

Appendices

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Appendix A

Hydrology

A Hydrology

A.1 Aquator™ simulation of baseline and Drought Permit operation

Baseline and Drought Permit operation of Severn Trent's Strategic Grid was simulated in 2018 using Severn Trent's Drought Library Aquator™ Model (DLAM), an enhanced form of the standard Severn Trent Aquator™ model with a drought library that facilitates simulation of stochastic hydrological regimes. DP operation was suppressed for the entire record for the "No DP" scenario, and DP operation of appropriate licences was enabled for the entire record for the "DP" Ambergate scenario.

Severn Trent's standard Aquator™ model represented Severn Trent's water supply network in 2018 with water resource zones that can be activated, or not, as required. "Modelled Historic baseline" series were generated using modelled historical flow inputs, which were derived using the rainfall-runoff model HYSIM (WRA, 2022). HYSIM flows are calibrated against gauged or naturalised (or semi naturalised) flows; hence, they are intended to reproduce actual historical inflows. These inflows were input into Aquator™, which then generated reservoir outflows, storages and river flows, assuming then extant infrastructure and licence arrangements, and assuming demands relevant to that time.

The DLAM implementation of Severn Trent's Aquator™ model extended this analysis to include stochastic "worse than historic" rainfall series. The "Modelled Stochastic" rainfall series were used in developing Severn Trent's Drought Plan, with their derivation documented in Severn Trent Water Ltd.'s Drought Plan 2022-2027 (Severn Trent, 2021) and as part of Severn Trent's Water Resources Management Plan (Severn Trent, 2019), maintaining consistency with this EAR. "Modelled Stochastic" series were modelled from rainfall in the same way as for the Modelled Historic baseline series, but the underlying rainfall inputs were modified to enable consideration of worse than historic droughts. To derive the Modelled Stochastic series, 200 different sequences of daily rainfall and potential evapotranspiration (PET) data were produced by a stochastic weather generator, using observed rainfall and PET data from the period 1918 to 1990. Daily flow data for each 73-year sequence were then produced from the rainfall and PET data, using the HYSIM rainfall-runoff model. Droughts of 12-, 18-, 24- and 30- month durations were then drawn from each stochastic flow sequence. The sequences and droughts that most reduced the baseline deployable output (DO) of each of Severn Trent's Water Resource Zones were then determined using Severn Trent's Aquator™ model. Note that the daily flow data output from simulation with the stochastic weather generator are timestamped from the start of the sequence and therefore the stochastic droughts are referred to in a similar way to historic droughts (1960 stochastic drought etc.). However, for stochastic series, these dates do not reflect historic recorded conditions.

A.2 Method for deriving flows at assessment points

Aquator™ model components and nodes defining river flow accretion only represent flows at the model nodes. Assessment Points (AP's) are at a finer spatial resolution than are Aquator™ model nodes. Scaling has been undertaken to interpolate to APs not represented within Aquator™. The scaling approach adopted makes best use of available data from model components, from EA gauging data and measured spot flow data to achieve a realistic accretion whilst maintaining consistency with modelled flows at Aquator™ nodes.

A.2.1 Lower Derwent

For the Lower Derwent APs, all the natural flow accretion that would occur between Ambergate and St. Mary's Bridge in Derby is input within Aquator™ as a single lumped timeseries immediately downstream of Ambergate. This inflow has been apportioned to each downstream AP to provide a more realistic estimate of river flow at that point. Within this section of the river the following flow data are available:

- Concurrent spot flow gauging at each of the APs.
- Continuous flow data at EA gauging station St Mary's Bridge.
- Aquator™ simulated flows at Ambergate and St Mary's Bridge.

- FEH catchment area values for each point of interest.

It was not possible to calculate scaling factors based on flow measurements in this reach. There are no measurement points upstream of Belper, which is halfway down the reach. There is also a large abstraction between Belper and Allestree and the spot gauging results at Belper were often higher than those at Allestree or St Mary's Bridge due to this abstraction. Therefore, the increase in catchment area between Ambergate (AB27) and each AP was calculated. The ratio between this value and the increase in catchment size to St Mary's Bridge then gives the scaling factor. The effect of artificial influences was removed by subtraction of flows immediately downstream of Ambergate (AB27) from Derby St. Mary (GS36) and scaling to interpolate as above:

$$Q_{\text{Sim}}^{\text{AB27_GS36}} = Q_{\text{Sim}}^{\text{GS36}} - Q_{\text{Sim}}^{\text{AB27}}$$

$$Q_{\text{Sim}}^{\text{AP7}} = Q_{\text{Sim}}^{\text{AB27}} + F_{\text{AP7}} * Q_{\text{Sim}}^{\text{AB27_GS36}}$$

A.3 Results of deriving flows at assessment points

Implementation of the Ambergate DP is conditional upon both reservoir storage and flow at St Mary's Bridge. An Ambergate DP reduces the Hands Off Flow (HOF) on the Ambergate abstraction from 680 MI/d to 500 MI/d at Derby St Mary's Bridge (equivalent to Q60 and Q75 in the modelled stochastic time series). When flows are greater than 680 M/d or below 500MI/d, there would be no difference between the DP and baseline scenarios. Low flows in the River Derwent (any flows below Q81) are therefore not affected by the implementation of the Ambergate DP. The maximum reduction in flows permitted by the Ambergate DP is therefore 180 MI/d, a 28% reduction from the No DP scenario flows.

The effect on flows in the River Derwent is illustrated for the 1959/60 Modelled Stochastic series in Figure A.1. The effect on the 1959/60 Modelled Stochastic series is shown because this is the most sustained period of flow change due to the Ambergate DP in the modelled series; changes associated with other periods (including the 1945/46 drought) are limited to short duration spates.

The effect of DP operation is primarily to reduce those small spate flows that fall between 500 and 680 MI/d, with variability in flow similarly reduced (Figure). Average reductions in flows over the period are therefore substantially less than the theoretical maximum quoted above. Over the worst affected period (19/12/59 - 3/3/1960), mean daily flow reduction was only 50 MI/d, a 7% reduction from the No DP baseline scenario.

Flow accretion during a reduction of flow from 680MI/d to 500MI/d at Derby St Mary's Bridge is shown in Figure A.1. Note that a cessation of abstraction is required when the daily mean flow falls below 340 MI/d in the River Derwent at DSM. Note also that the flow controls can be managed by supporting river flows from additional Derwent Valley Reservoirs releases, subject to allowance for travel time and losses.

The modelled percentage flow change downstream of Ambergate differs little between APs. This is due to the modest accretion in these reaches (Table A.1). The effect on the lowest flows (below Q75) is positive due to conservation of reservoir storage (primarily Ogston), which makes more water available for release during lowest flows.

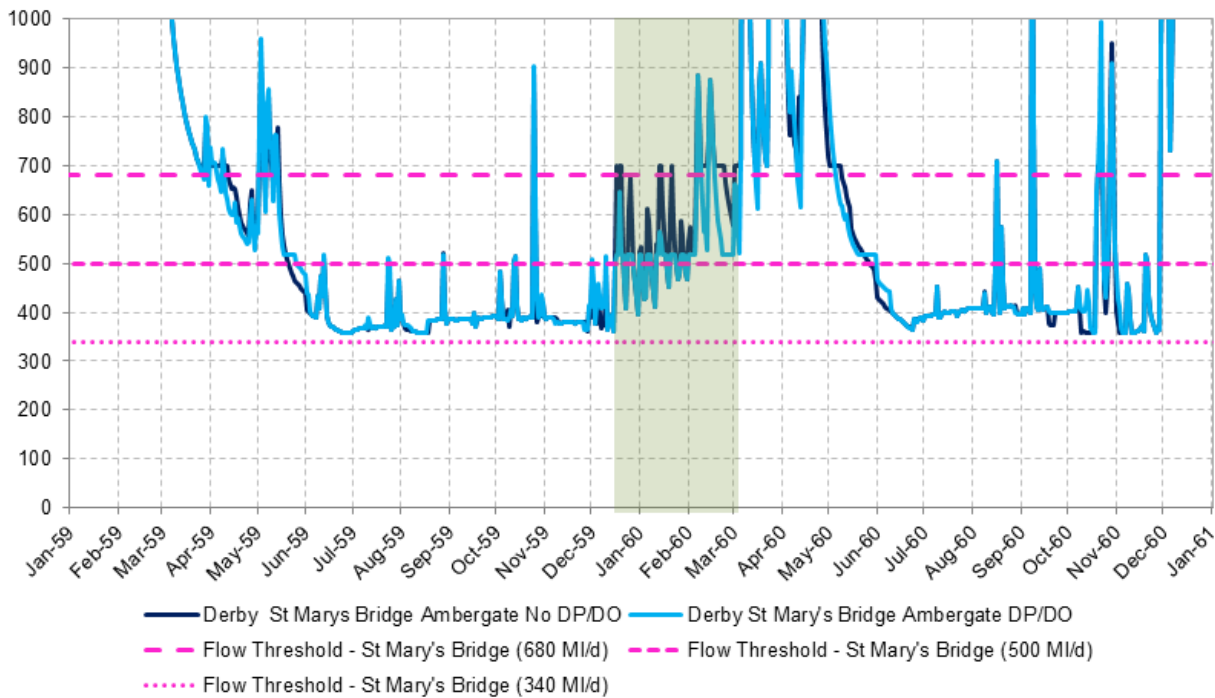


Figure A.1 Effect of Ambergate DP operation during the 1959/60 Modelled Stochastic drought. Y axis = discharge in MI/d. DP/DO operation period shaded grey

Table A.1 Estimated flows at Assessment Points; Baseline vs Ambergate DP/DO

Location	No DP/DO (MI/d)	No DP/DO (MI/d)	% Change from No DP
AP6 Belper	680	500	-26%
AP7 Allestree	687	517	-25%
AP8 Derby St Marys Bridge	688	518	-24%

Table notes: Accretion experienced on 25th January 1960, selected as representative of driest relevant period from modelled drought.

90-year gauged flow record from Derby St Mary’s (1935–2024) (Table A.2) provides a basis for evaluating the operational relevance of the drought permit associated with Ambergate abstraction. Across the full dataset, there were 388 days where flows were within the 500–680 MI/d range, equating to an average of 4.3 days per year, representing a small proportion of the total record.

Monthly averages show that November had the highest frequency of qualifying flows, with 2.3 days per year, corresponding to 8% of November days. March and December each averaged 0.7 days per year, or 2% of days, while January and February had the lowest usage, at 0.3 days per year, or just 1%. These figures confirm that under typical hydrological conditions, the drought permit would be used sparingly—generally for 1–8% of days per month. This is increased during drought years - in 1996, the driest year on record the permit would have been applicable for 43 days. This highlights the permit’s role as a contingency measure, providing critical abstraction flexibility when conventional thresholds are too restrictive. Even so, however, the DP would only be used on a minority of days.

Maximum monthly usage also varies, with March reaching up to 21 days, and November and January each seeing up to 14 days. These peaks demonstrate that while the average usage is low, the permit has the capacity to support abstraction during prolonged low-flow events, without breaching environmental safeguards. In summary, although the drought permit would be in use for a small percentage of time in most years, its presence ensures resilience during hydrological extremes. It is a low-frequency, high-importance mechanism that supports water supply security while maintaining ecological integrity.

Table A.2 Derby St Mary's Gauged flow data summary 1935-2024

Data from 1935 to 2024 DSM Gauge flows	Nov	Dec	Jan	Feb	Mar
Days between 500 and 680MI/d	209	59	27	31	62
Days Not Between 500 and 680MI/d	2491	2731	2763	2512	2728
Total Days	2700	2790	2790	2543	2790
Average Number Days that are between 500 and 680	2.3	0.7	0.3	0.3	0.7
Average Number Days that are not between 500 and 680	27.7	30.3	30.7	27.9	30.3
% Days that are between 500 and 680	8%	2%	1%	1%	2%
% Days that are not between 500 and 680	92%	98%	99%	99%	98%
Max days between 500 and 680	14	11	14	9	21

A.4 Certainty

The Drought Library Aquator Model (DLAM) platform was the most comprehensive environment for the development and simulation of conjunctive use of Severn Trent's sources along the River Derwent, within the wider context of Severn Trent's Strategic Grid. Even so, it is in the nature of modelling that uncertainty remains. Sources of such uncertainty include:

1. Estimation of historical and stochastically generated inflows.
2. The estimation of Severn Trent and third-party artificial influences, some of which are not well measured.
3. Aquator™ assumes operation to defined rules without human interpretation. As such, modelled operation is likely to differ from real operation during a drought, at least to some degree.
4. Severn Trent's supply network, and its representation in Aquator™ continues to evolve.

With respect to the first point, Aquator™ simulations use models to simulate runoff generation from rainfall and potential evapotranspiration inputs. These are consistent with those used for Severn Trent's Water Resource Management Plan (Severn Trent, 2019) and Draft Drought Plan 2022-2027 (Severn Trent, 2021), but neither the rainfall inputs themselves, nor the characterisation of runoff generation processes are free of error, and it is common for modelled flows not to characterise extreme low flows well. Accounting for climate change is likewise problematic. This may affect contextual information, such as the predicted likely frequency or timing of DP operation but is not considered to be a big effect on the assessment of environmental impacts.

With respect to the third point, the assessment of drought flows is based upon Aquator™ simulated operation of Severn Trent's water resource network to pre-defined rules and demands, as extant in 2018. Demands during drought events may differ from those estimated, and pre-defined rules may not be implemented as precisely in practice; for example, the crossing of a reservoir control curve remains an important trigger, but other factors, such as the water company undertaking demand management actions and the application process for a DP may affect the timing of DP operation. Severn Trent also use Drought Zones to gain more

flexibility about when demand management and other measures are applied for. Such variations from rules-based implementation if drought triggers is not simulated in Aquator™.

With respect to the fourth point, it should be acknowledged that the representation of inflows and of Severn Trent's supply system have been upgraded since this modelling was undertaken in 2018. Aquator™ output represented the best estimate of drought flows and system behaviour available at the time of drafting of Severn Trent's Water Resource Management Plan (Severn Trent, 2019) and Drought Plan (Severn Trent, 2021). The DPEAR is intended as a 'snapshot' of likely operation within a continually evolving water resources system. Within this context, the representation of Severn Trent's abstraction is considered to remain acceptable.

Analysis of gauged records for Derby St Mary's Bridge (DSM) provides a degree of reassurance of uncertainties. In the measured record there were 390 days between 1935 and 2017 when mean daily flow fell below 340 MI/d (a little over 1% of the days). Of these, most pre-date the operation of the water resource system in its current form, so cannot be expected to be comparable with Aquator™ simulations. Of the few instances which post-date the construction and fill of Carsington Reservoir in December 1993, mainly during notable drought periods (1994-1996, 2003, 2011), most are single daily measurements only just below the 340 MI/d threshold. These appear likely to be due to time delay before the Carsington release was activated or, potentially, because operators do not always release flows when rain is forecast. As such, these instances both highlight the disparities in real and modelled operation of the water resource system, but being so limited, also suggest a good representation in other respects.

A.5 References

Severn Trent (2019). Water Resources Management Plan 2019; available online at <https://www.severntrent.com/content/dam/stw-plc/our-plans/severn-trent-water-resource-management-plan.pdf> (accessed August 2022)

Severn Trent (2021). Revised Draft Drought Plan 2022-2027; available online at <https://www.severntrent.com/content/dam/stw-plc/water-resource-zones/revised-draft-drought-plan-2022-2027.pdf> (accessed August 2022)

WRA (2022). HYSIM; available online at <https://www.watres.com/software/HYSIM/> (accessed August 2022)

Appendix B

Physical character

B Physical character

B.1 Approach to this assessment

River Habitat Survey

RHS provides an assessment of morphological and physical habitat data based on observed forms in the channel and riparian zone, summarising these into indices of habitat quality (Habitat Quality Assessment, HQA) and channel modification (Habitat Modification Score, HMS). The HQA score provides a broad indication of habitat diversity in the channel and riparian zone and is derived from scores assigned to channel and riparian structure (including substratum, flow type, channel form and vegetation) and the presence of ecologically relevant features such as bars, woody debris and backwater habitat (Raven *et al.*, 1998). The HMS is derived from scores assigned for the presence and extent of alterations to planform (e.g., channel resectioning), artificial features (such as weirs, bridges or channel reinforcement) and of sources of disturbance (such as fords and poaching). Each type of modification can affect the river habitat in different ways, but the HMS provides an overall measure of the degree of modification to river channel morphology (Raven *et al.*, 1998). River structures and physical channel modifications (such as bank reinforcement or channel lining) are listed separately. These are an important control on hydraulic response and the connectivity of the channel.

Habitat walkover

Habitat walkover mapping (Hendry and Cragg-Hine, 1997) is complementary to RHS, describing the type and amount of habitat that is functionally important to different fish species in the river reach. It is less time consuming and can therefore be used to cover reaches of greater length, although in a proportionate assessment this can still only cover a small part of the total length of the Derwent. Habitat walkover records some habitat features in greater detail than RHS but excludes some other habitat features that are not functionally important to fish. Habitat features, including combinations of flow type, substrate suitability and the presence of prominent features (such as log jams, macrophyte beds, etc.) are also mapped to produce a mosaic of the different habitat types encountered under the flow conditions extant during the survey. The resulting maps provide a more intuitive visual representation of the river than RHS.

B.2 Data collection

River Habitat Survey and habitat walkover

RHS data were collected by Severn Trent at Allestree Ford (AP7) in 2012. RHS data were also available from the Environment Agency (EA) at 6 sites. Habitat walkover surveys were conducted by APEM along 1 km sections centred on APs in August 2010.

B.3 Baseline

B.3.1 River Habitat Survey

RHS data for 7 locations along the River Derwent are listed in Table B.1.

River Derwent from Amber to Bottle Brook (GB104028052310)

Data are available from only three RHS sites on the River Derwent from Amber to Bottle Brook. Site 6510 received an HQA score of 38 and was assigned to HMC 1 ('pristine'), Site 510 received an HQA score of 25 and was assigned to HMC 3 ('Obviously Modified'), and site 40816 received an HQA score of 54 and was assigned to HMC 4 ('Significantly Modified'). The HQA scores of the first two sites are below the average for the river as a whole, with the HMS of Site 510 being largely the result of a weir, with an additional contribution from bed/bank reinforcement.

River Derwent from Bottle Brook to Trent (GB104028053240)

HQA scores for the three sites on the River Derwent from Bottle Brook to Trent range from 27 to 39 with a mean of 33, suggesting that the diversity of physical habitat on this water body is below average for the river as a whole. The extent of habitat modification was found to be variable, with site 6544 being assigned to HMC 2 ('Predominantly Unmodified') and site Severn Trent_2 being assigned to HMC 4 ('Significantly Modified').

Site Severn Trent_2 includes the monitoring location at Allestree Ford (AP7) and is the most modified. The computed HMS of this site is largely due to the bridge at the monitoring location, bed/ bank reinforcement and weirs.

B.3.2 Walkover

The percentage composition of habitats within each survey reach has been calculated to inform the abundance of individual surface flow types and habitat areas during the baseline conditions. From this, information can be inferred regarding the extent of habitat within each survey reach and waterbody that may be considered most vulnerable to low flow induced impacts during DP/DO conditions (e.g., spawning and juvenile habitat in areas of riffle and shallow run flow). Walkover survey data are summarised in Table B.1 with a more comprehensive presentation of the survey data previously provided in ESI & APEM (2012). Cross-sections were located within habitat broadly representative of each reach. Cross-sections were located within each reach. Cross section data are explained further in Appendix C.

The flow types mapped at the different locations support the RHS data in suggesting only modest diversity of in-channel habitat in the River Derwent. Glide is the predominant flow type at all locations, covering between 66.8% and 100% of the surface area of surveyed reaches. Run flow type was recorded at two of the three sites, covering up to 24% of the surface area at Cromford (near AP4) and Allestree (AP7). Riffles were recorded at two of the three sites but covered no more than 1.5% of the surface area. Parr habitat made little to no contributions to total habitat area at APs.

The general reduction in habitat diversity with distance downstream suggested by RHS data is also evident in the general increase in cover of glide from AP6 to AP8 (Table B.1). Conversely, the reach centred on St Mary's Bridge, Derby (AP8) was the least diverse, with only glide recorded here.

Table B.1 HQA scores and underlying data for RHS sites on the River Derwent

Water body	Survey ID	NGR	HQA score	Channel				Banks and riparian zone				
				Channel Features	Channel Substrates	Flow Types	In Stream Channel Vegetation	Bank Features	Bank Vegetation	Trees Associated Features	Land Use	Special Features
Derwent from Amber to Bottle Brk	6510	SK3449	38	3	1	5	5	0	11	7	5	1
	510	SK3445	25	0	1	4	5	0	6	8	1	0
	40816	SK3539	54	4	5	7	6	13	7	10	2	0
Derwent from Bottle Brook to Trent	6544	SK3539	32	1	1	4	4	3	11	6	2	0
	Severn Trent_2	SK3540	43	8	6	10	4	6	5	2	2	0
	544	SK3635	27	2	7	4	1	1	6	6	0	0
	41613	SK3854	39	0	1	8	2	3	12	8	3	2

Table B.2 HMS scores and underlying data for RHS sites on the River Derwent

Water body	Survey ID	NGR	HMS Score	HMS Class	Fords	Poaching	Culverts	Outfall Deflector	Bridges	Reinforced Bed Bank	Re-sectioned Bank Bed	Berms Embank-ments	Weirs
	510	SK3445	360	3	0	0	0	0	0	60	0	0	300
	40816	SK3539	935	4	0	40	0	0	0	260	560	0	75
Derwent from Bottle Brook to Trent	6544	SK3539	20	2	0	20	0	0	0	0	0	0	0
	Severn Trent_2	SK3540	605	4	0	0	0	0	250	100	0	0	255
	544	SK3635	200	3	0	0	0	50	0	150	0	0	0
	41613	SK3854	2582	5	0	0	0	50	0	40	2320	172	0

Table B.3 Walkover flow statistics at all locations. Dominant flow type highlighted in bold.

	% composition		
	AP6	AP7	AP8
Salmonid spawning	0.0	0.8	0.0
Fry	0.0	3.0	0.0
Parr	0.6	0.0	0.0
Mixed juvenile	0.0	0.0	0.0
Riffle	1.5	1.4	0.0
Glide	74.5	66.8	100.0
Run	11.1	24.0	0.0
Pool	6.8	0.2	0.0
Cascade	0.0	0.0	0.0
Chute	0.0	0.0	0.0
Torrent	0.0	0.0	0.0
Eddy	0.0	0.5	0.0
Exposed substrate	0.0	3.0	0.0
Vegetated island	0.3	0.4	0.0
Obstruction	3.0	0.0	0.0
Weir	2.2	0.0	0.0

B.3.3 Structures

The River Derwent has a large number of mills and associated weirs. There are also numerous less intrusive structures, such as bridges and localised channel reinforcements. Table B.4 lists the main in-river structures.

