought Permit

Afon Henwy (Reach 1)	
Flows in the Afon Henwy <i>No impacts</i>	<ul style="list-style-type: none"> No hydrological changes anticipated
Afon Henwy (Reach 2)	
Flows in the River Henwy <i>No impacts</i>	<ul style="list-style-type: none"> No hydrological changes anticipated
Afon Dwyfor (Reach 3)	
Flows in the River Dwyfor <i>No impacts</i>	<ul style="list-style-type: none"> No hydrological changes anticipated
Afon Dwyfor (Reach 4)	
Flows in the River Dwyfor <i>Negligible impacts anticipated for up to five months during the period from September to January inclusive</i>	<ul style="list-style-type: none"> Impacts have been assessed as negligible

B5 CUMULATIVE IMPACTS

The focus of this EAR is the Afon Dwyfor increased river abstraction drought permit. The assessment, as described in previous sections, has considered how the proposed drought permit 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 Afon Dwyfor Drought Permit with other Drought Options

Organisation	Potential In-combination Impacts	Further Consideration Required (Yes/No)
Welsh Water - other drought options in the Lley n Harlech WRZ / Afon Henwy / Afon Dwyfor catchments	None	No
Natural Resources Wales - Drought options in the Afon Henwy / Afon Dwyfor catchment	No in-combination effects are anticipated at this time but this will be reviewed at the time of any drought permit application.	No