Table B.4 In-stream structures, listed by waterbody and from upstream to downstream.

Derwent from Amber to Bottle Brook Water Body (GB104028052310)	Derwent from Bottle Brook to Trent Water Body (GB104028053240)
Belper, SK 3488	Darley Abbey, SK 3538
Milford (Glow-worm), SK 3445	Longbridge Weir, Derby, SK 3536
Milford (Rec Ground), SK 3544	Incinerator plant, SK 3834
Peckwash Mill, Duffield, SK 3542	Power station sluices, SK 3934
	Derby power station, SK 4032
	Borrowash, SK 4134
	Borrowash, SK 4134
	Wilne gauging weir, SK 4431
	Church Wilne, SK 4431

B.4 Summary

RHS and walkover data are consistent, indicating only moderate physical habitat diversity, decreasing with distance downstream and limited variability of flow types, with glide being the dominant flow type. This dominance is also shown to increase with distance downstream, and particularly in the lower reaches a predominance of glide might be expected.

RHS data also indicate that physical habitat modification, whilst not extreme, is common on the River Derwent downstream of Ladybower Reservoir and the presence of numerous in-stream structures throughout the water bodies of interest exacerbates the predominance of glide habitat. Within the River Derwent from Bottle Brook to Trent, point modifications (weirs, fords, culverts, outfalls/ deflectors and bridges), rather than linear features (re-sectioning, embankments, reinforcements), tend to be the main type of alteration.

Where RHS sites coincide with APs, computed indices of habitat quality and physical modification are broadly in line with average values for all sites in the area of interest.

B.5 Certainty

Hydromorphological surveys have sought to characterise baseline habitat over long river reaches using data centered upon three APs. The walkover sections surveyed were discrete lengths of 1 km, and are therefore a limited sample, rather than a comprehensive description, of the entire channel.

The APs themselves are centred on preceding EA survey locations, which strike a compromise between representativeness and logistical considerations, with several located close to access points. Whilst aerial

photography has been used to assess representativeness, this is likely to introduce some bias towards localised modifications in the reaches surveyed. It should be noted, however, that these surveys are primarily used to provide an understanding of baseline conditions and to support interpretation of other (e.g. hydraulic, macroinvertebrate and fish survey) data, the quantitative aspects of the impact assessment being based upon hydraulic calculations/ modelling. As such, and acknowledging the limitations inherent in representing long river reaches within a proportionate study, the data are considered suitable for this purpose.

B.6 References

ESI & APEM (2012). Drought Permit environmental assessment report: River Derwent at Ambergate and Derwent Valley Reservoirs. Report reference 60083j R1, April 2012.

Hendry, K. and Cragg-Hine, D. (1997). *Restoration of riverine salmon habitat. Fisheries Technical Manual 4.* Environment Agency, Bristol.

Raven, P.J., Holmes, N.T.H., Dawson, F.H., Fox, P.J.A, Everard, M., Fozzard, I.R. and Rouen, K.J., (1998). *River Habitat Quality: The Physical Character of Rivers and Streams in the UK and the Isle of Man.* Environment Agency, Bristol.

Appendix C

Hydraulics

CHydraulics

C.1 Transects

C.1.1 Data collection

Spot gauging at transects was undertaken between June 2011 and 2014 using an Acoustic Doppler Current Profiler (ADCP). These data have been augmented by channel surveys above gaugeable depths. A record of gaugings undertaken has been previously provided in annual data reports (ESI, 2012, 2013 & 2014). A further low flow gauging was also taken at each AP in August 2018, providing additional discharge data, but these were not used to update the hydraulic assessment due to difficulties in locating the precise gauging transect used in previous assessments.

Photographs and walkover outputs for the locations of the gauged transects in the Lower Derwent (AP6-8) are presented in Figure C.1 and Figure C.2.

The River Derwent is affected by weirs and bridges at intervals along its length, which can cause extensive backwater effects. This is reflected in some of the transect locations, which were also selected to be co-located with established macroinvertebrate and fishery sampling/ survey locations or important controls on the operation of the water supply system:

- The transect at AP6 is a short distance downstream of a weir. There is a tributary inflow on the left-hand bank but is again considered unlikely to be subject to weir induced backwater effects.
- The transect at AP7 is over 2 km upstream of the nearest weir and not obviously affected by backwater effects or localised disturbance from nearby bridges, although aerial photography does suggest a local depositional feature at or close to the transect.
- AP8, in Derby is c.0.5 km upstream of the nearest weir and is potentially subject to backwater effects.

Estimates of hydraulic behaviour at the transects assumes free surface flow and does not account for backwater effects. Generally, as demonstrated by modelling in the River Derwent from Westend to Wye (GB104028057880) for the Derwent Valley Reservoirs DP, backwater effects of weir impoundment tend to reduce flow velocity under the baseline and drought permit operation, and subdue any reductions in depth due to abstraction-induced flow reductions that might otherwise occur under free-surface flow. As such, the predicted hydraulic response to the Ambergate DP may be overestimated at AP8, Derby St Mary's Bridge.

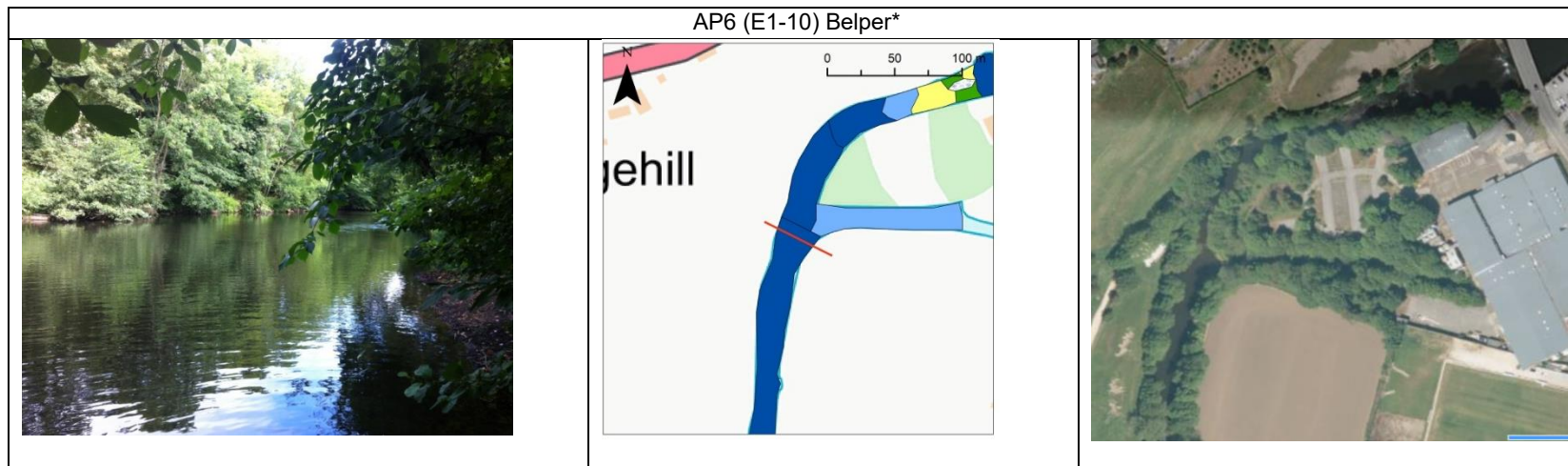


Figure C.1 Location of AP6, Derwent from Amber to Bottle Brook Water Body G(B104028052310*) *Contains Ordnance Survey data © Crown copyright and database right [2018]. Aerial imagery, Bing maps*

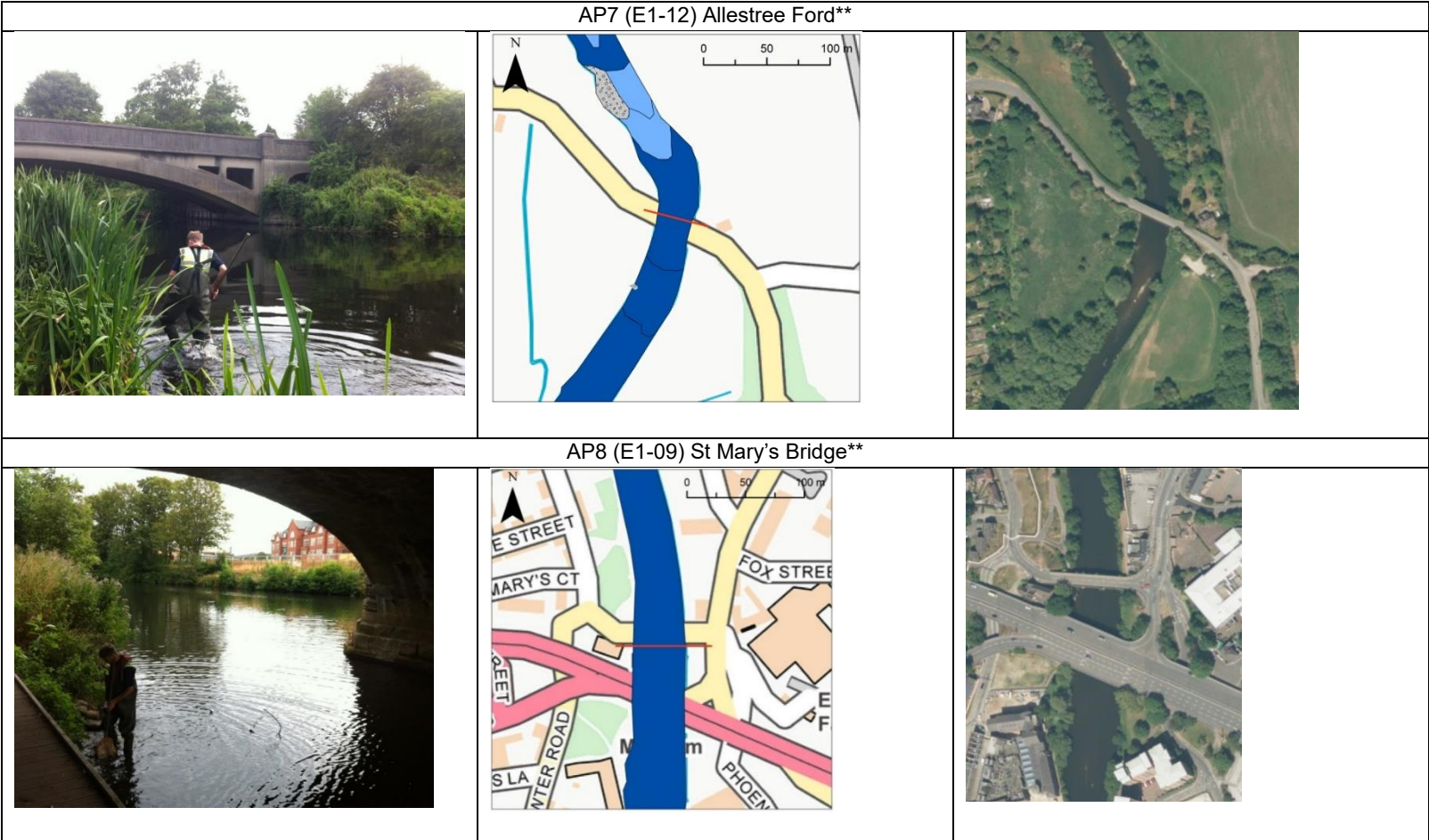


Figure C.2 Location of AP7 and AP8 Derwent from Bottle Brook to Trent Water Body GB104028053240**)

Contains Ordnance Survey data © Crown copyright and database right [2018]. Aerial imagery, Bing maps

C.1.2 Baseline

Cross-section profiles (transects) for the Assessment Points (APs) downstream of the Ambergate abstraction are presented in Figure C.3 along with stage under both baseline and DP conditions. Cross sections upstream of Ambergate are not presented, because Aquator™ modelling has demonstrated that these APs would not be subject to flow reductions from baseline operation during an Ambergate DP.

Cross-sections are not complex. There are some irregularities which may result in large changes to physical habitat parameters (e.g., wetted width) at very low depths, but these are only predicted to occur at depths well below those estimated for the baseline and DP scenarios.

Under baseline conditions, estimated flow is deep (0.4 – 0.7 m) or very deep (>0.7 m) at all transect locations, and flow depth exceeds 1 m at AP6 to AP8 under baseline conditions. In general, depth increases with distance downstream. Flow velocity is variable between APs under baseline conditions and ranges from 0.06 m/s (sluggish) at AP8 to 0.60 m/s (very fast) at AP4. There is no consistent trend in estimated mean transect velocity with distance downstream.

Flow intensity, quantified using the Froude number (Fr), is low at all APs under baseline conditions, a consequence of generally high depths and slow or only moderately fast flows. Fr of this magnitude is generally associated with glide/ run flow types. Lower modelled Fr at all other APs is indicative of pool/ glide habitat as also indicated by RHS and walkover data.

C.1.3 Impact assessment (Ambergate DP)

River Derwent from Amber to Bottle Brook (GB104028052310)

Reduction in flows under the Ambergate DP/DO scenario translate into only modest changes in hydraulic parameters; the moderate change in flow is essentially shared between smaller changes in wetted area and velocity. Moreover, because the channel is wide, a loss in wetted area is achieved with only a small change in depth, and because the channel is deep, this results in only a small loss of wetted perimeter at the banksides (none of the riverbed is likely to be exposed). Change in physical habitat is therefore expected to be minimal, and, because of the predicted duration of abstraction, any changes to hydraulic conditions will not be sustained over long periods. The largest modelled change is a 10% reduction in shear stress from c.11 to 9.25 N/m². A change of this magnitude is unlikely to have any significant impact on geomorphic processes (i.e., sediment erosion, transport and deposition) which will be primarily driven by spate flows.

River Derwent from Bottle Brook to Trent (GB104028053240)

As at Belper, reductions in flow under the Ambergate DP/DO scenario translate into only modest percentage reductions in depth and velocity, with absolute changes being small (0.03 m/s). Moderate percentage changes in Froude number are indicated, but the absolute magnitude of reduction is low at both APs (<0.013) and as such, only minor changes in flow characteristics are expected on this water body. It should be acknowledged that rating extrapolation at both AP7 and, particularly at AP8 may indicate very small changes in depth and velocity in part due to backwater effects. However, this is also true of many locations in the reach and, even were changes more akin to those at Belper (AP6, where backwater effects are less likely), only very modest hydraulic changes would be introduced by the Ambergate DP. Because of the predicted duration of abstraction, any changes to hydraulic conditions will also not be sustained over long periods.

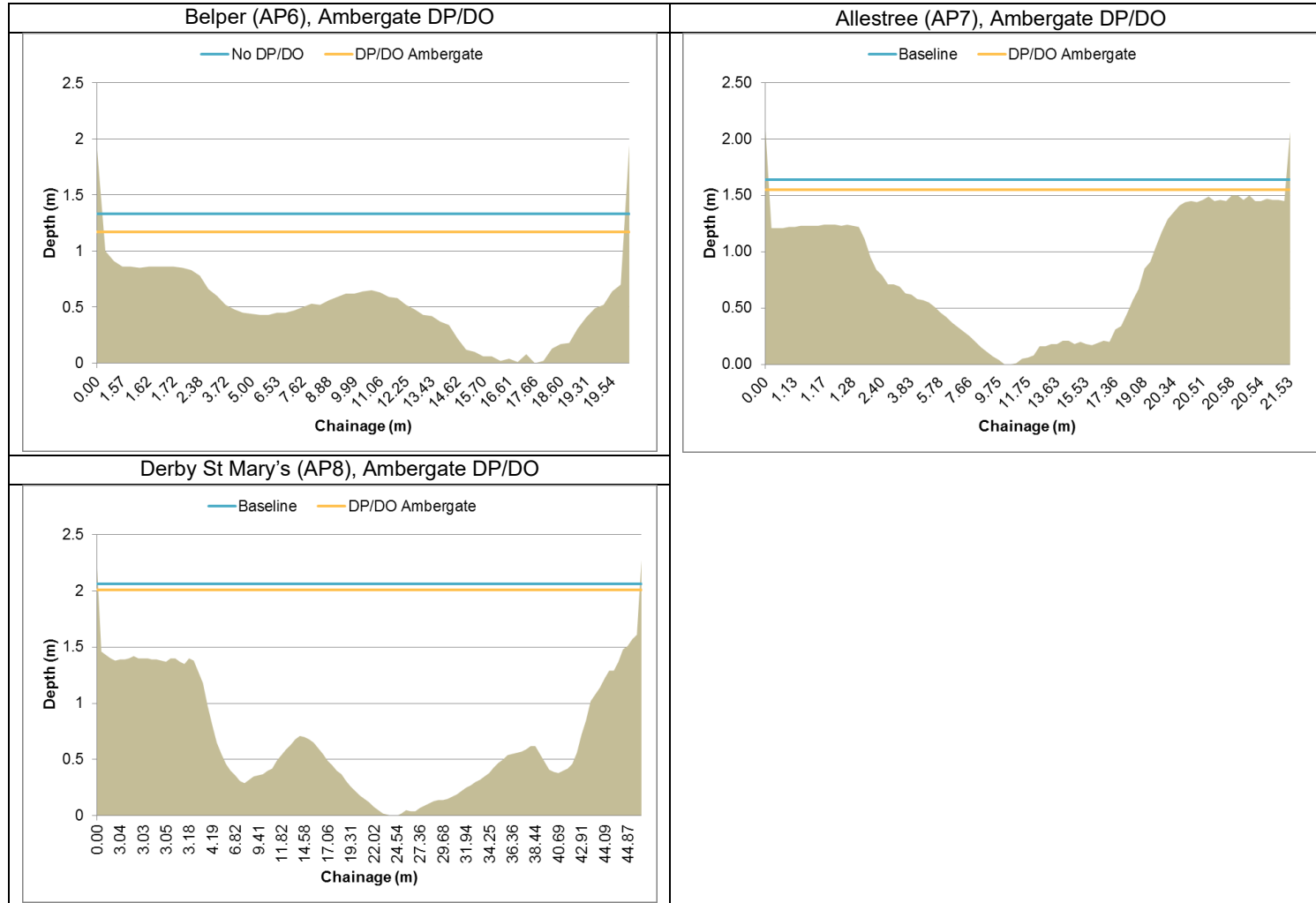


Figure C.3 River stage of DP/DO implementation at Ambergate AP6-8

C.2 References

ESI (2012). Drought Monitoring 2010 and 2011: River Derwent. Report produced by ESI APEM and HydroLogic on behalf of Severn Trent. 60083U AR2.

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C.3 Data tables

C.3.1 Transect modelling results

Table C.1 Ambergate DP; predicted hydraulic change at AP6 (Belper)

Orange = medium reduction; yellow = small reduction, light yellow = negligible reduction

	Ambergate DP	
	No DP/DO	DP/DO Ambergate
Discharge (Ml/d)	672	482
Depth (m)	1.33	1.17
Wetted Width (m)	19.48	19.06
Wetted Perimeter (m)	20.18	19.66
Velocity (m/s)	0.46	0.41
Froude Number (Fr)	0.13	0.12
Shear Stress (N/m ²)	11.03	9.25

Table C.2 Ambergate DP; predicted hydraulic change at AP7 (Allestree)

Orange = medium reduction; yellow = small reduction, light yellow = negligible reduction

	Ambergate DP	
	No DP/DO	DP/DO Ambergate
Discharge (Ml/d)	679	499
Depth (m)	1.64	1.55
Wetted Width (m)	20.33	20.08
Wetted Perimeter (m)	21.39	21.08
Velocity (m/s)	0.32	0.26
Froude Number (Fr)	0.08	0.07
Shear Stress (N/m ²)	11.10	10.41

Table C.3 Ambergate DP; predicted hydraulic change at AP8 (Derby St Mary's Bridge)

Orange = medium reduction; yellow = small reduction, light yellow = negligible reduction

	Ambergate DP	
	No DP/DO (Ml/d)	DP/DO Ambergate
Discharge (Ml/d)	680	500
Depth (m)	2.06	2.01
Wetted Width (m)	46.31	45.90
Wetted Perimeter (m)	47.27	46.85
Velocity (m/s)	0.11	0.08
Froude Number (Fr)	0.02	0.02
Shear Stress (N/m ²)	1.46	1.42

Table C.4 Percentage change in hydraulic parameters at APs under the Ambergate DP/DO relative to baseline conditions.

Orange = medium reduction; yellow = small reduction, light yellow = negligible reduction, pale green = negligible increase

Assessment Point	%Change Relative to Baseline (No DP/DO)						
	Flow (MI/d)	Depth (m)	Wetted Perimeter (m)	Velocity (m/s)	Froude number	Wetted width (m)	Shearstress (N/m ²)
AP6	-26	-12	-3	-11	-5	-2	-16
AP7	-25	-5	-1	-18	-16	-1	-6
AP8	-25	-2	-1	-22	-21	-1	-2

D Water quality

D.1 Background

This section assesses the significance of impacts on water quality within the study area as a result of the proposed drought permit. The aim of the water quality impact assessment was to calculate and compare concentrations of a number of parameters at the current (baseline) and proposed drought permit flows. Having established the baseline, potential changes in water quality resulting from implementation of the proposed drought permit have been assessed using model data, mass balance calculations and expert judgement.

There are a number of significant stressors affecting water quality in the River Derwent, including diffuse source pollution from farms, roads and urban areas, sewage discharges and abandoned mines, (EA Catchment Data Explorer)¹.

D.2 Potential routes of impact

Where there are waste water treatment works (WwTWs) discharging directly into the affected river reaches the proposed drought permit could impact water quality by reducing the dilution of these discharges, as well as small sewage discharges such as those from septic tanks and private sewage treatment plants. This could result in an increase in biochemical oxygen demand (BOD), suspended solids, ammonia and orthophosphate concentrations. Lower flows could also reduce the dilution of intermittent discharges from combined sewer overflows (CSOs) if heavy rainfall events were to occur during implementation of a drought permit.

The impact from any pollution incidents could be more severe due to the reduced volume of the river available for dilution. The impact of this would depend on the nature and severity of the pollution incident.

Conversely, given the likelihood of reduced rainfall associated with a drought, there could be concurrent reductions in diffuse pollution inputs which are driven by rainfall. This could result in a reduction in nutrient and suspended solids concentrations.

Water temperature could increase during the proposed drought permit, leading to increases in ammonia in the form of un-ionised ammonia (UIA) which is toxic to fish and other aquatic life.

D.2.1 Sources of information

Assessment water bodies

Two WFD water bodies were of interest for this assessment:

- Derwent from Amber to Bottle Brook (GB104028052310).
- Derwent from Bottle Brook to Trent (GB104028053240).

Physico-chemical data review

Physico-chemical data used to describe the historical water quality baseline of the water bodies affected by the proposed drought permit were downloaded from the EA's water quality data archive² and collated

¹ <https://environment.data.gov.uk/catchment-planning/>

² <https://environment.data.gov.uk/water-quality/view/landing>

from Severn Trent's abstraction licence and drought monitoring programmes, which have been delivered by APEM (2015-2021) and Ricardo (2022-2023).

Sampling locations of interest to this assessment are listed in Table D.1

Table D.1 Water quality monitoring location details

WFD waterbody (ID)	Site ID	Site name	Data source
Derwent from Amber to Bottle Brook (GB104028052310)	MD-49701620	River Derwent At Belper Mill	EA
	E1-10	Belper Mill	APEM/Severn Trent
	MD-49700000	River Derwent At Milford	EA
Derwent from Bottle Brook to Trent (GB104028053240)	MD-49698650	River Derwent At Allestree Ford	EA
	E1-12	Allestree Ford	APEM/Severn Trent
	MD-49697380	River Derwent St Marys Bridge Derby	EA
	MD-49695250	River Derwent At Raynesway	EA
	E1-14	Raynesway	APEM/Severn Trent
	MD-49694100	River Derwent Coutaulds Brdg Old Intake	EA
	MD-49692300	River Derwent Anglers Car Park D Cut	EA
	MD-49692250	River Derwent At Borrowash	EA
	MD-49691360	River Derwent At Draycott Ferry	EA
	MD-49690300	River Derwent At Wilne	EA

The physico-chemical parameters of interest for this assessment were: water temperature, dissolved oxygen (DO), pH, BOD, suspended solids, nitrate, ammonia (as nitrogen (N)), UIA and orthophosphate concentration. Data on bioavailable copper and zinc are also included where available.

Where available, up to 11 years' of data (2014-2025) were presented and reviewed for historical trends.

The physico-chemical data were compared against the relevant WFD environmental quality standards (EQS) for each parameter. No standards for nitrate are proposed in the WFD therefore, nitrate data were compared to the Nitrate Vulnerable Zone (NVZ) standard for indicative purposes only. There are also no WFD standards for suspended solids or UIA, and so data were compared to the EC Freshwater Fish Directive (FFD) (78/659/EEC) guidelines (although this Directive has been repealed, the WFD requires equivalent levels of protection to the FFD).

D.3 Baseline

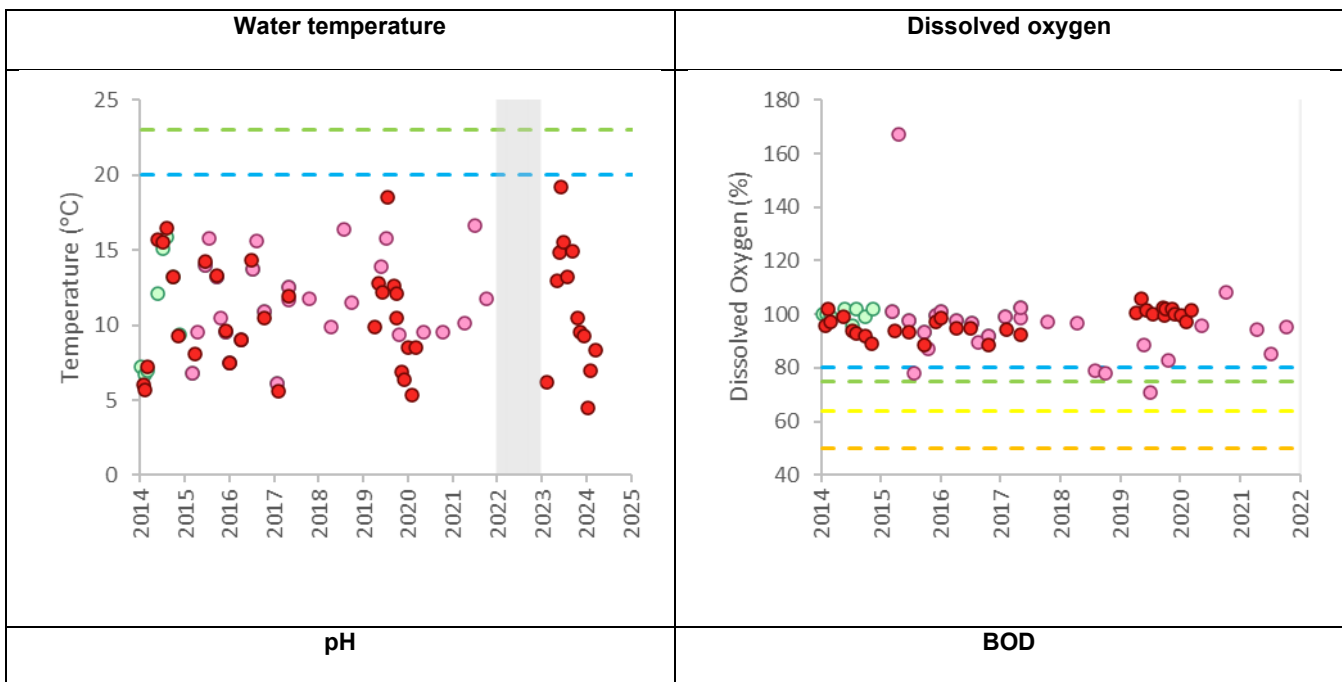
According to the latest WFD classifications available on the EA's Catchment Data Explorer, the 'Derwent from Amber to Bottle Brook' and 'Derwent from Bottle Brook to Trent' water bodies are at Moderate status. The 'Derwent from Amber to Bottle Brook' and 'Derwent from Bottle Brook to Trent' water bodies achieved Moderate status for physico-chemical quality elements, due to Moderate status for phosphate; all other elements were at High status. All water bodies failed to achieve Good Chemical status (2019

classification) due to elevated concentrations of some or all of the following: PBDE, PFOS, and cadmium and its compounds.

Physico-chemical data

Physico-chemical data for the years 2014 to 2025 are presented in **Error! Reference source not found.** to Figure D.9. The data were reviewed to highlight chronic and intermittent water quality issues.

In the Derwent from Amber to Bottle Brook water body there were no apparent issues with water temperature, pH, BOD, nitrate, ammonia, or bioavailable copper with all results indicative of High status or below their indicative guideline limits. DO was indicative of High status at all sites except for E1-10 where there were one off readings indicative Good or Moderate status. The FFD standard for suspended solids was exceeded on one occasion at the River Derwent at Belper Mill (January 2014) and E1-10 (October 2017) sites and on two occasions at the River Derwent at Milford site (September 2019 and March 2020). At sites E1-10 and the River Derwent at Milford there were one off UIA readings which exceeded the FFD guideline standard, but were below the mandatory standard, in October 2019 and June 2019 respectively. Orthophosphate concentrations ranged from Good to Poor status. Most results for bioavailable zinc exceeded the standard at the River Derwent at Milford site (the only site where this was measured).



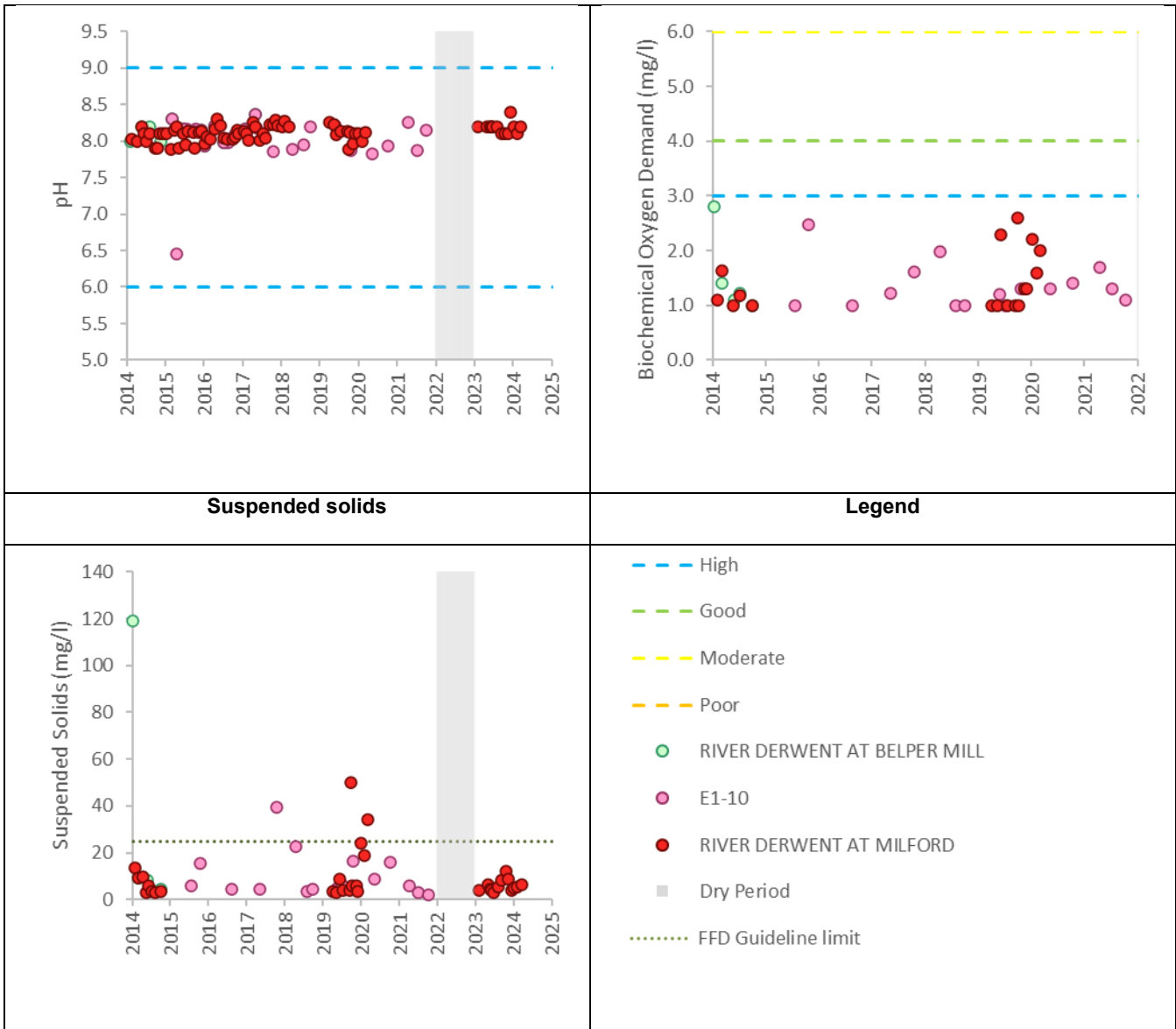


Figure D.1: Physico-chemical parameters recorded at sampling locations within the Derwent from Amber to Bottle Brook water body (GB104028052310)

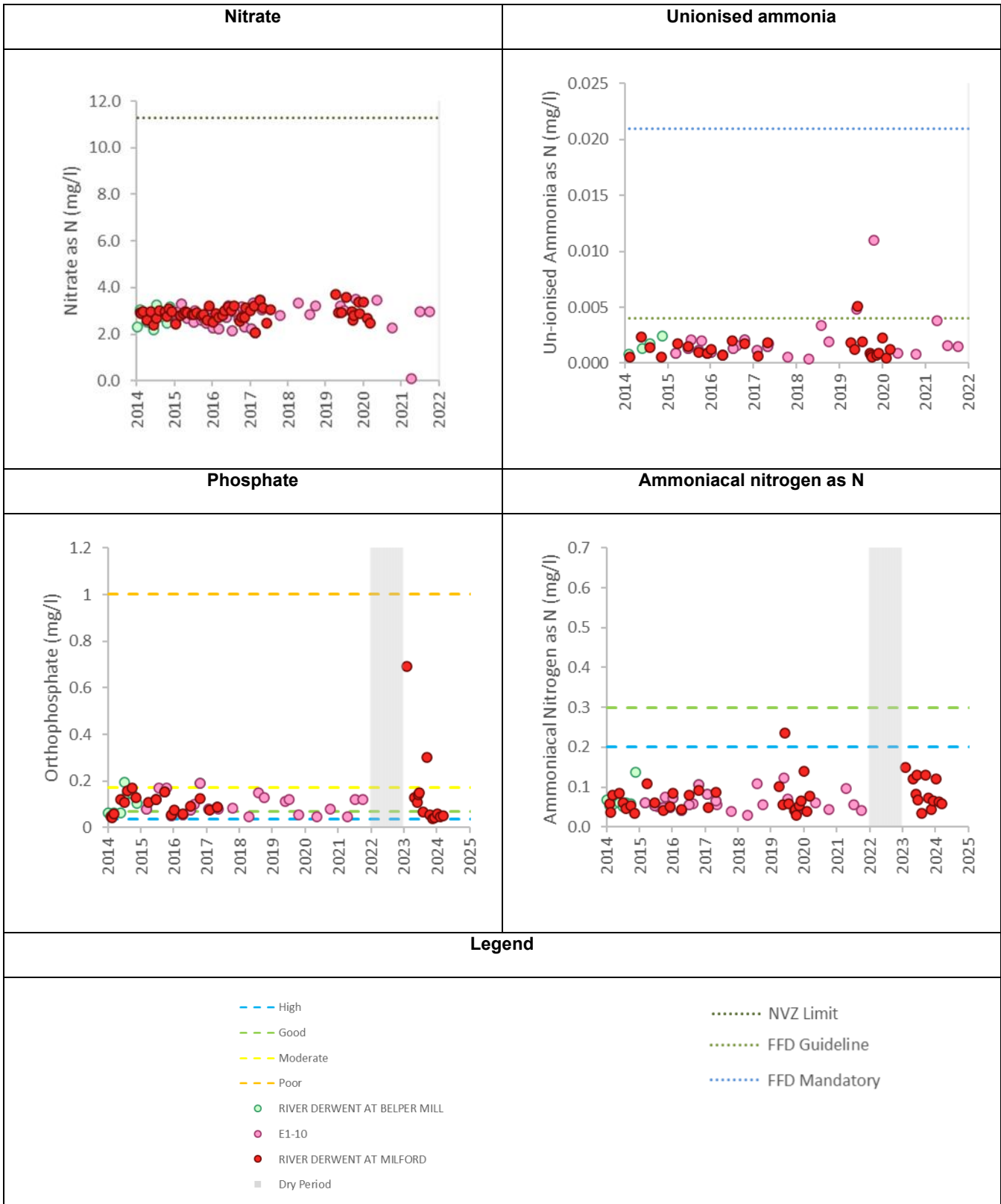


Figure D.2: Nutrient parameters recorded at sampling locations within the Derwent from Amber to Bottle Brook water body (GB104028052310)

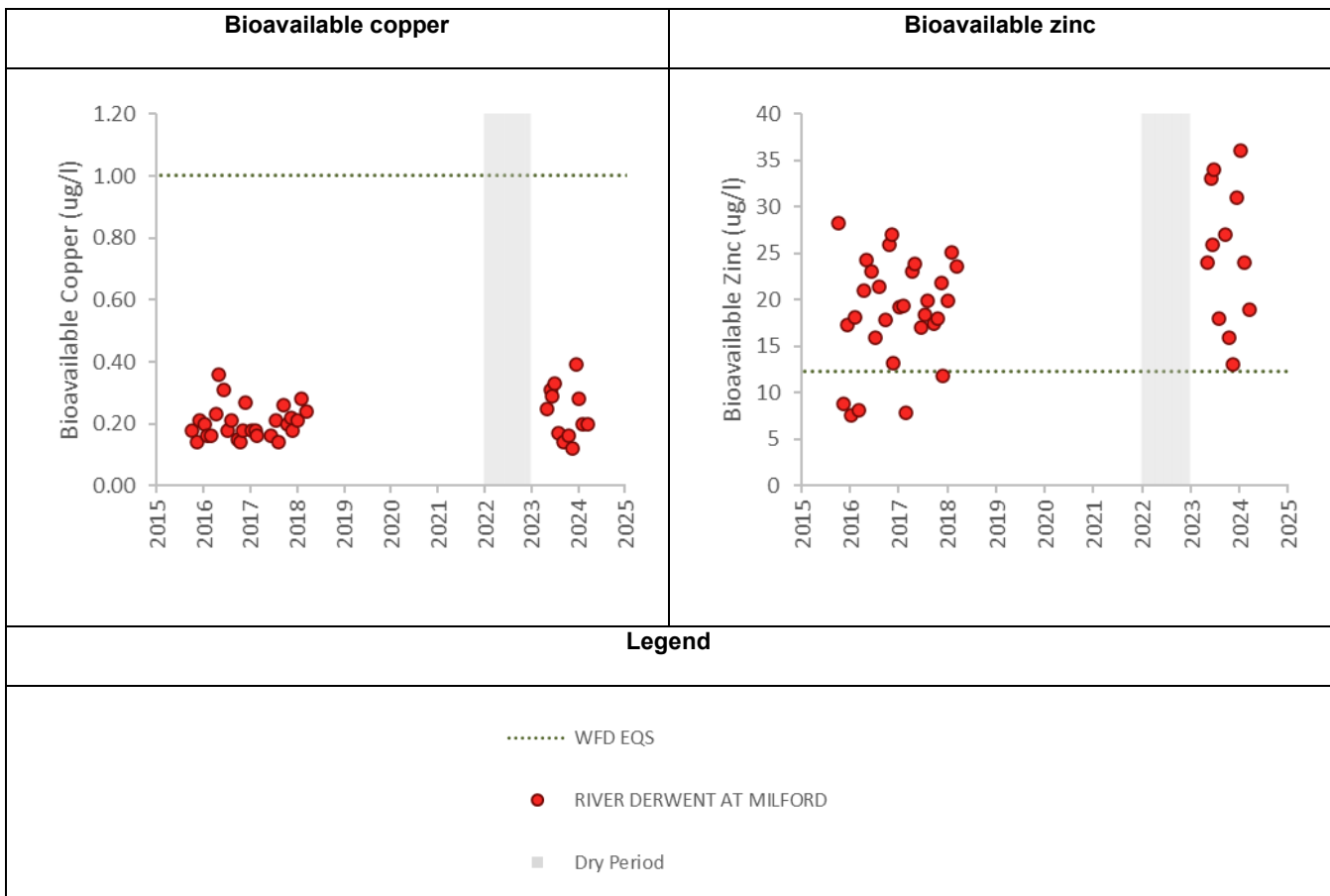
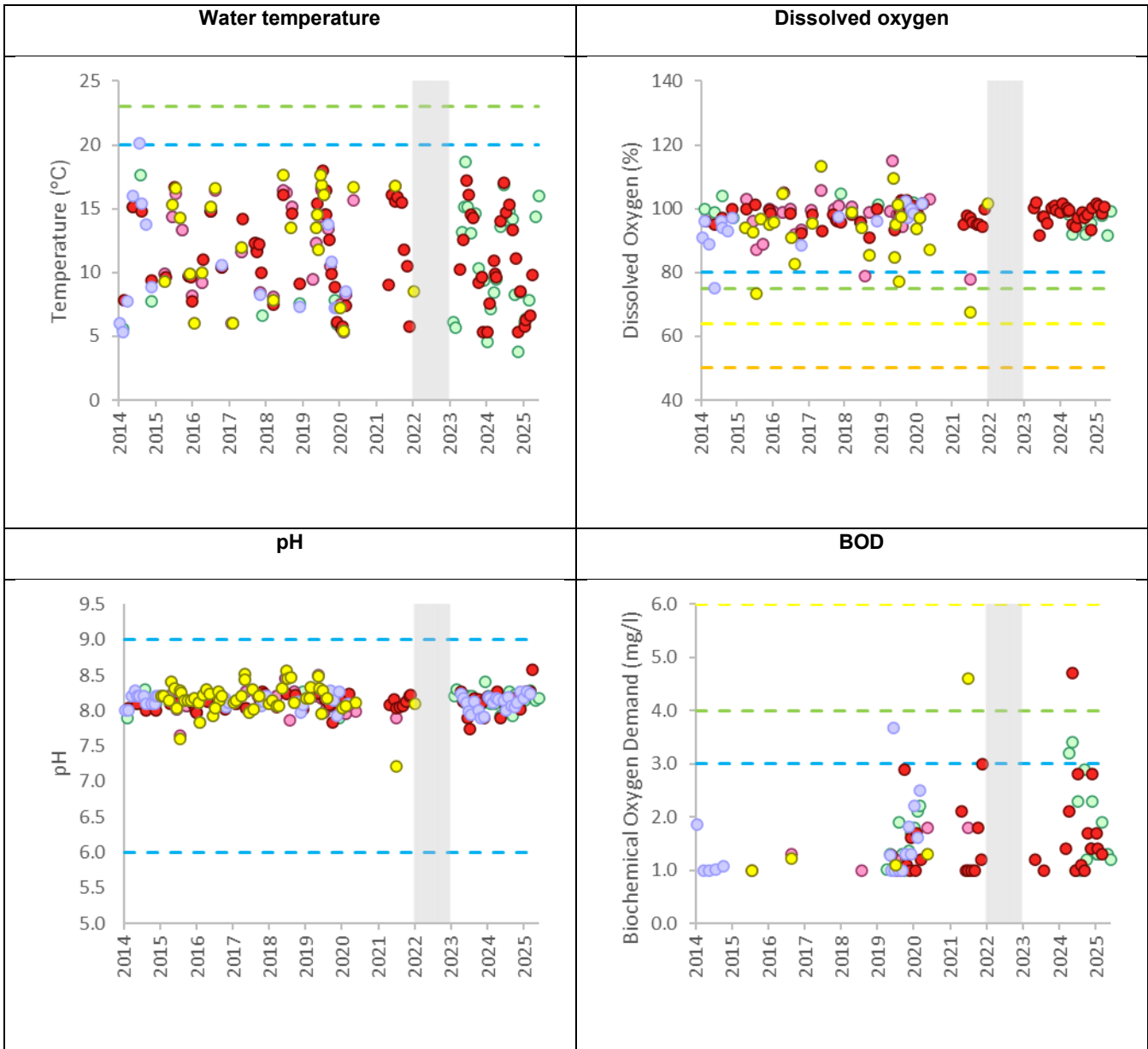


Figure D.3: Bioavailable copper and zinc concentrations recorded at sampling locations within the Derwent from Amber to Bottle Brook water body (GB104028052310)

In the Derwent from Bottle Brook to Trent water body there were no apparent issues with nitrate or bioavailable copper with results indicative of High status or below their indicative guideline limits. Temperature was indicative of High status except on one occasion at Raynesway, Wilne and Borrowwash where readings were indicative of Good status. DO was mostly indicative of High status but there were one off readings indicative of Good or Moderate status at E1-12, E1-14, Raynesway, Coutaulds Brdg Old, Draycott Ferry and Wilne sites. There was one pH reading >9 at the Wilne site in June 2023. All other results at this site and the others were between 6 and 9. BOD concentrations were mostly indicative of High status, there were one off readings at Good status at some sites, and one reading indicative of Poor status at Borrowwash, in June 2019. There were one off exceedances of the standard for suspended solids at most sites. UIA concentrations exceeded the FFD guideline standard on occasion at all sites from the Coutaulds Brdg Old site and downstream. Orthophosphate concentrations ranged from Good to Poor status at all sites. Ammonia concentrations were mostly indicative of High status. There were a few readings at Good status at the Coutaulds Brdg Old, Draycott Ferry and Wilne sites. There was one reading indicative of Poor status at the Coutaulds Brdg Old site in March 2014 and one at Moderate status in August 2021. A reading indicative of Moderate status was also recorded at the Borrowwash site in June 2019. Most results for bioavailable zinc exceeded the standard.



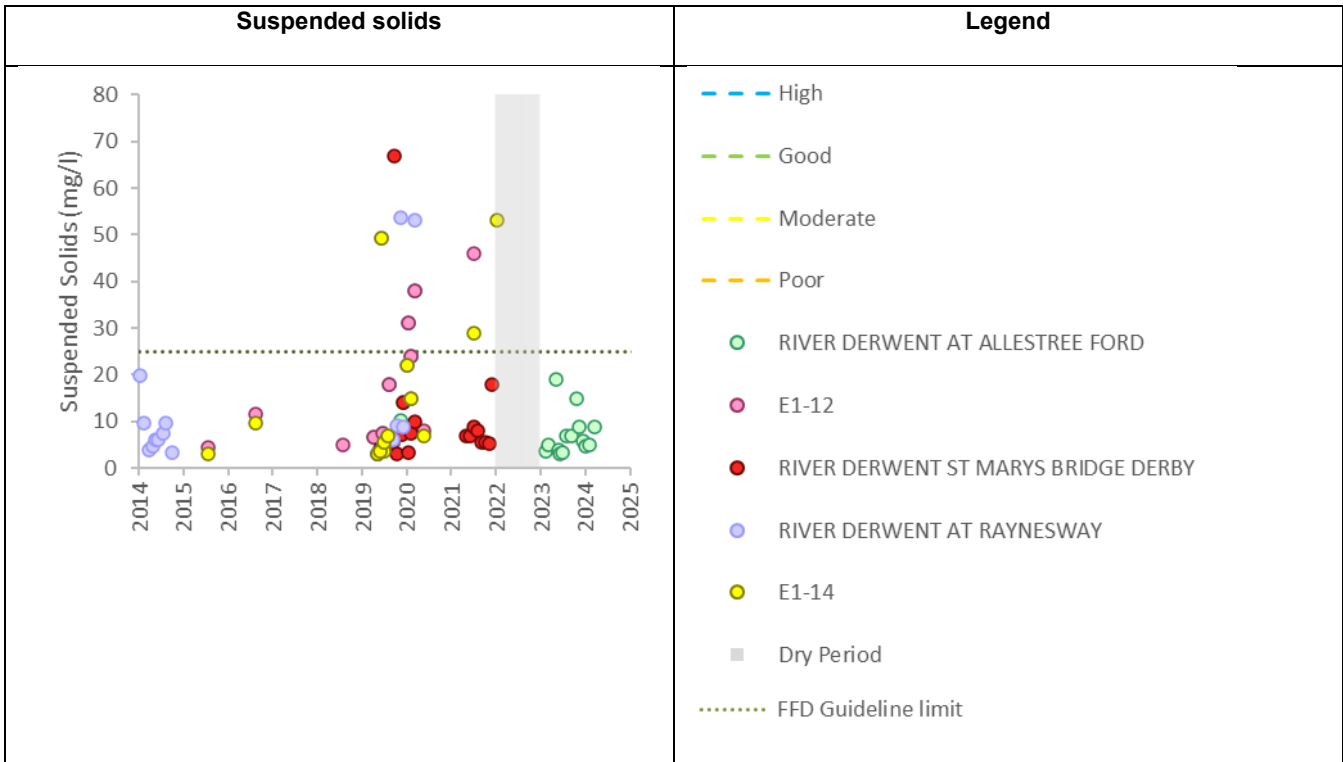
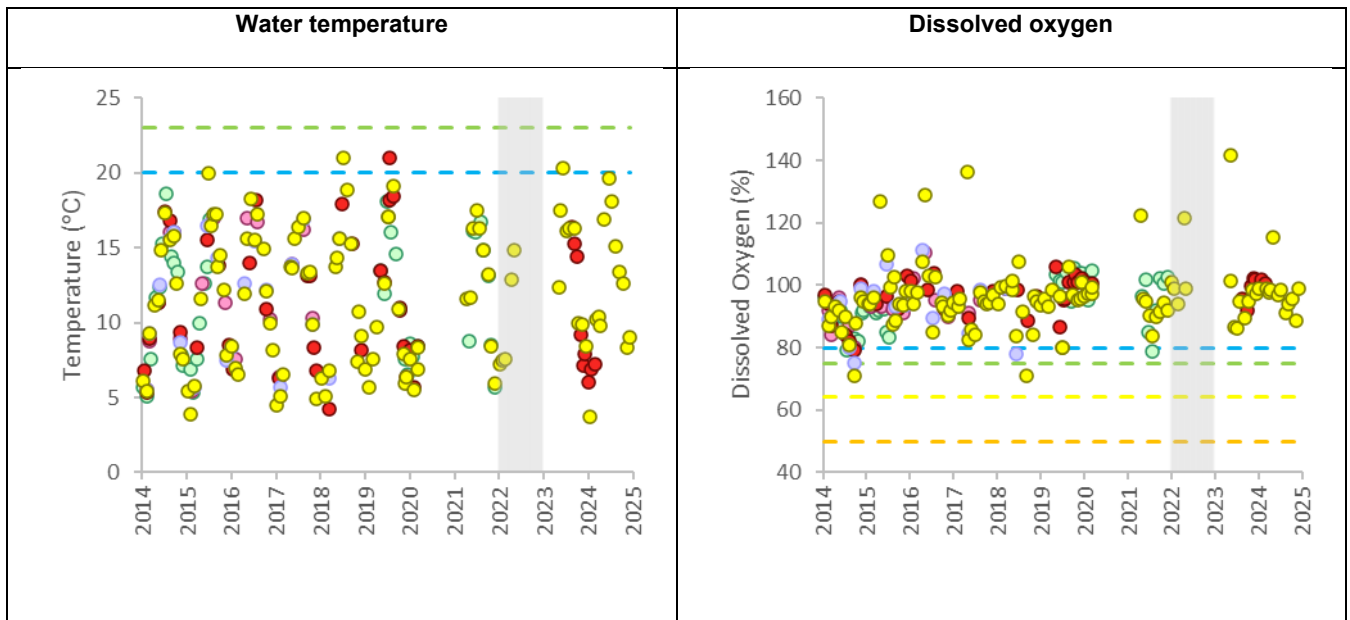


Figure D.4: Physico-chemical parameters recorded at sampling locations within the Derwent from Bottle Brook to Trent water body (GB104028053240) (1 of 2)



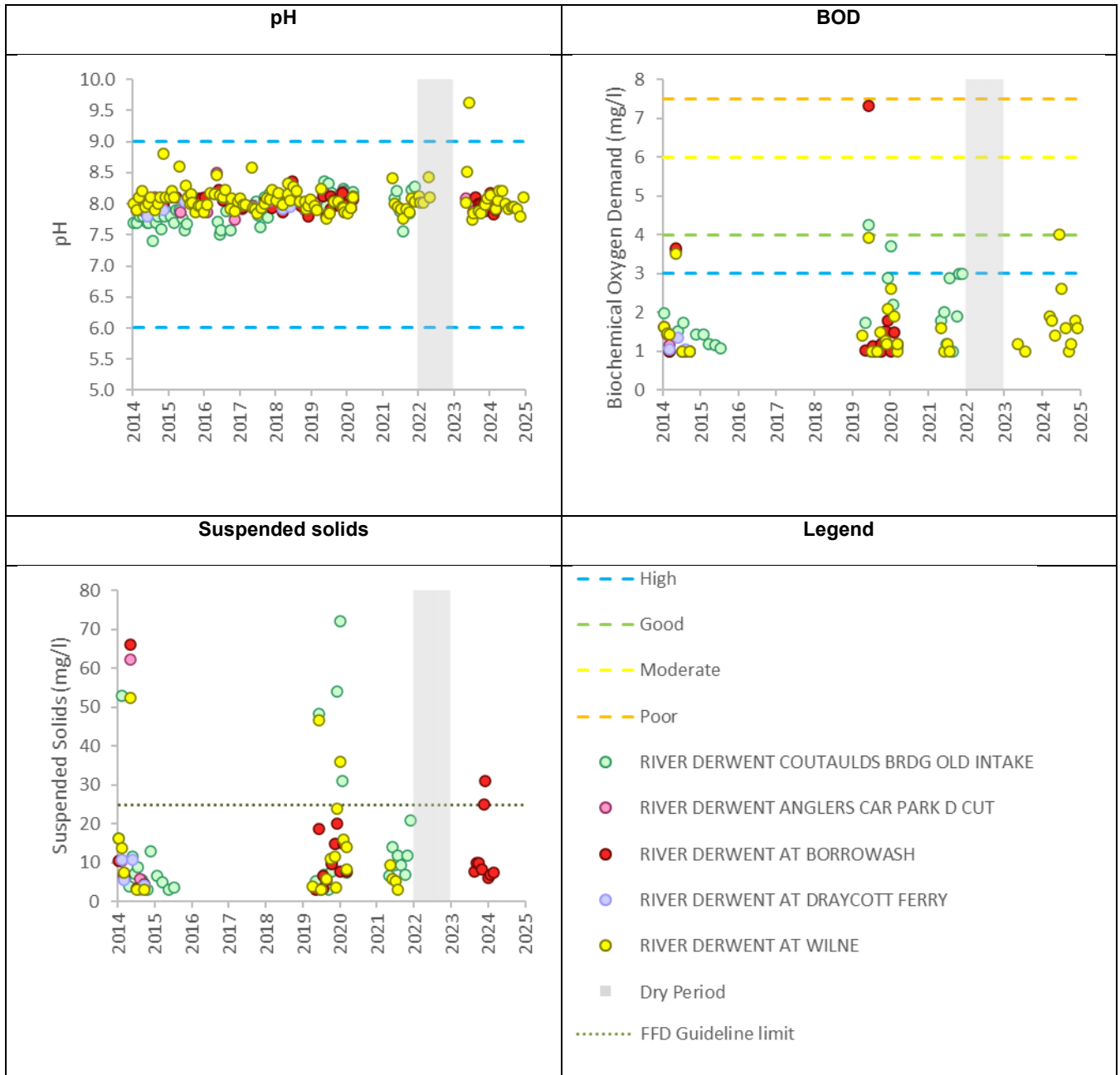


Figure D.5: Physico-chemical parameters recorded at sampling locations within the Derwent from Bottle Brook to Trent water body (GB104028053240) (2 of 2)

Nitrate	Unionised ammonia
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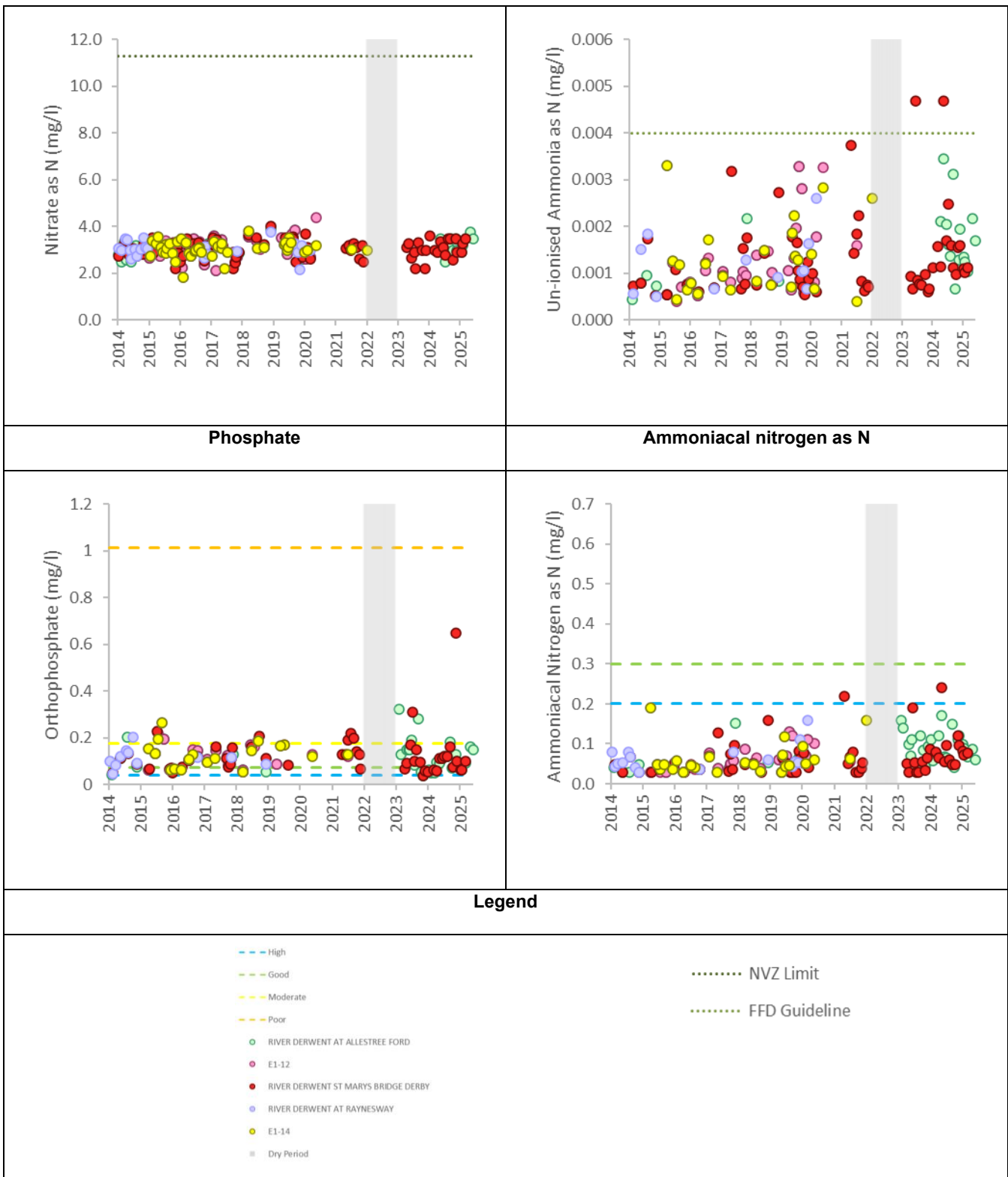


Figure D.6: Nutrient parameters recorded at sampling locations within the Derwent from Bottle Brook to Trent water body (GB104028053240) (1 of 2)

Nitrate	Unionised ammonia
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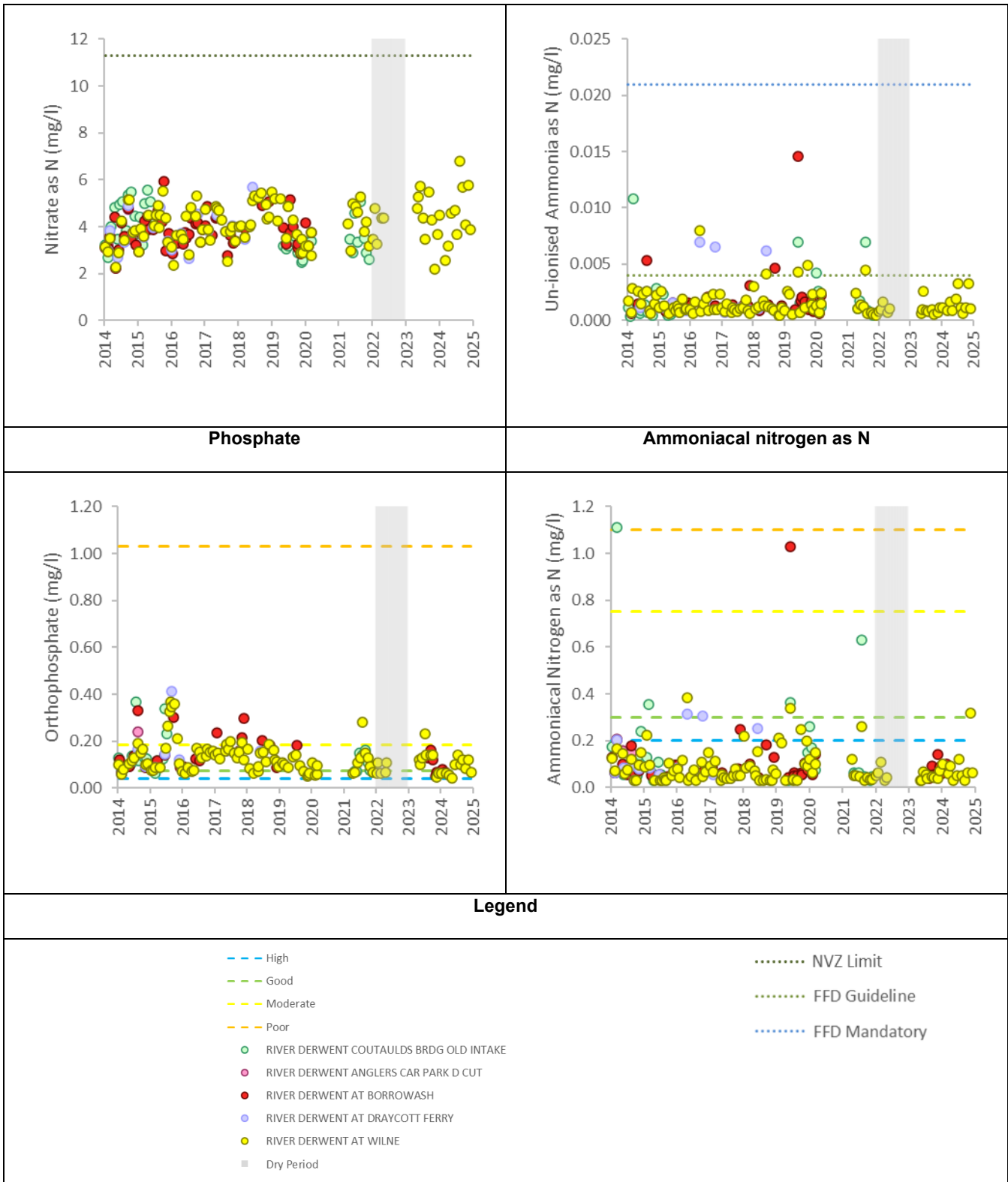


Figure D.7: Nutrient parameters recorded at sampling locations within the Derwent from Bottle Brook to Trent water body (GB104028053240) (2 of 2)

Bioavailable copper	Bioavailable zinc
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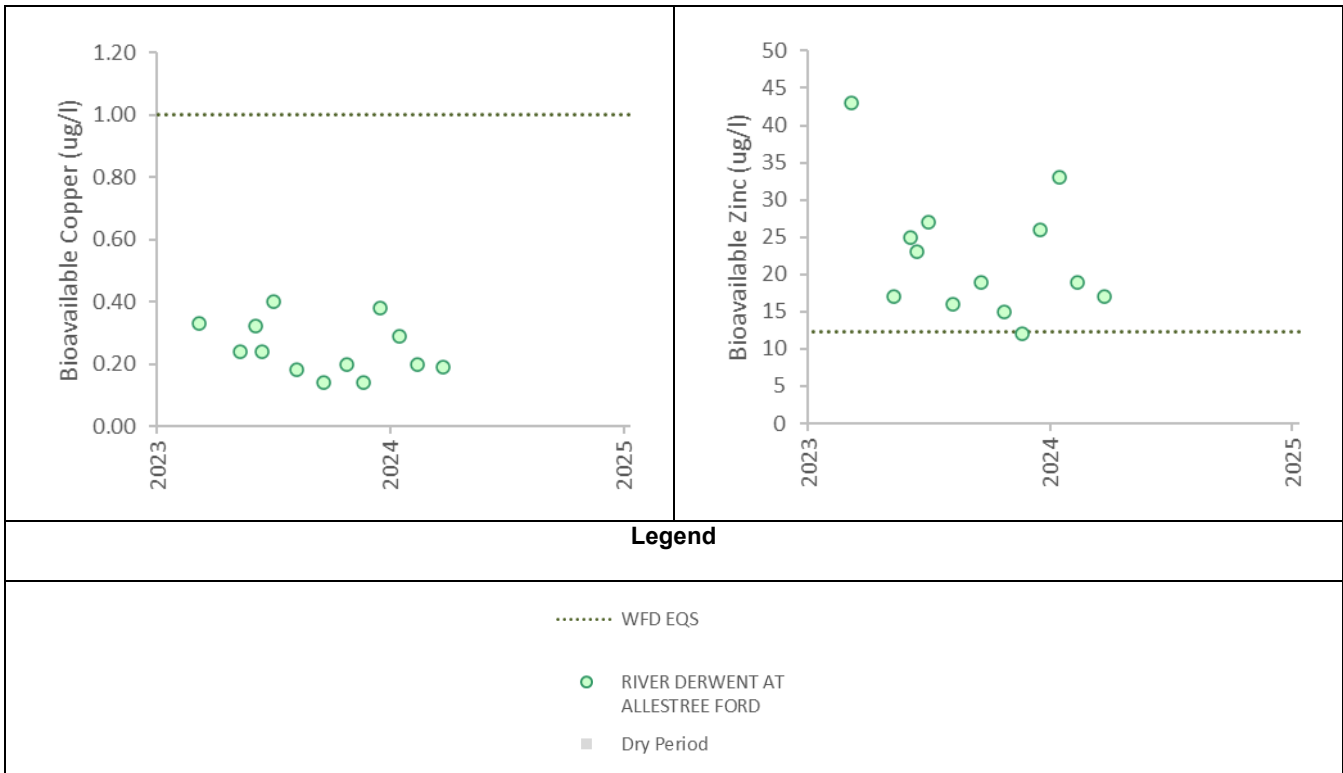


Figure D.8: Bioavailable copper and zinc concentrations recorded at sampling locations within the Derwent from Bottle Brook to Trent water body (GB104028053240) (1 of 2

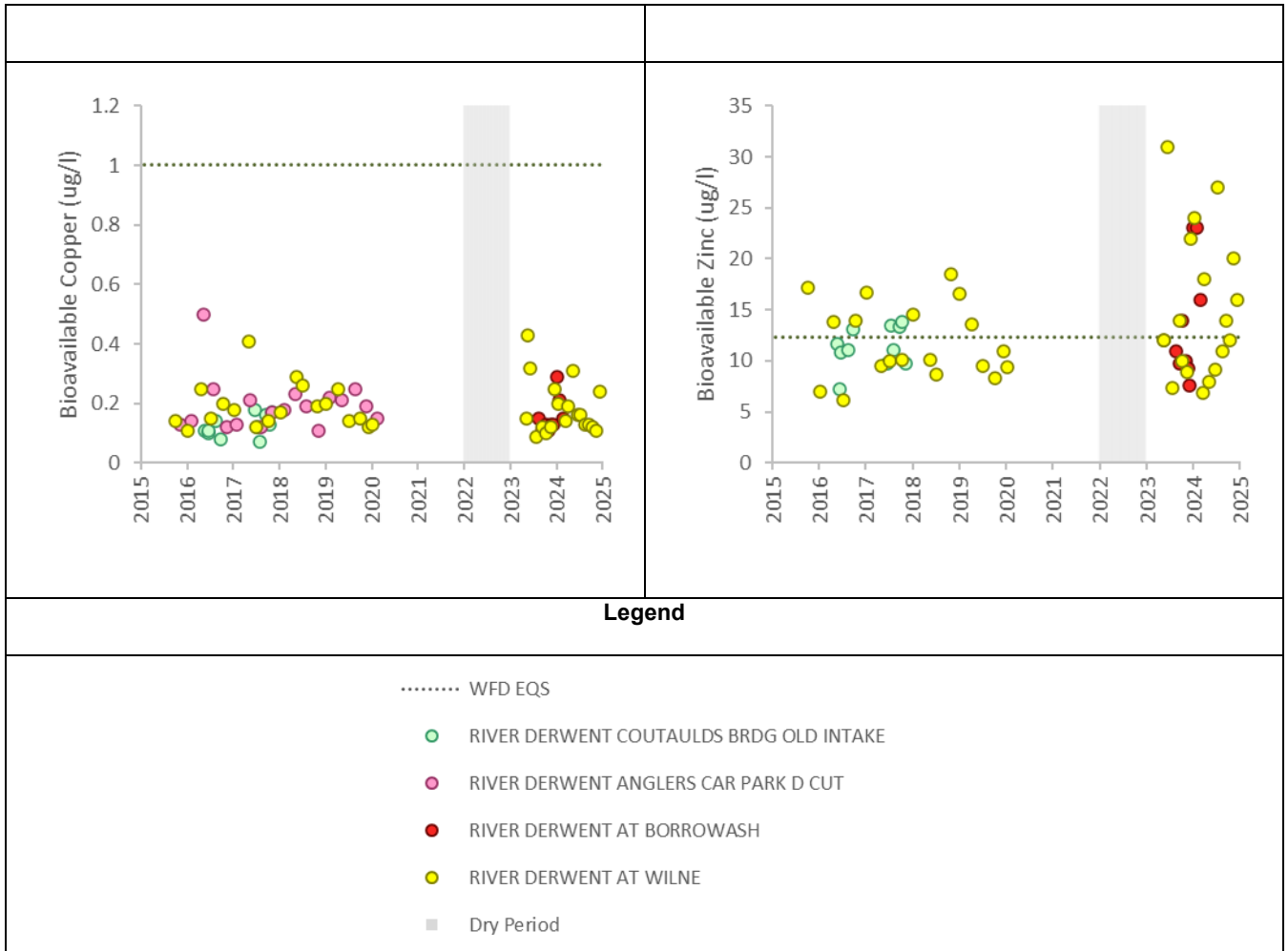


Figure D.9: Bioavailable copper and zinc concentrations recorded at sampling locations within the Derwent from Bottle Brook to Trent water body (GB104028053240) (2 of 2)

D.4 Impact assessment

No updates have been made to the impact assessment relative to the previous (2022) application-ready EAR. This is justifiable because there is insufficient evidence of any substantial changes in baseline water quality since the previous assessment was carried out, i.e. there were no clear changes in water quality during the period 2019-2025, compared to the period 2014-2018 (data up to 2018 was used as the baseline for the previous assessment). Data for the majority of parameters at all sites was closely in line with 2014-2018 data. Exceptions to this were minor, as noted below.

There appeared to be a small increase in phosphate concentrations at Milford (in the Derwent from Amber to Bottle Brook water body); overall the data remained indicative of Moderate status. In addition, there appeared to be a slight increase in zinc concentrations at Milford (Derwent from Amber to Bottle Brook) and Wilne (Derwent from Bottle Brook to Trent). Finally, several sites in the Derwent from Bottle Brook to Trent water body appeared to show an increase in suspended solids concentrations. It is noted that this parameter was not included in the previous impact assessment and is not subject to EQS under the WFD.

Water quality parameter load contributions

The EA's Derwent SIMCAT model was interrogated to provide an approximation of the discharge load for common STW discharge parameters throughout the catchment.

SIMCAT analyses were first undertaken to estimate percentage load contributions at the downstream extent of the study area below Derby STW (EA monitoring location: 'RIVER DERWENT AT ANGLERS CAR PARK BRIDGE D CUT'). The contributory point sources were reviewed to identify additional targeted locations for SIMCAT analyses upstream of this location (based on distribution and input of the most significant catchment point sources). This focussed attention on AP8 (RIVER DERWENT AT ANGLERS CAR PARK BRIDGE D CUT). This location is the focus of the water quality assessment (particularly with regards consideration of dilution effects) and they are considered suitably representative of conditions elsewhere (based on review of flow change and water quality at all sites).

AP8 (or for water quality assessment purposes the EA monitoring location data downstream of Derby STW) is located in the most downstream WFD water body in the study area (Table D.1). Table D.1 presents estimated load contributions (% of entire load at that location) for Total ammonia (as N), Phosphate (orthophosphate), BOD and Total Oxidised Nitrogen (TON).

The load proportion of ammonia, BOD and nitrate (TON) contributed by point sources relative to diffuse sources is a heavily point dominated system (approximately 87%) at AP8.

Point source contributions for ammonia, BOD and nitrate are made up of a larger number of contributory discharges i.e. they are not as dominated by just one or two individual discharges in the mid and lower catchment (e.g. Figure). Downstream of Derby STW diffuse phosphate inputs still contribute approximately 40% of the total load.

Consideration of these loading proportions has subsequently been made in the context of predicted flow change associated with proposed drought actions and the relevant background conditions, as illustrated by the long-term water quality graphs.

Table D.2 Relative load contributions (EA Derwent SIMCAT model).

	Approx. AP	EA water quality monitoring location	Point source contribution	Diffuse source contribution
Total ammonia (as N)	AP8	RIVER DERWENT AT ANGLERS CAR PARK BRIDGE D CUT	87.3%	12.7%
Phosphate	AP8	RIVER DERWENT AT ANGLERS CAR PARK BRIDGE D CUT	59.9%	40.1%
BOD	AP8	RIVER DERWENT AT ANGLERS CAR PARK BRIDGE D CUT	39.4%	60.6%
Nitrate (TON)	AP8	RIVER DERWENT AT ANGLERS CAR PARK BRIDGE D CUT	42.9%	57.1%

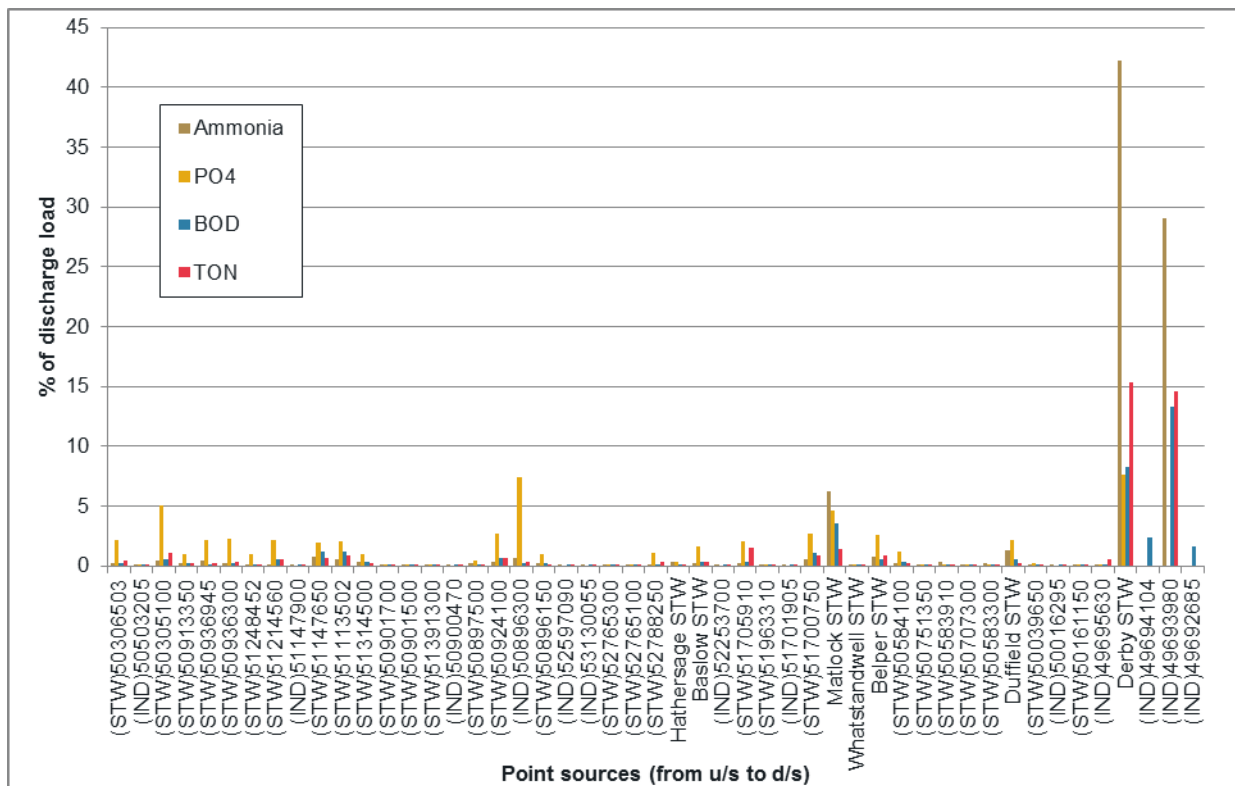


Figure D.10: Ammonia, phosphate, BOD and TON point source contributions at AP8, from SIMCAT. Arranged u/s to d/s.

Relationships with low flow periods

The long-term water quality data have been plotted against low flow periods as defined by the Yorkshire Bridge gauging record. The baseline description describes parameter trends in the data and the only data that was found to show a clear relationship with low flow periods was phosphate. Additional analysis of phosphate during low flows has therefore been undertaken.

The lowest rainfall years since 2000, based on annual data are 2003 and 2010 (met office, 2018). Summer and autumn rainfall totals were low in 2003, and the spring period was particularly low in 2010 and 2011 (Met Office 2018). The 2010/11 period is taken as a targeted low flow period for additional assessment effort based on:

- background water quality data show a step change for several parameters, including phosphate, around 2008 (thus excluding the direct relevance of earlier periods such as 1995/1996);
- the river flow series (Yorkshire Bridge and SMB) for 2010 and 2011 show prolonged low flow periods; and
- the 2011 gauging record has the lowest daily flows (as an annual mean) at SMB of all years since 2000.

Representativeness of Assessment Points

AP6, AP7 and AP8 are all located within the same WFD waterbody i.e. the Derwent from Bottle Brook to Trent water body. Predicted % low flow change at AP6, AP7 and AP8 is very similar, however given the scale (relative loading proportions) of point sources around Derby, including Derby STW, AP8 (or more accurately with regards water quality the EA monitoring location downstream of Derby STW) is the focus of this assessment.

Impact assessment: ammonia

Point sources account for the majority (87%) of total ammonia load downstream of Derby STW. The majority of load contribution is accounted for by the largest few point sources; the largest source being Derby STW and the third largest being Matlock STW. The second largest total ammonia point source within the Environment Agency’s SIMCAT model (Figure D.24) relates to an industrial discharge (reference 49693980) associated with Acordis Acetate chemicals (Courtaulds site), which is understood to have run down its associated production and subsequently closed down.

Even though the ammonia load in the lower river is dominated by point source inputs, there is no evidence of a relationship between the long-term data and low flow river periods. Background concentrations are very low and the river has a large capacity to absorb increased ammonia concentrations whilst still remaining at High status. Irrespective of these considerations, to ensure a precautionary assessment a dilution assessment was undertaken for AP8 to illustrate the scale of theoretical worst-case concentration change under the Ambergate DP. The calculations assume a DP related reduction in flows of 24%. The results of the dilution assessment are presented as Figure D.11.

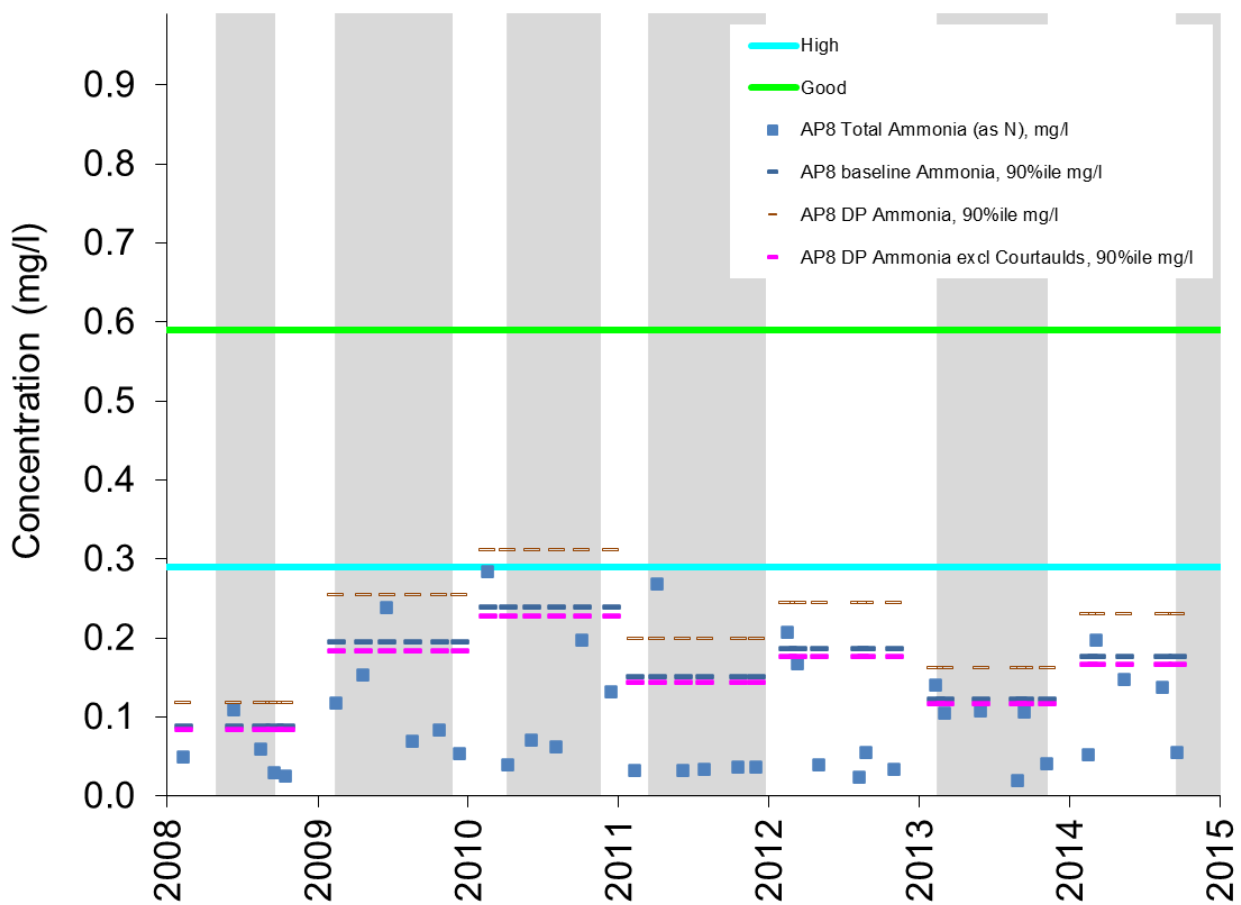


Figure D.11: Illustrative Total Ammonia (as N) dilution, ‘ANGLERS CAR PARK BRIDGE D CUT’

‘ANGLERS CAR PARK BRIDGE D CUT’ is immediately downstream of Derby STW. NB: ‘H’, ‘G’ & ‘M’ series denote WFD status lower boundary of High, Good and Moderate respectively.

The results presented show some increase from background ammonia concentrations assuming total ammonia contributions as per the Environment Agency’s SIMCAT model. The predicted concentrations remain at High status for all years with the exception of 2010, which crosses just into Good status. This assessment approach is considered highly precautionary for a number of reasons:

- Data are associated with the single Environment Agency monitoring point (ANGLERS CAR PARK BRIDGE D CUT) immediately downstream of Derby STW i.e., where the background ammonia concentrations are greater than elsewhere in the water body. Effects on water body data taken as a collective (for WFD classification purposes for example) are likely to be negligible;
- The dilution calculations assume the worst case predicted flow reduction occurs across the entire year, when in reality only a 6-month DP would be pursued (initially at least) and in reality the DP flow reduction would not affect all portions of the flow duration curve;
- Unlike phosphate the long-term data shows no trends/correlation between flow and ammonia concentration; hence we would not expect the scale of concentration change to approach that suggested by this illustrative analysis.

When the now redundant Courtauld's discharge is excluded from the loading calculations the net effect is a negligible reduction in ammonia concentration relative to baseline.

Given potential for reduced dilution of large point source discharges at Derby, there remains a theoretical potential for ammonia concentrations to increase in the lower river, under the Ambergate DP. A precautionary assessment finds the scale of potential water quality pathways change (ammonia) to be **low**.

There is **no predicted adverse change** to current ammonia status of any water body and there is **no predicted adverse** potential for the WFD ammonia objectives at any of the waterbodies to be affected.

Impact assessment: phosphate

Background phosphate concentrations increase with distance downstream and the lower river currently has conditions consistent with Moderate status. The phosphate load also shifts from a diffuse source dominated system in the upper catchment to a point source dominated system in the downstream reaches.

The lower reaches have the greatest potential to be adversely impacted by a DP flow reduction, in respect to phosphate and specifically the river at Derby given the two dominant phosphate point sources in this stretch of the river (see above, Figure).

WFD classification of phosphorus (orthophosphate) employs an annual mean in recognition of seasonal variations. There is evidence from the background data that orthophosphate follows a seasonal cyclical trend as illustrated in the 2008-2014 period (Figure D.). This seasonal trend does not follow seasonal plant uptake trends (which would largely be the opposite) but appears to be influenced by the underlying flow (see correspondence with low flow periods [grey shading on all figures]) suggesting peak concentrations are associated with lower summer dilutions (noting also the absence of low flow period in summer 2012 and absence of phosphate peak).

Consideration of the scale of potential flow change downstream of Derby (~AP8) finds a maximum flow change under the Ambergate DP of -24%. The 2010 to 2011 low flow period was investigated further. Figure D. shows the orthophosphate (Bottle Brook to Trent waterbody) annual mean against WFD classification threshold boundaries. In 2011 for example, the annual mean orthophosphate was 0.15 mg/l compared to the moderate status threshold of 0.19 mg/l.

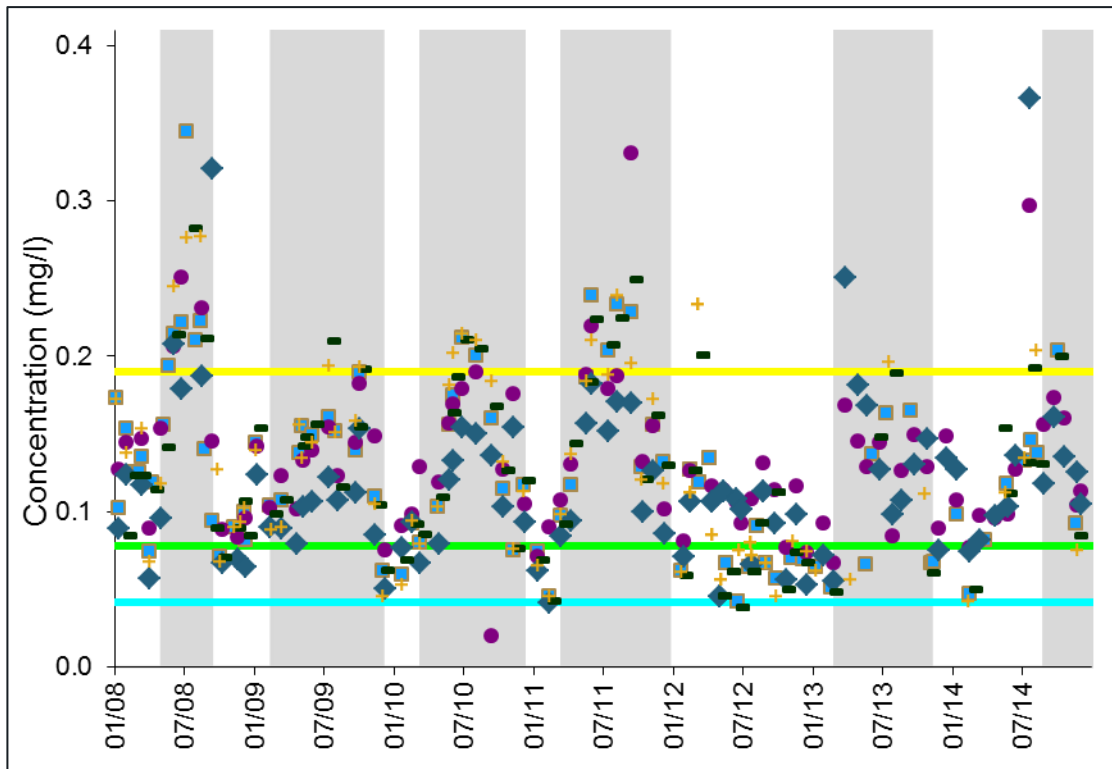


Figure D.12 Orthophosphate Derwent from Bottle Brook to Trent WFD waterbody 2008-14

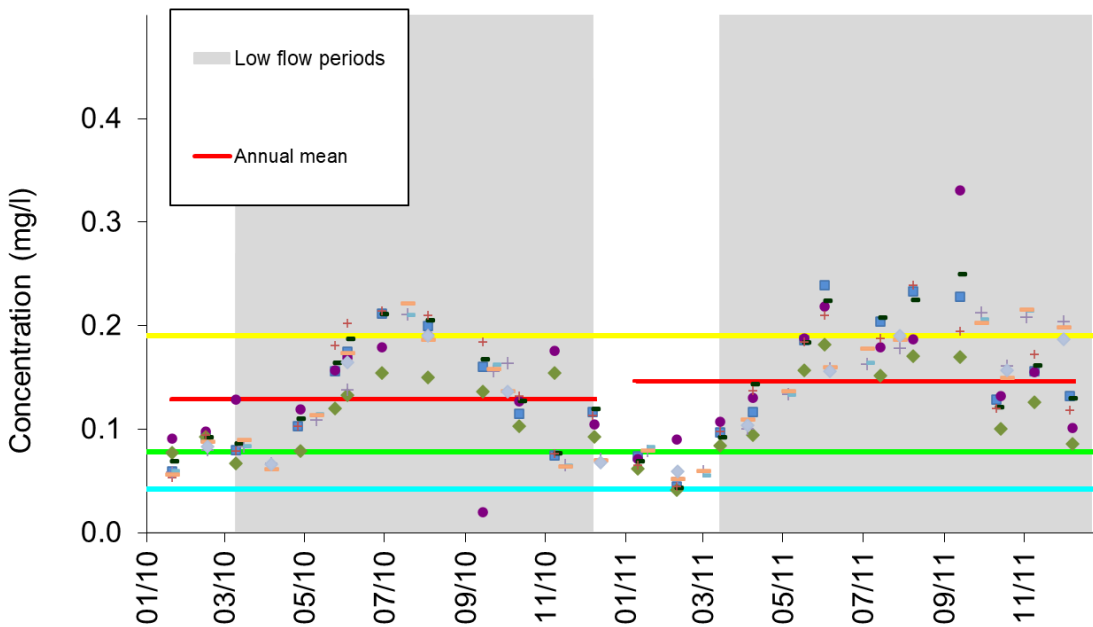


Figure D.13 Orthophosphate, Derwent from Bottle Brook to Trent WFD waterbody 2010-11

Annual mean shown (red line) for direct comparison against WFD status thresholds.

Mass balance calculations have been carried out to account for a -24% flow change (across the entire 2010-2011 period for simplicity); Figure D.14. Approximately 40% of the phosphate load at AP8 is predicted to derive from diffuse sources and these would generally be expected to decrease at times of drought (notwithstanding catchment storm runoff, which is not considered within this assessment). The diffuse phosphate load was scaled with flow, but the point source load was assumed to remain unchanged. The predicted DP annual concentration increases to 0.17 mg/l, which is still within the same Moderate WFD status

classification band. In reality the DP flow reduction at AP8 would not affect all portions of the flow duration curve and would only be implemented over a portion of the year, hence the assessment approach may be considered to be precautionary.

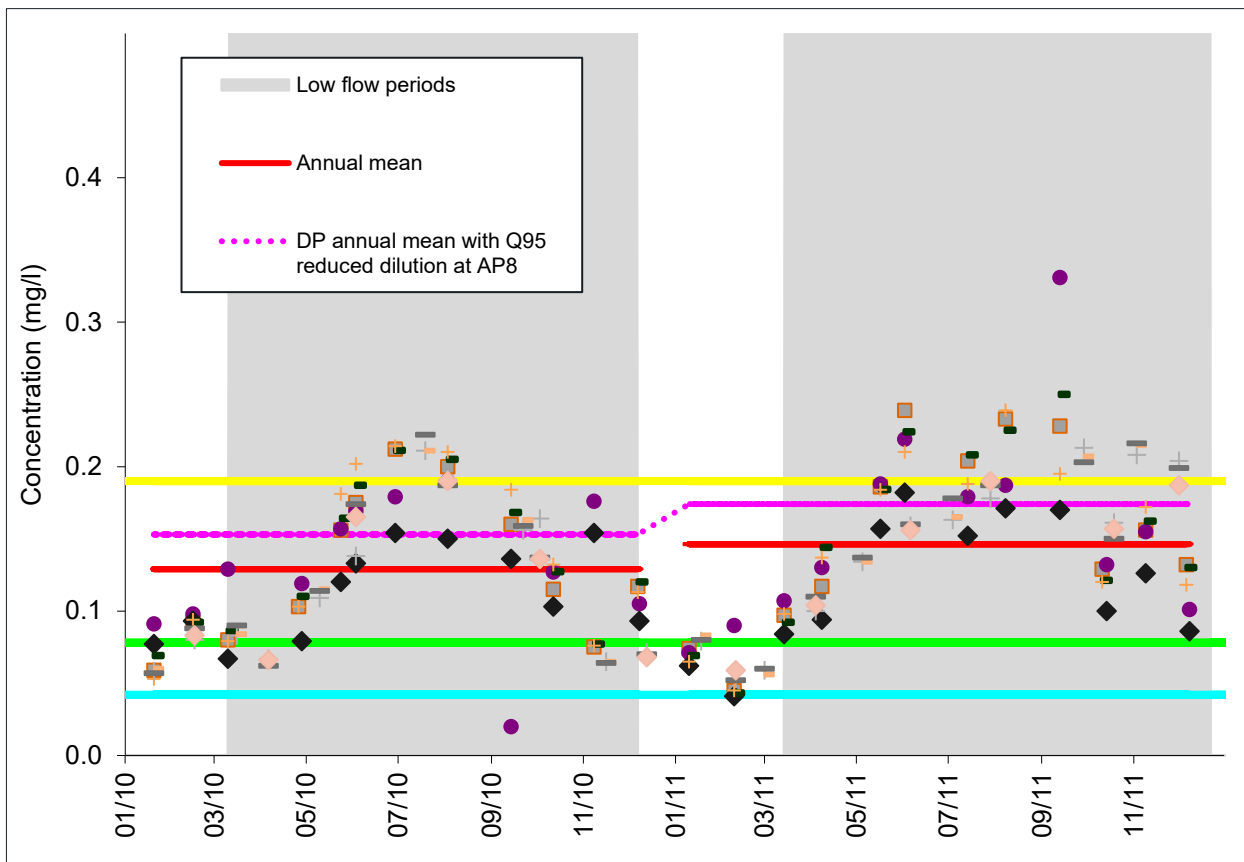


Figure D.14 Orthophosphate, Derwent from Bottle Brook to Trent WFD waterbody 2010-11

Annual mean shown (red line) and dotted line showing a theoretical worst-case mean based on -24% flow change.

Although the mass balance approach is generally precautionary, this assessment does assume that the Derby STW discharge continues to operate in a similar fashion at times of drought - relative to the 2010/2011 operating conditions. Figure D.15 presents a time series of phosphorus discharge concentrations (Total Phosphorus as P) from Derby STW (Environment Agency monitoring point MD-49694151) with annual mean phosphorus concentration for individual years. This suggests that Derby STW may discharge at higher phosphorus concentrations (relative to the 2011 baseline) in recent years. The STW was discharging at 29% of the phosphorus limit in 2011 (total phosphorus being taken as representative of phosphate in this instance). To consider potential changes to phosphate loadings further, sensitivity analysis was carried out, with Derby STW discharging at the permit maximum. Table D.3 summarises the quality of the final sewage effluent from Derby STW in 2011 versus the permit maximum.

Table D.3 Derby WwTW final sewage effluent discharge quality vs licensed maxima.

	Total Phosphorus as P (mg/l)	Ammoniacal Nitrogen as N (mg/l)	BOD ATU (mg/l)
2011 mean	0.29	0.39	2.167
Long term mean	0.51	0.57	2.163
Derby WwTW permit limit	1 (AA)	3*	20^
2011 mean as a % of permit limit	29%	13%	11%

AA – Annual average. * 1 May to 31 October inclusive limit. ^ Spot sample - Opra for EPR.

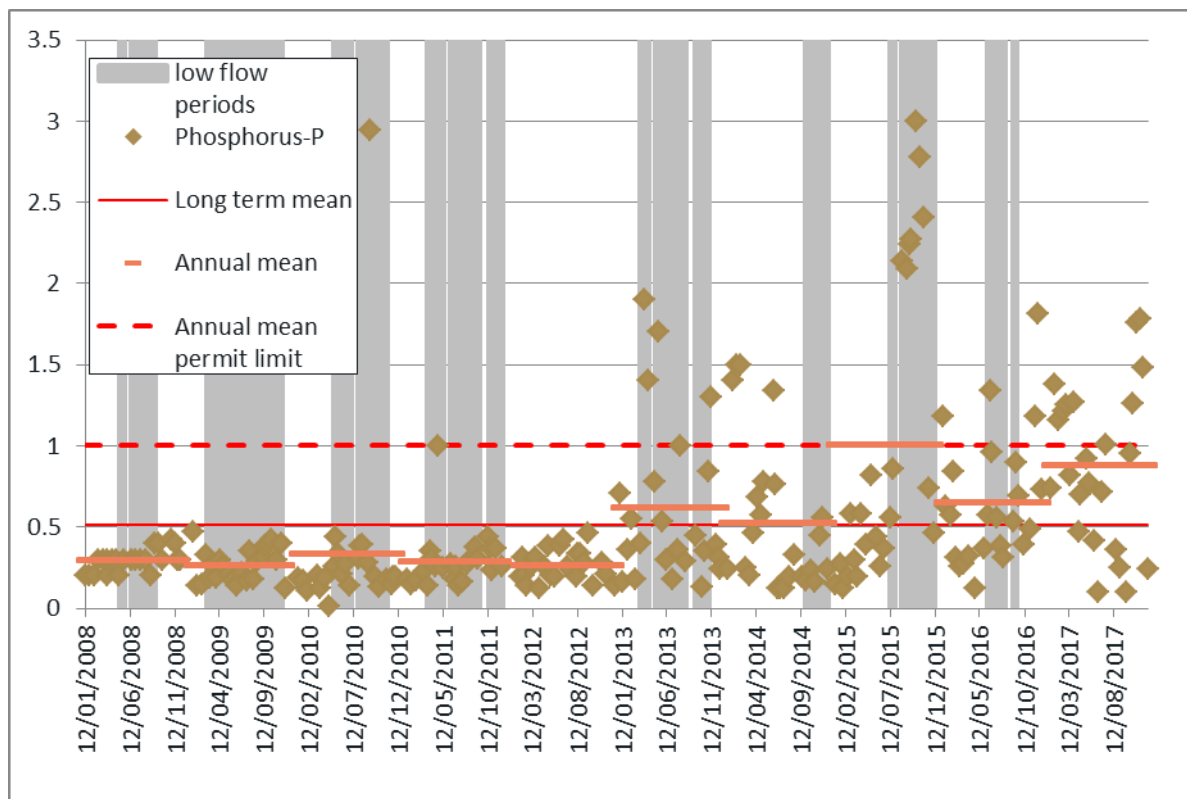


Figure D.15 Phosphorus concentrations vs permit limit for Derby STW discharge effluent
 Low flow periods (grey shading) overlain for information.

If the phosphorus load contribution from Derby STW is increased from 29% of the permit limit (as in 2011) to 100% of the permit limit, maintaining the precautionary 24% flow reduction across the entire year as presented above, the predicted annual average value would increase to 0.220 mg/l (adopting 2011 data) and would cross the WFD threshold into Poor status. However, the Ambergate DP has only been predicted to reduce small spates over a relatively short period in the late winter of 1959/60. Under such circumstances, the predicted increases in phosphate concentrations would be short-term/ temporary, which should be set in the context of an annual mean WFD classification threshold. The Ambergate DP would not affect the lowest flow percentiles and would not be implemented throughout the year, as implied by a simple comparison of WFD status classification bands, especially given the limited duration of simulated Ambergate DP operation under the Modelled Stochastic DP scenario and especially given that any application for DP powers would be implemented, at least in the first instance, for a period of six months. Therefore, the assessment against permit maximum may be considered highly precautionary. Assuming the current suite of Environment Agency water

body monitoring locations are maintained in a drought event, the overall water body annual mean is unlikely to be shifted into Poor status as suggested by this precautionary assessment.

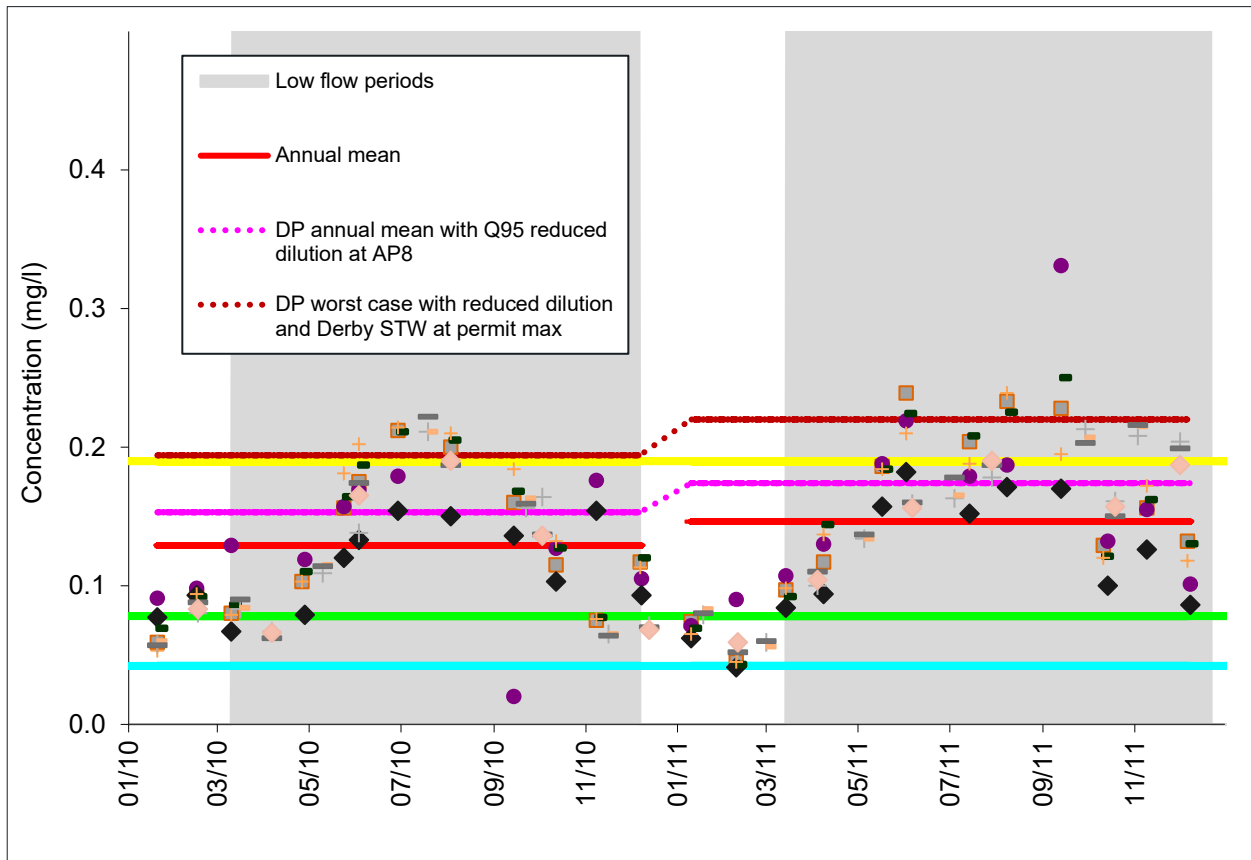


Figure D.16 Orthophosphate Derwent from Bottle Brook to Trent WFD waterbody 2010-11

Annual mean shown (red line); dotted pink line showing a theoretical worst case mean based on -24% flow change; dotted red line also including Derby STW discharge at permit limits (applied over entire calendar year).

An assessment of the Ambergate DP assuming a short term and temporary deterioration within the current status band, set in the context of an annual mean WFD classification threshold suggests a **Low** impact in orthophosphate concentrations downstream of Derby STW in the River Derwent (Bottle Brook to Trent). The permit limit assessment demonstrates that a temporary deterioration in status is unlikely, but cannot be discounted entirely during the summer months, resulting in a **Medium** impact over this period, however the timescale for implementation would be before this period. Water bodies upstream of Derby STW are predicted to have negligible change under the Ambergate DP scenario. There will be **no predicted adverse** change to current phosphorus status under WFD for the three upstream Derwent waterbodies. Noting that any adverse measurable change will be temporary, there will be **no predicted adverse** potential for the WFD phosphorus objectives at any of the waterbodies to be affected.

Impact assessment: BOD

The predicted scale of change to the water quality pathway (BOD) is predicted to be **Negligible**.

Impact assessment: nitrate

The predicted scale of change to the water quality pathway (nitrate) is predicted to be **Negligible**.

Impact assessment: dissolved oxygen

Uncertainty will always remain surrounding potential interactions of multiple parameters that may influence DO; therefore a precautionary assessment has been adopted for the lower river, where STW inputs are significant and flow change under the Ambergate DP scenario substantial. Any resultant and theoretical small-scale decreases to dissolved oxygen concentration in the lower river are unlikely to cause measurable change outside of the normal background concentration range and are therefore assessed to be a **Negligible** change.

Impact assessment: temperature

The mid-summer is clearly the most sensitive time of year for temperature induced effects on account of being when peak seasonal temperatures are exhibited. The risk of elevated temperature effects (during the summer months) increases with distance downstream given that normal background peak temperatures increase. Even in the lower river, however it is considered unlikely that individual summer drought or summer DP scenario temperatures would be exhibited in excess of the WFD good status classification threshold of 23°C (which itself is a percentile threshold).

Adopting a precautionary assessment at AP8 that assumes a theoretical or small-scale increase to water temperature (as a result of hydraulic change) which is unlikely to cause measurable change outside of the normal background temperature range, and only during the summer months, risks due to temperature changes associated with an Ambergate DP, are assessed to be **Low** however the timescale for implementation would be before this period. During other months, the change is assessed to be **Negligible**.

Impact assessment: metals

The predicted scale of change to the water quality pathway (metals) is predicted to be **Negligible**.

Impact assessment: further consultations

The EA have advised that a mine discharge on the Amber is a Bromide source. This is understood to be problematic only during very low flows when a discharge constraint may be applied. Flow changes from the Derwent Reservoirs DP are very small downstream of the Wye confluence, and reductions from the Ambergate DP are at mid to low flows, so it is unlikely the DP will impact the discharge.

A detrimental water quality impact could in theory also arise from the soughs (historical mine drainage) into the receiving surface waterbodies due to proposed reduced discharge from the reservoirs resulting in less dilution capacity in the river, e.g. Magpie Sough, Merebrook Sough. Magpie sough discharges to the River Wye, approximately 15km upstream of the Wye's confluence with the River Derwent. It is anticipated that dilution would occur along the River Wye and any temporary reduced dilution offered by the River Derwent should be insignificant in this context. Merebrook sough is believed to discharge to the River Derwent near Whatstandwell (River Derwent, Wye to Amber water body). Given that flow changes downstream of the Wye confluence are expected to be small, and that the metals impact assessment predicts negligible change at all locations, it is anticipated that any temporary, reduced dilution offered by the River Derwent should be insignificant in this context.

D.5 References

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E Macroinvertebrates

E.1 Background

This assessment focusses on potential effects of implementation of a DP on macroinvertebrate communities associated with the River Derwent downstream of Ladybower Reservoir, including consideration of potential effects on WFD status and notable species.

E.2 Potential routes of impact

The impact assessment for this study focuses on the macroinvertebrate community present in the River Derwent, their habitat requirements, and the potential for impacts due to implementation of the proposed DP. Ecological assessment has been undertaken in accordance with CIEEM (2016) guidelines based on the predicted magnitude and duration of habitat alteration highlighted in and using expert judgement to inform decisions on important ecological receptors and the wider ecological community.

E.3 Baseline

Macroinvertebrate data were available for 5 EA monitoring locations sited in the two waterbodies Derwent (Amber to Bottle Brook) (GB104028052310) and Derwent (Bottle Brook to Trent) (GB104028053240) for which data were available (Table E.). Data covered the period 1985-2024. Data has also been collected since 2011 as part of the Severn Trent drought baseline monitoring program at EA monitoring locations on the River Derwent. Inclusion of data in the assessment was determined by the availability of environmental data (required for expected biotic index ratios to be generated), the number of samples available for a given location and the relevance of locations to the proposed DP.

Table E.1 Macroinvertebrate data for River Derwent water bodies, u/s to d/s order.

EA location name	EA Site ID	Water Body ID*	NGR	Data period	No. of samples	Data used
BELPER MILL	53543	GB10402 8052310	SK3427847984	1985- 2016	42	Y
ALLESTREE FORD	53873	GB10402 8053240	SK3591540079	1985- 2024	79	Y
ST MARYS BRIDGE DERBY	48473	GB10402 8053240	SK3539736758	1985- 2016	28	Y
RAYNESWAY	49359	GB10402 8053240	SK3808334506	1985- 2024	85	Y
BORROWASH	53374	GB10402 8053240	SK4153733956	1985- 2019	58	Y

Macroinvertebrate data were summarised as a suite of biotic indices, calibrated to detect the biological effects of water quality, flow alteration and sedimentation:

- Whalley Hawkes Paisley Trigg (WHPT) method (UKTAG 2014) is an index of overall biological quality similar to the BMWP index generating an average score per taxon (ASPT) and a number of scoring taxa (NTAXA). WHPT ASPT responds to the same environmental pressures as BMWP ASPT (mainly water quality but also flow and habitat quality) though, unlike BMWP, is species based rather than family based and abundance-weighted. WHPT NTAXA also responds to the same environmental pressures as BMWP NTAXA. The WHPT and WHPT NTAXA are the indices used to determine WFD status of the macroinvertebrate biological quality element and are useful for identifying impacts of water pollution, although they can be influenced by flow alterations and local variations in habitat quality.
- Lotic Invertebrate index for Flow Evaluation (LIFE; Extence *et al.*, 1999) is used to index the effect of river flow alteration on macroinvertebrate communities and is also reported as an ASPT and NTAXA. It is calibrated to the preference of each taxon (species or family) for high water velocities and gravel/cobble substrata versus slow/still water velocities and finer substrata.
- Proportion of Sediment-sensitive Invertebrates (PSI, Extence *et al.*, 2013)) is used to index the effect of fine sediment deposition on macroinvertebrate communities and is also reported as an ASPT and NTAXA. It is calibrated to the preference of each taxon (species or family) for coarser clean substrata versus substrata versus fine sediment-logged substrata.

E.3.1 Overview

Biotic Observed/Expected (O/E) ratios (LIFE, ASPT, WHPT ASPT, NTAXA, WHPT NTAXA and PSI) for all sites are presented, in an upstream to downstream direction in Figure E.1. Deterioration in biotic scores is evident with ASPT, WHPT ASPT, NTAXA, WHPT NTAXA, LIFE and PSI ratios reduced on the two downstream waterbodies (GB104028052310 and GB104028053240). Different pressures were possibly evident at two of the downstream locations. WHPT ASPT and NTAXA were reduced at Raynesway, suggesting poor water quality (i.e. organic pollution) and poor habitat. Whereas at St Marys Bridge, although there were cases of reduced WHPT ASPT O/E ratios, generally WHPT ASPT (post 2001) was indicative of Good/High status, whereas WHPT NTAXA were severely low. This trend was also evident at Baslow Devenshire Bridge

and suggest that although these locations may not be impacted by low flows, sedimentation or water quality pressures, there is low taxon richness.

E.3.2 Derwent (Amber to Bottle Brook) (GB104028052310)

Only one monitoring location was present within this waterbody (Belper Mill). Macroinvertebrate index O/E ratios (ASPT, NTAXA, LIFE and PSI) are given in Figure E.1.

ASPT

Historically, ASPT O/E ratios were reduced and indicative of Moderate status. There was an improvement in O/E ratios evident over time, though several samples were indicative of Moderate status. Recent data suggest that WHPT ASPT O/E ratios were generally indicative of Good/High status with high seasonal variation. Notable low ratios include the autumn samples of 2022 and 2024, however, ratios returned to High status in 2023. Data spanned the dry years of 1995, 2003, 2010 and 2011 with no relationship with ASPT O/E ratios observed with reduced O/E ratios occurring in both wet and dry years.

NTAXA

NTAXA O/E ratios had improved between 1985 and 2001, increasing from Bad/Poor status to Good/High status. A decline in NTAXA O/E ratios is evident in recent data which suggest that the macroinvertebrate community is severely impacted by habitat pressures at Belper Mill. Notably, NTAXA O/E ratios were indicative of Bad status in 2020, 2021, 2022, 2023 and 2024. There is high variation within years across the data set, however, no seasonal pattern was evident. Data spanned the dry years of 1995, 2003, 2010 and 2011 with no relationship with NTAXA O/E ratios observed with reduced O/E ratios occurring in both wet and dry years.

LIFE

LIFE O/E ratios are below the guidance threshold across much of the data record. LIFE O/E ratios vary both within and between years with no obvious seasonal pattern evident. Data spanned the dry years of 1995, 2003, 2010 and 2011 with no relationship with LIFE O/E ratios observed with reduced O/E ratios occurring in both wet and dry years.

PSI

PSI O/E ratios followed a similar pattern to LIFE O/E ratios with variation both within and between years. However, PSI O/E ratios occur above the guidance threshold more frequently than LIFE O/E ratios. Data spanned the dry years of 1995, 2003, 2010 and 2011 with no relationship with PSI O/E ratios observed with reduced O/E ratios occurring in both wet and dry years.

E.3.3 Derwent (Bottle Brook to Trent) (GB104028053240)

Biotic O/E ratios for the Derwent (Bottle Brook to Trent) are given in Figure E.1.

ASPT

Recent data for WHPT ASPT O/E ratios were indicative of Good/High status at all locations except Raynesway, with the greatest number of samples achieving High status being from the two most upstream locations, Allestree Ford and St Mary's Bridge Derby. A notably low (Bad status) WHPT ASPT O/E ratio was observed at St Mary's Bridge Derby in autumn 2022. WHPT NTAXA and PSI O/E ratios were also low at this time which indicate compounding pressures, therefore poor water quality cannot be confirmed at this time. At Raynesway, O/E ratios were largely indicative of Poor/Moderate status but improved between the years 1983 and 2010. Since 2010, ASPT O/E ratios have reduced whilst ASPT O/E ratios improved upstream at Allestree ford and plateaued downstream at Borrowash and Wilne. This suggests that isolated water quality pressures impacted the macroinvertebrate community at Raynesway. Data spanned the dry years of 1995, 2003, 2010 and 2011

with no relationship with ASPT O/E ratios observed with reduced O/E ratios occurring in both wet and dry years.

NTAXA

Recent WHPT NTAXA O/E ratios were indicative of Good/High status at Allestree Ford and Borrowash. At all other locations WHPT NTAXA O/E ratios were reduced with variation evident both within and between years. At St Mary's Bridge Derby and Raynesway, deterioration in NTAXA O/E ratios is evident with recent samples being indicative of Bad status. Historically NTAXA O/E ratios were reduced prior to 1995 at all locations with an improvement in NTAXA O/E ratios over time between 1983 and 1995. Data spanned the dry years of 1995, 2003, 2010 and 2011 with no relationship with NTAXA O/E ratios observed with reduced O/E ratios occurring in wet and dry years.

LIFE

LIFE O/E ratios are above the guidance threshold across much of the data record at both Allestree Ford and St Mary's Bridge Derby, particularly in recent years. At Raynesway, Borrowash and Wilne, LIFE O/E ratios were mostly below the guidance threshold and indicated that low flow pressures impacted the macroinvertebrate communities. As with other biotic indices there is variation both within and between years at Raynesway. Data spanned the dry years of 1995, 2003, 2010 and 2011 with no relationship with LIFE O/E ratios observed with reduced O/E ratios occurring in both wet and dry years.

PSI

Macroinvertebrate index PSI O/E scores followed similar trends to those observed in LIFE O/E ratios. At Allestree ford and St Mary's Bridge Derby, LIFE O/E ratios were largely above the guidance threshold. At Raynesway, PSI O/E ratios improved though mostly remained below the guidance threshold, although highly borderline, whereas PSI O/E ratios at Borrowash improved and frequently appeared above the guidance threshold. At Wilne, PSI O/E ratios also improved however, recent data (post-2016) suggests a downward trend. Data spanned the dry years of 1995, 2003, 2010 and 2011 with no relationship with PSI O/E ratios observed with reduced O/E ratios occurring in both wet and dry years.

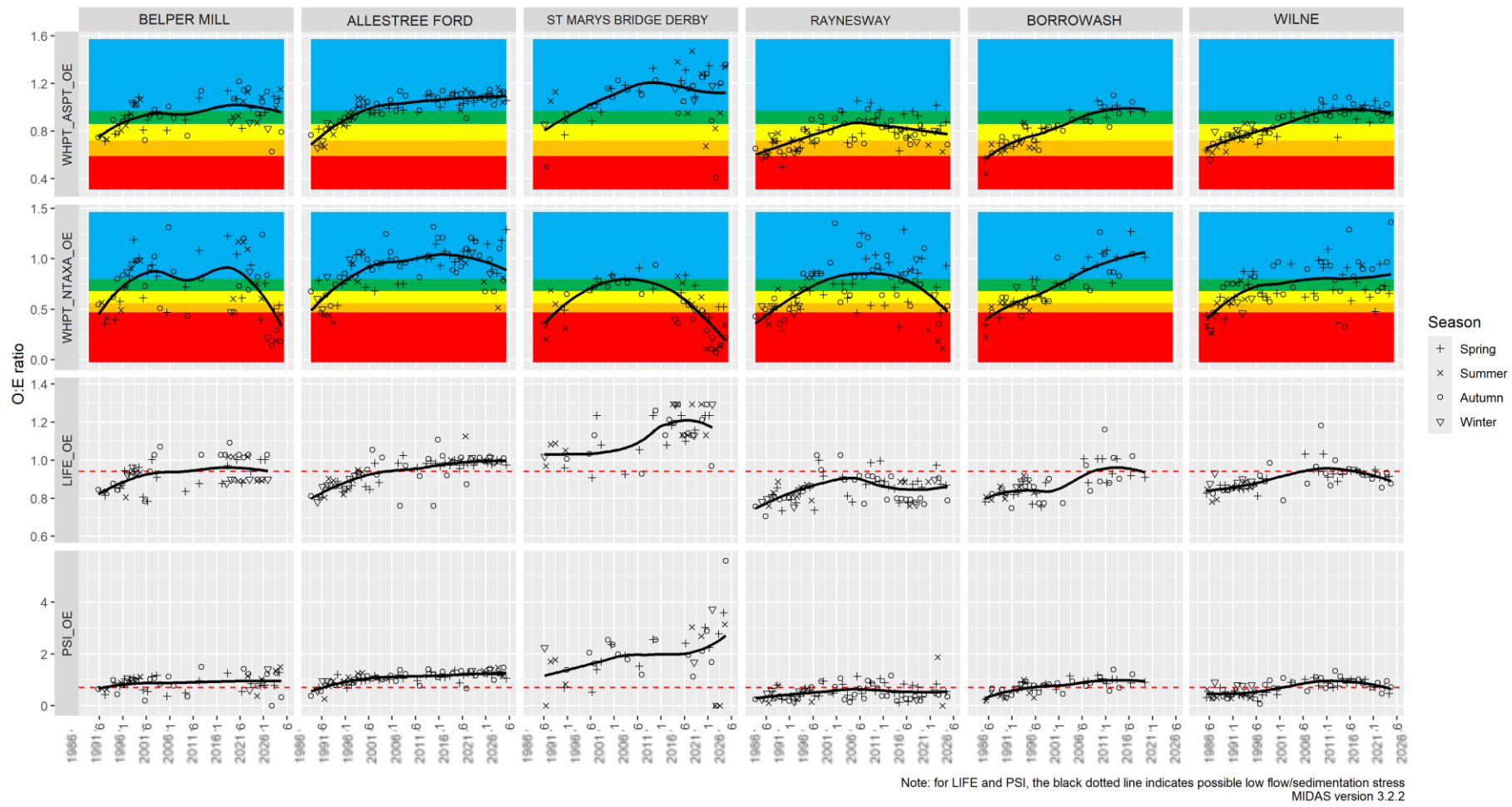


Figure E.1: Macroinvertebrate biotic indices (EA and Severn Trent data combined)

E.4 Impact assessment

E.4.1 Ambergate DP

Derwent (Amber to Bottle Brook) GB104028052310

Moderate flow reductions are predicted in this waterbody, but reductions in hydraulic parameters are predicted to be modest (<10%) and unlikely to have a significant impact on geomorphic processes. No changes in water quality are predicted due to implementation of the Ambergate DP. Therefore, it is not anticipated that there will be any significant impact on the macroinvertebrate community of the River Derwent within this waterbody. The current WFD status of this waterbody is also not expected to reduce in status due to implementation of the DP.

Derwent (Bottle Brook to Trent) GB104028053240

Moderate flow reductions are predicted in this waterbody, but reductions in hydraulic parameters are predicted to be modest (<10%) and unlikely to have a significant impact on geomorphic processes. Changes in water quality are, however, predicted due to implementation of the Ambergate DP. Increases in ammonia and phosphate are predicted, but the macroinvertebrate community at Raynesway reflects a baseline community assemblage responding to pressures from organic pollution as evidenced by the current ASPT and WHPT O/E ratios. Therefore, it is not anticipated that there will be any significant impact on the macroinvertebrate community of the River Derwent within this waterbody. The current WFD status of this waterbody is also not expected to reduce in status due to implementation of the DP.

E.5 Summary

The macroinvertebrate community of the affected waterbodies is, overall, indicative of Good/High ecological status (considered to be of National importance) and (excepting some indication of an impact of poor water quality in reaches downstream), is relatively unimpacted by environmental pressures upstream of Belper Mill. Macroinvertebrate data indicates that the community response to the Ambergate DP is likely to be negligible: the magnitude of effect is negligible as hydraulic change in this reach was considered to be within the range of natural variation. Consequently, changes in flow attributable to implementation of the Ambergate DP will be **Negligible**, with the communities of these waterbodies resilient to low flow periods of the magnitude and duration predicted under the proposed DP, as evidenced in the long-term data record.

E.6 References

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F Fish

F.1 Methodology

F.1.1 Habitat changes

Impacts due to physical habitat change have been assigned based upon expert opinion. Consideration has been given to the seasonal requirements of relevant species and life stages and the likely ecological function of each reach. However, given the modest changes in hydraulic behaviour (transect-averaged velocity, maximum depth etc.), explicit comparisons of the suitability of depth and velocity combinations across transects have not been undertaken.

Individual species and life stages require access to a variety of habitats and conditions on a seasonal basis if they are to succeed in recruiting subsequent generations. While some species, such as perch (*Perca fluviatilis*) and roach (*Rutilus rutilus*), demonstrate greater plasticity in their habitat requirements (termed eurytopic species), other species, including salmonids and certain cyprinid species (e.g. barbel (*Barbus barbus*), dace (*Leuciscus leuciscus*)) require the use of riffle and shallow run habitat to fulfil essential life stage requirements such as spawning, egg incubation and nursery functions (termed rheophilic species). These habitat types are typically more sensitive to impacts during periods of low flow, due for example, to more rapid losses in wetted width compared to deeper glide and pool habitat frequently occupied by eurytopic species. Likewise, species occupying specialist niche habitats such as the utilisation of marginal silts by lamprey ammocoetes are also potentially sensitive to changes in flow. This is due to the nature of the marginal habitats that these species occupy being subject to amplified flow-driven changes in usable wetted area.

Fish species that display similar ecological requirements and life history characteristics have been grouped into distinct 'functional guilds' for the purpose of the ecological assessment. With regards to coarse fish, the majority of species can be defined as either rheophilic or eurytopic in nature. Rheophilic fish display a preference for areas of moderate to fast flowing water; spawning habitat for these species is therefore typically associated with coarse gravel and cobble substrate. Eurytopic fish species display a much wider preference range with regards to habitat requirements, although optimal habitat is typically characterised by areas of static or low velocity water with a greater mean depth. Limnophilic fish species present in the lowermost waterbody have been included within the eurytopic assessment group given a general shared preference towards deeper, slow flowing bodies of water. The majority of coarse fish species have been assigned to one of these functional guilds on the basis of information provided in EA (2004) and Fieseler and Wolter (2006).

Abundant and widespread species such as stone loach (*Barbatula barbatula*), minnow (*Phoxinus phoxinus*), stickleback (*Gasterosteus aculeatus*) were grouped into a "minor coarse fish species" assessment group, which is consistent with the approach taken to define these species within the EA's FCS2 assessment model (and ultimately WFD Fish status outputs). Bullhead (*Cottus gobio*) have been specifically assessed separately on account of their protected status. Lamprey (*Lampetra* sp.) species are also assessed separately given the specific habitat requirements associated with different lamprey life stages.

F.1.2 Migration

The River Derwent supports a number of diadromous species (those that migrate between the sea and freshwater at particular stages of life), including European eel (*Anguilla anguilla*) and salmon (*Salmo salar*). These species require unimpeded connectivity through river systems to access habitat types which fulfil distinct ecological requirements specific to certain life stages. Where free passage for diadromous species is impeded (e.g. due to the impact of weir structures or low-flow induced reductions in water depth), fish may be exposed to migration delay (leading to inopportune seasonal timings for spawning or habitat utilisation), or prevention of migration, each of which can impact on productivity and recruitment of populations.

In addition to diadromous species, there are a number of rheophilic coarse fish species which are known to undertake potamodromous (i.e. within freshwater) migrations (in some cases over quite considerable

distances) for the purpose of depositing their eggs within the upper catchment. In the case of species such as dace, this strategy is to offset the downstream drift of newly hatched larvae, thus preventing their export to sea. For barbel and resident brown trout (*Salmo trutta*), however, this often corresponds with the selection of optimal lithophilic habitats, which offer the best prospects for egg incubation and successful rearing of fry.

To assess the impacts of a drought permit upon migration, structures that are deemed to be impassable under baseline conditions have not been considered as an additional impact as they would remain impassable during the drought permit implementation. However, barriers which are negotiable under all or certain flow conditions during baseline conditions may pose an increased barrier during a drought permit. For example, a reduction in flow may increase the hydraulic head drop over a weir, reduce water depths over the crest or face of a weir or decrease the depth of water on the approach to a structure, each of which have the potential to pose a greater obstruction to migration. Similarly, where fish passes are present adjacent to weir structures a reduction in river flow may decrease the depth of water through the fish pass – depending on the magnitude of the reduction this may be sufficient for a fish pass to fall outside of the design parameters required for effective operation. It is acknowledged that river flows also play an important role in providing part of the cues required to trigger upstream salmon migration (though to be in the region of 101% to 284% of the Q95 flow (Hendry & Cragg-Hine, 2003), depending on the river. Whilst a detailed investigation of migratory flows has not been undertaken as part of this drought permit, the anticipated short-term nature of DP implementation coupled with the fact that the DP will not reduce flows below those experienced under Baseline conditions suggests that any impacts on upstream salmon migration will be temporary and will occur over a very small temporal scale.

F.1.3 Fisheries data

The majority of the survey data comprise previous EA monitoring surveys, which is summarised for each of the waterbodies in at the end of this appendix with the survey sites being listed from upstream to downstream within each table. The majority of these population surveys have been collected through either semi-quantitative (single run) or quantitative (multiple run with depletion) standard methodology electric fishing surveys. Since 2004, the frequency of surveys has increased at a number of sites; however, the months in which surveys are undertaken vary between years for the majority of sites, meaning that between-year variation is difficult to quantify (e.g. the effect of natural mortality, particularly for juvenile life stages, precludes direct comparison between different months and years without the application of a mortality adjustment factor).

The EA fish datasets are supplemented by data collected by APEM for Severn Trent. In September 2010 APEM undertook a monitoring programme to provide baseline data to support future drought permit applications. The surveys comprised a quantitative electric fishing survey targeting 0+ fish to assess recruitment success. In light of the extensive stocking activity on the River Derwent, which includes both salmonid and coarse fish species, 0+ (or young-of-the-year) fish provide the most appropriate biological receptor for categorising the quality of the fish population within context of the WFD fisheries assessment criteria, as all stocked fish are older than 0+ (i.e. >0+). Species only shown as >0+ may also be recruiting naturally, but their numbers may be supplemented, or entirely created, by stocking. Where the size of fish has been recorded, EA catch data has therefore been further analysed to indicate whether the fish found for each species are 0+ or >0+, or both.

The results of the APEM electric fishing and seine (fry) surveys are summarised in at the end of this appendix. Subsequent data collected from 2011 and 2013 has used several different survey methods; electric fishing (both multi-run, fully- quantitative and single-run, semi-quantitative), targeted quantitative electric fishing for lamprey ammocoetes, targeted point sampling and seine netting. Given that the data have simply been used to characterise the baseline fish community present with each waterbody, as opposed to informing any quantitative analysis, the differing survey methods are not of concern to this study. These data are presented at the end of this appendix. Details of stocking activity are given in ESI and APEM (2012).

Lastly, Ricardo's 2023 Derwent Fisheries Report (Ricardo, 2023) also provides relevant population data at numerous sites on the Derwent. The site details, survey methodologies and data are detailed within Ricardo's

report and are therefore not repeated within this report, but the results of the surveys have been used to inform the list of species under consideration below.

A total of 23 fish species were recorded as being present at sites within the River Derwent. As would be expected, the data show distinct differences in community composition in the upper and lower reaches of the River Derwent. The following species/ guilds have been considered for impact assessment, not all of which are considered for all waterbodies:

- Atlantic salmon;
- Brown/sea trout;
- Rheophilic coarse fish (comprising barbel, chub (*Squalius cephalus*), dace, grayling (*Thymallus thymallus*), gudgeon (*Gobio gobio*), stone loach and spined loach (*Cobitis taenia*));
- Eurytopic coarse fish (comprising perch, pike (*Esox lucius*), roach, ruffe (*Gymnocephalus cernua*), tench (*Tinca tinca*), bleak (*Alburnus alburnus*) and common bream (*Abramis brama*));
- Minor coarse fish species (comprising minnow and three-spined stickleback);
- Bullhead;
- European eel;
- Brook lamprey (*Lampetra planeri*); and
- River lamprey (*Lampetra fluviatilis*).

Effects on Atlantic salmon have been considered for all waterbodies in the event of future restoration of the salmon population through the removal or mitigation of barriers.

F.1.4 Walkover data

A habitat walkover survey was conducted for the previous drought permit EAR (ESI & APEM, 2012) over a total river length of 20 km, comprised of individual sections ranging in length from 1.9 km to 2.7 km. For the purpose of the habitat and fisheries impact assessment, surveys focused primarily upon habitat walkover data collected 500 m upstream and downstream of hydrological cross sections (i.e. a total reach length of 1 km).

The percentage composition of habitats within each survey reach has been calculated to inform the abundance of individual surface flow types and habitat areas during the baseline conditions. From this, information can be inferred regarding the extent of habitat within each survey reach and waterbody that may be considered most vulnerable to low flow induced impacts during drought permit conditions (e.g. spawning and juvenile habitat in areas of riffle and shallow run flow). Cross-sections were located within habitat broadly representative of each reach. Walkover and cross section data are explained further in Appendix B.

F.1.5 Passability at structures

Passability of structures, originally assessed by Bottomly and Jarrams (1985), has been updated based upon information on fish passage improvements by the EA. The River Derwent has a large number of mills and associated weirs, as well as flood relief and gauging weirs and fish passes. Table F.1 lists all those structures and categorises them according to the degree to which they are passable by adult salmon migrating upstream. Where applicable, the original classifications have been revised at structures where fish passes have been constructed.

It should be noted that the categories within Table F.1 are based upon salmon passage, and that structures which are passable for salmon may often be impassable for other fish species, particularly weaker swimming coarse fish species such as perch and bream. If a structure is impassable to salmon migrating upstream it has been considered impassable to the majority of other species. That said, there may also be additional barriers that were not considered for upstream migrating salmon yet would act as a barriers to other species.

Table F.1 Passability of in-stream structures for Atlantic salmon

Listed from upstream to downstream. A = Impassable at all flows, B = Passable at high flows, C = Passable at all flows with difficulty, D = Passable at all flows with no difficulty. Taken from Bottomly and Jarrams (1985).

Site	Grid reference	Category	Comments
Derwent from Amber to Bottle Brook (GB104028052310)			
Belper	SK 3448	A	Currently the subject of fish passage investigation works by Derwent Valley Mills
Milford (Glow-worm)	SK 3445	B	HEP offtake upstream of weir which creates a depleted reach, including the weir. Weir likely to be passable to high flows (revised from category A to B)
Milford (Rec Ground)	SK 3544	D	Fish pass
Peckwash Mill, Duffield	SK 3542	D	Weir partly collapsed
Derwent from Bottle Brook to Trent (GB104028053240)			
Darley Abbey	SK 3538	D	Larinier fish pass constructed in 2014
Longbridge Weir, Derby	SK 3536	D	Larinier fish pass constructed alongside HEP scheme in 2013
Incinerator plant	SK 3834	A	Flood relief weirs only – upstream passage possible via other routes
Power station sluices	SK 3934	A	
Derby power station	SK 4032	A	
Borrowash	SK 4134	D	Larinier fish pass constructed in 2012
Wilne gauging weir	SK 4431	D	Severn Trent owned
Church Wilne	SK 4431	C	Old derelict fish pass

F.2 Baseline

F.2.1 Derwent from Amber to Bottle Brook (GB104028052310)

The fish species composition within the Amber to Bottle Brook waterbody comprises of a mixture of resident salmonids, rheophilic and eurytopic coarse fish species.

Salmonids, including brown trout and grayling, remain present and juvenile Atlantic salmon have been recorded in the waterbody during recent survey years. However, the walkover survey for the River Derwent in close proximity to AP6 (Belper) shows the majority of the channel to comprise pool and glide surface flow types and there is an increasing trend towards a coarse fish dominated community through the middle courses of the river. A number of rheophilic species, including barbel, chub and dace are present, in addition to eurytopic species such as perch, pike and roach.

F.2.2 Derwent from Bottle Brook to Trent (GB104028053240)

The Derwent from Bottle Brook to Trent is characteristic of an increasingly lowland waterbody and the fish species composition differs somewhat to the three upstream waterbodies. Data from the habitat surveys in close proximity to the two cross-sections (AP7 Allestree and AP8 Derby St Mary's Bridge) are similar to the previous waterbody – the reach surrounding AP7 comprises predominantly of glide habitat (ca. 65 %) and AP8

comprises exclusively of glide habitat. However, there is a reduction in the presence of salmonids and a shift towards a species composition dominated by a greater number of limnophilic species – i.e. those preferring still or slow-moving water (e.g. tench, rudd, bream). This reflects the increasingly lowland nature of the River Derwent.

F.2.3 Summary

There are a number of fish species of conservation importance and also considered to be sensitive to the impacts of low flows. Atlantic salmon (*Salmo salar*), bullhead (*Cottus gobio*) and brook lamprey (*Lampetra planeri*) are each designated as Annex II species under the Habitats Directive. Both brook lamprey and bullhead are Annex II species and qualifying features of the Peak District Dales SAC (although not listed as primary reasons for this designation).

Historically, extensive stocking has been conducted throughout the Derwent for enhancement and mitigation purposes. Stocking effort has been reduced year on year as management focus has shifted to maintaining sustainable fish populations, but barriers to fish migration remain and stocking of juvenile coarse fish species is understood to be on-going (Matt Buck, EA Fisheries, pers. comm., 5 September 2018).

Historical channel modifications are an important influence on fish populations. Impoundments have created large areas of deep and slow flowing water and are likely to have contributed to the development of the coarse fishery. The upper reaches of the river are also considered impenetrable to diadromous species (salmon and sea trout) due to the presence of barriers (these were also impassable to coarse fish species that might undertake upstream migrations within the river). Prior to the industrial revolution, the River Derwent is known to have supported a healthy run of Atlantic salmon, with run sizes exceeding 3,000 fish still reported from the River Trent in the late 19th Century. More recently, a number of studies were conducted during the 1980s to assess the feasibility of reintroducing salmon to the Derwent (Cowx, 1986). These reports concluded that, despite the availability of suitable physical habitat within the upper River Derwent, such habitats could not be utilised by self-sustainable populations until returning adults were afforded migratory passage around the many instream structures which continue to compromise fish passage today. In recent years connectivity in the lower River Derwent has been improved through the construction of fish passes at barriers to migration. Consequently, juvenile salmon have been recorded at a number of EA monitoring sites in recent years.

F.3 Impact Assessment – physical habitat and water quality

Derwent from Amber to Bottle Brook (GB104028052310) waterbody

The proposed DP would reduce flows in the River Derwent at the AP6 cross-section. The hydrology studies have illustrated that the DP implementation would be unlikely to affect low summer flows and would be most likely to affect the small to moderate spate peaks in the late winter/early spring. There would be no change in the lowest river flows, relative to a baseline drought situation.

The fish assessment has adopted the worst-case hydraulic changes as presented in the hydromorphology assessment (associated with the driest period from the modelled drought series). Change would be manifested as a temporary increased duration of modestly slower flowing glide and a perceptible, but not significant loss of water depth and velocity. Predicted reductions in wetted width and perimeter are very small (2% and 3% respectively). Based on the seasonality of the anticipated impacts (late winter/early spring), the most sensitive life stages of concern would be the egg incubation and alevin/early fry emergence phases of salmonid species. However, given that the lowest flows are not affected and that the primary effect would be to reduce small to moderate spate events, the risks of dewatering to salmonid redds is considered minimal. Furthermore, there is a relatively small proportion of low flow sensitive habitat in the Derwent from Amber to Bottle Brook waterbody, with the majority of the surveyed reach comprising pool and glide surface flow types. As such, any effects associated with the DP are likely to extend over a small spatial scale and be short term in duration, leading to a **Negligible** magnitude of effect and a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) impact significance for all species and life stages during all months.

Negligible changes were predicted for all water quality parameters during DP operation. Specifically, negligible impacts are anticipated as a result of the DP on BOD, nitrate, dissolved oxygen, temperature and metals (Appendix D). A negligible effect on all species and life stages at all times of years is therefore considered likely, resulting in a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) impact significance.

Derwent from Bottle Brook to Trent (GB104028053240) waterbody

Hydraulic modelling and hydromorphology interpretation for the AP7 and AP8 cross-sections indicate that changes during the proposed DP would be minor in magnitude (noting as above that flow change relative to baseline would not occur at low flows i.e., <500MI/d at Derby SMB). The associated wetted width and perimeter change is small. Data from walkover surveys in the Derwent from Bottle Brook to Trent waterbody identified a greater proportion of pool and glide flow and a relatively small proportion of low flow sensitive habitat compared to the upstream water bodies. In addition, the fish species composition of the waterbody is dominated by a greater proportion of species that are either eurytopic or limnophilic in nature and thus tolerant of, or displaying a preference for, areas of slower moving water. As such, any effects associated with the DP are likely to extend over a small spatial scale and be short term in duration, leading to a **Negligible** magnitude of effect and a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) impact significance for all species and life stages during all months.

A small increase in the concentration of phosphate is predicted downstream of Derby STW (Appendix D). However, the predicted DP annual phosphate concentration increases to 0.17 mg/l, which is still within the same Moderate WFD status classification band, and would not realistically affect all portions of the flow duration curve and would only be implemented over a portion of the year. The scale of this predicted water quality change is therefore unlikely to be sufficient to affect fish populations, if the precautionary assumptions that form part of the phosphate assessment are taken into account. However, to ensure a precautionary assessment, the worst-case (**Low** magnitude) phosphate change at AP8 is assumed. Acknowledging the temporary nature and small spatial scale of effect and the low likelihood of predicted phosphate changes, but retaining a precautionary approach with regard to impacts on fish, a **Minor** impact significance (dependent on receptor values of individual fish species/groups) on fish populations is concluded (across all months and life stages). The predicted scale of effects, particularly associated with Derby STW, would be validated during any future DP implementation via monitoring (e.g., proposed water quality monitoring downstream of Derby STW). Negligible changes were predicted in response to all other water quality parameters.

F.4 Impact Assessment – passability at structures

Derwent from Amber to Bottle Brook (GB104028052310) waterbody

A reduction in flow is predicted under the Ambergate DP, but the reduction would only apply at flows above 500 MI/d due to the HOF associated with the abstraction. Two of the structures within the waterbody (Milford and Belper) are deemed to be migration barriers under all flow conditions and thus passage would not be worsened by the Ambergate DP. There is the potential for passage at the remaining two structures – Peckwash Mill and Milford (Rec Ground) - to be adversely impacted during the implementation of the DP. The EA's default requirement for multi-species fish passes is for suitable hydraulic conditions to be maintained through the fish pass across an operating window of Q95 – Q20 (extending to Q10 for salmon). Therefore, on the assumption that the fish pass has been designed to operate effectively down to a low flow of Q95, there would remain sufficient flow in the river for the pass to remain operational during implementation of the DP.

It is not fully known how a reduction in flow may affect the passability of the Peckwash Mill Weir (noted to be partly collapsed), particularly for species other than salmon that have a poorer swimming ability. Issues associated with reduced passability at the structure are most likely to manifest during the spawning migration season for brown trout (October to December) and coarse fish species (March – June). Any impacts would, however, be small in spatial scale (applying only to the single structure) and short term in duration (passability would return to normal baseline levels upon cessation of the DP), equating to a **Negligible** overall effect and

a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) impact significance for all species and life stages.

Derwent from Bottle Brook to Trent (GB104028053240) waterbody

Each of the Larinier fish passes is designed to operate effectively at flows down to Q95 (confirmed via information provided as part of the EA's data request response) and thus the reductions in flow associated with the Ambergate DP would not be expected to cause any of the fish passes to fall outside of their operational design range. Consequently, a **Negligible** effect on migration is considered likely for all species and life stages, leading to a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) impact significance.

F.5 Summary

The expected impacts on fish species following the implementation of the Ambergate drought permit are summarised below in Table F.2 to Table F.3. The summary assessment presents the worst case scenario in terms of impacts of the drought permit on any given species.

Table F.2 Fish assessment, River Derwent (from Amber to Bottle Brook), Ambergate drought permit

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Atlantic salmon	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*
Brown trout	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*
Bullhead	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*
Rheophilic coarse fish	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*
Eurytopic coarse fish	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*
Minor coarse fish	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*	M*

M*= (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category)

Table F.3 Fish assessment, River Derwent (from Bottle Brook to Trent), Ambergate drought permit

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Atlantic salmon	Min	Min	Min	M*	M*	M*	M*	M*	M*	Min	Min	Min
Brown trout	Min	Min	Min	M*	M*	M*	M*	M*	M*	Min	Min	Min
Bullhead	Min	Min	Min	M*	M*	M*	M*	M*	M*	Min	Min	Min
Rheophilic coarse fish	Min	Min	Min	M*	M*	M*	M*	M*	M*	Min	Min	Min
Eurytopic coarse fish	Min	Min	Min	M*	M*	M*	M*	M*	M*	Min	Min	Min
Minor coarse fish	Min	Min	Min	M*	M*	M*	M*	M*	M*	Min	Min	Min
European eel	Min	Min	Min	M*	M*	M*	M*	M*	M*	Min	Min	Min
Brook lamprey	Min	Min	Min	M*	M*	M*	M*	M*	M*	Min	Min	Min

Min = Minor significance, M*= (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category)

Spawning / egg incubation life stages only

F.6 Certainty

While the WFD fisheries classification scheme has been developed to broadly categorise waterbodies, the level of uncertainty within the assessment tool is too high to separate the effects of contributory factors such as anthropogenic manipulations of flow. Furthermore, the level of stocking that is known to take place within the Derwent further confounds any conclusions that may be drawn.

Report Reference:

Report Status: Final

Historical EA data provide some useful information such as identifying the presence of low-flow sensitive species that could potentially act as indicators from which to measure drought and drought permit effects. Stocking data may also be used to provide important supplementary information relating to the level of natural occurrence and recruitment of certain species of interest. However, the EA electric fishing survey approach has not been specifically designed to provide comparison of the same months between years, and thus data are not amenable for quantitative comparison. Sampling design may have further restricted the detection of lamprey species at all sites. Due to their cryptic nature, standard, single run electric fishing surveys often fail to identify lamprey even where present.

F.7 References

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F.8 Data tables

Table F.4 EA electric fishing surveys, River Derwent (Amber to Bottle Brook)

Site name	Grid reference	No. of surveys	Years	Species recorded
Wyver Lane	SK 34 48 (1998) & SK 34 48 (2005)	2	1998, 2005	Brown / sea trout, pike, chub
Belper Weir	SK 34 48	2	2017, 2018	Atlantic salmon
Duffield	SK 34 43	9	1998, 2001*, 2002*, 2004*, 2005*, 2006*, 2007*, 2008*, 2009*	Brown / sea trout, barbel, grayling, chub, minnow, roach, 3-spined stickleback, perch, pike, bullhead, dace
Duffield Bridge	SK 35 43	8	2014, 2015, 2016, 2017, 2018, 2022, 2023, 2024	Brown / sea trout, Atlantic salmon, barbel, grayling, chub, minnow, bullhead, stone loach
Peckwash Mill	SK 35 42	1	2010	Brown / sea trout, chub, dace, minnow, bullhead, stone loach

*By rod and line

Table F.5 EA electric fishing surveys, River Derwent (Bottle Brook to Trent)

Site name	Grid reference	No. of surveys	Years	Species recorded
DS Longbridge Weir	SK 35 36	2	2014, 2015	Brown / sea trout, Atlantic salmon, grayling, bullhead, stone loach
Alverston	SK 37 34	2	1993, 1998	Barbel, grayling, chub, bullhead, gudgeon, dace, common bream, roach, European eel, pike, tench, perch, ruffe
Raynesway Weir Pool	SK 38 34	1	2015	Stone loach, minnow, bullhead, 3-spined stickleback, brook lamprey
Borrowash Black Weir	SK 40 33	1	2015	Minnow, 3-spined stickleback, gudgeon, perch, European eel, bullhead, stone loach, brook lamprey
Borrowash	SK 40 33	9	2001*, 2002*, 2004*, 2005*, 2007*, 2008*, 2009*, 2010**, 2013*	Barbel, chub, dace, grayling, bleak, common bream, silver bream, tench, gudgeon, roach, perch, minnow, bullhead, rudd, pike, 3-spined stickleback
Chub Alley	SK41 34	5	2010, 2012, 2012***, 2014, 2017	Barbel, bleak, chub, dace, pike, perch, bullhead, stone loach, spined loach, minnow, gudgeon, tench, roach, 3-spined stickleback, brook lamprey
Nooning Lane Net	SK 43 33	3	2010***, 2012***, 2024***	Barbel, bleak, chub, gudgeon, 3-spined stickleback, roach, stone loach, spined loach, dace, minnow, perch
Nooning Lane	Three sites, centred on SK 43 32	8	1998, 2005, 2007, 2008, 2009, 2010, 2014, 2017	Barbel, chub, grayling, dace, European eel, bleak, gudgeon, spined loach, stone loach, minnow, bullhead, perch, ruffe, 3-spined stickleback, brook lamprey
Draycott	SK 44 32	1	2005	Barbel, chub, common bream, dace, roach, pike minnow
Church Wilne	SK 44 31 & SK 44 31	9	1994, 1993, 2001*, 2002*, 2003*, 2004*, 2005*, 2007*, 2008*	Barbel, bleak, chub, gudgeon, dace, roach, perch, stone loach, silver bream, common bream, minnow, tench, rudd

*By rod and line

**By seine netting. NB the site name for this event is given on the EA records as Chub Alley, but the NGR is for Borrowash

***By seine netting

Table F.2 Species recorded at Baslow

Single quantitative electric fishing survey and seine netting surveys conducted on 06-08/09/10 by APEM. Present (1), absent (0). APs ordered from upstream to downstream.

Species	Baslow SK 25 72		Whatstandwell SK 33 54	Belper SK 34 47		Raynesway SK 38 34		Allestree Ford SK 15 89	
	0+	>0+		0+	>0+	0+	>0+	0+	>0+
3-spined stickleback	0	0	0	1		1		1	
Barbel	0	0	0	0	0	1	0	1	0
Bream	0	0	0	0	0	1		0	0
Brown trout	1	1	0	0	0	0		0	0
Bullhead	1		1	1		1		1	
Dace	0	0	0	1	0	0	0	1	0
Grayling	0	1	0	0	0	0	0	0	0
Gudgeon	0	0	0	1		0	0	0	0
Perch	0	0	0	0	0	1		0	0
Lamprey	0	0	1	0	0	0	0	0	0
Minnnow	0	0	1	1		1		1	
Rainbow trout	1		0	0	0	0	0	0	0
Ruffe	0	0	0	1		0	0	0	0
Roach	0	0	0	1		0	0	1	
Stone loach	0	0	0	1		1		1	

Table F.3 APEM fish surveys on the River Derwent between 2011 and 2013.

Site		Grid reference	No. of surveys	Years	Species recorded
Name	Ref				
Yorkshire Bridge	E1-04	SK 19 85	3	2011, 2012, 2013	Brown / sea trout, bullhead
Hathersage	E1-05	SK 23 80	2	2011, 2013	Brown / sea trout, bullhead, grayling
Baslow	E1-06	SK 25 72	3	2011, 2012, 2013	Brown / sea trout, Atlantic salmon, bullhead, grayling, rainbow trout, stone loach, river / brook lamprey
Whatstandwell	E1-01	SK 33 53	3	2011, 2012, 2013	Brown / sea trout, minnow, bullhead, river / brook lamprey, grayling, chub, 3-spined stickleback, dace, stone loach
Belper	E1-10	SK 34 48	3	2011, 2012, 2013	Bullhead, stone loach, minnow, 3-spined stickleback, chub, gudgeon, roach, rudd, ruffe
Duffield	E1-11	SK 34 43	3	2011, 2012, 2013	Brown / sea trout, bullhead, chub, dace, gudgeon, minnow, roach, 3-spined stickleback, barbel, stone loach
Allestree Ford	E1-12	SK 35 40	3	2011, 2012, 2013	Barbel, bullhead, stone loach, minnow, 3-spined stickleback, chub, gudgeon, perch, roach, river / brook lamprey
Raynesway	E1-14	SK 38 34	3	2011, 2012, 2013	Brown / sea trout, minnow, pike, perch, 3-spined stickleback, chub, stone loach, bullhead

G Protected Species

G.1 Background

This assessment focusses on the potential effects of implementation of the proposed drought permit on protected and notable species. The Ambergate DP scenario simulates the maximum permitted abstraction with a reduction in Hands-off Flow (HoF) from 680 Ml/d to 500 Ml/d. This will only apply to the lower Derwent (i.e., downstream of Ambergate). The geographical extent of the study area covered includes a total of two WFD surface water bodies (water body ID in brackets):

The River Derwent from Amber to Bottle Brook (GB104028052310); and

The River Derwent from Bottle Brook to Trent (GB104028053240).

This assessment covers: bats (*Chiroptera*), beaver (*Castor fiber*), birds (inclusive of waders, riverine species, wildfowl and gulls), common amphibians, great crested newts (*Triturus cristatus*; GCN), otters (*Lutra lutra*), reptiles, water voles (*Arvicola amphibious*), and white-clawed crayfish (*Austropotamobius pallipes*; WCC). Possible impacts on protected macroinvertebrate, fish species, and invasive non-native species (INNS) are covered separately in Sections E, F, and G, respectively.

Macrophytes and diatoms receptors have been scoped out of further assessment due to the absence of designation in any of the study watercourses (See Introduction, Section 1.3 'Scope of Assessment').

Furthermore, the proposed drought permits are not predicted to have any significant impact on terrestrial ecosystems (see Designated Sites, Section I for details) and thus potential effects on most terrestrial species have not been considered.

G.1.1 Legislation

Bats

All bat species are designated and protected as European Protected Species (EPS) under Schedule 2 of the Conservation of Habitats and Species Regulations 2017. As an EPS in England, the legislation provides full protection to bat breeding sites and resting places also known as roosts.

All bat species in the UK receive full protection in England under Schedule 5 of the Wildlife and Countryside Act (WCA) 1981 (as amended).

The following bat species are listed under Section 41 of the NERC Act 2006 as a Species of Principal Importance for Nature Conservation in England: barbastelle bat (*Barbastella barbastellus*), Bechstein's bat (*Myotis bechsteinii*), noctule (*Nyctalus noctula*), soprano pipistrelle (*Pipistrellus pygmaeus*), brown long-eared bat (*Plecotus auritus*), greater horseshoe bat (*Rhinolophus ferrumequinum*) and lesser horseshoe bat (*Rhinolophus hipposideros*).

Beavers

Beavers are designated and protected as an EPS under Schedule 2 of the Conservation of Habitats and Species Regulations 2017. As an EPS in England, the legislation provides full protection to beaver breeding sites and resting places also known as lodges. They receive further legal protection under the WCA, as amended.

Birds

Regulation 10 of the Conservation of Habitats and Species Regulations 2017 places a duty on public bodies to take measures to preserve, maintain, and re-establish habitat for wild birds. The regulation has regard to

the European Union (EU) Wild Birds Directive 2009/147/EC and the EU Habitats Directive 92/43/EEC, where bird species receive protection through European designated sites including both Special Protection Areas (SPA) and Ramsar sites.

All breeding birds, their eggs and active nests are protected under the WCA 1981 (as amended). Additional protection is afforded to those species listed on Schedule 1 of the Act, where protection is extended to protect these species against intentional or reckless disturbance at the nest.

Common Amphibians

Common frogs (*Rana temporaria*), common toad (*Bufo bufo*), smooth newt (*Lissotriton vulgaris*) and palmate newt (*Lissotriton helveticus*) receive partial protection in England under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) with respect to sale only.

Common toads are listed under Section 41 of the NERC Act 2006 as a Species of Principal Importance for Nature Conservation in England.

Great Crested Newts

GCN are designated and protected as an EPS under the Conservation of Habitats and Species Regulations 2017. As an EPS in England, the legislation provides full protection to GCN breeding sites and resting places.

GCN receive full protection in England under Schedule 5 of the WCA 1981 (as amended).

GCN are listed under Section 41 of the NERC Act 2006 as a Species of Principal Importance for Nature Conservation in England.

Otters

Otters are designated and protected as an EPS and are protected under the Conservation of Habitats and Species Regulations 2017. As an EPS in England, the legislation provides full protection to otter breeding sites and resting places, known as holts and couches respectively.

Otters receive full protection in England under Schedule 5 of the WCA 1981 (as amended).

Otters are listed under Section 41 of the NERC Act 2006 as a Species of Principal Importance for Nature Conservation in England.

Reptiles

Six native reptile species live and breed within England. The two rarest reptiles, including sand lizard (*Lacerta agilis*) and smooth snake (*Coronella austriaca*), are designated and protected as an EPS and are protected under the Conservation of Habitats and Species Regulations 2017. As an EPS in England, the legislation provides full protection to sand lizard and smooth snake breeding sites and resting places.

Four of the native species, including common lizard (*Zootoca vivipara*), slow-worm (*Anguis fragilis*), adder (*Vipera berus*) and grass snake (*Natrix helvetica*) receive partial protection under Schedule 5 of the WCA 1981 (as amended), in respect to killing, injuring, and sale. The WCA 1981 (as amended) act affords full protection to both the sand lizard and smooth snake.

Reptiles are protected under the WCA (1981), and although widespread throughout the UK, their populations are considered to be declining. As a result, all species of reptile (six in the UK) are listed as a biodiversity priority species under the NERC Act (2006).

Water Voles

Water voles receive full protection in England under Schedule 5 of the WCA 1981 (as amended).

Report Reference:

Report Status: Final

Water voles are listed under Section 41 of the NERC Act 2006 as a Species of Principal Importance for Nature Conservation in England.

White-clawed crayfish

The Conservation of Habitats and Species Regulations 2017 places a duty on public bodies to take measures to preserve, maintain, and re-establish habitat for WCC. The regulation has regard to the EU Habitats Directive 92/43/EEC, where WCC receive protection through European designated sites including Special Area of Conservation (SAC) for their protection.

WCC receive partial protection in England under Schedule 5 of the WCA 1981 (as amended), in respect to killing, injuring, and sale.

WCC are listed under Section 41 of the NERC Act 2006 as a Species of Principal Importance for Nature Conservation in England.

G.1.2 Potential routes of impact

The main potential effects of the proposed drought permit would occur as a result of potential changes to the availability of suitable habitats for breeding or refuge and potential changes to the availability (access to and quantity of) food sources. At a receptor-specific level these potential routes of impact are as follows:

- Bats
 - Waterways provide a pivotal ecological corridor for foraging and commuting bats, and a reduction in bankside vegetation coverage, river flow, water quality, or change in marginal exposure and wetted width, could result in a decrease in insect prey availability (invertebrates with aquatic life stages e.g. stoneflies and mayflies) and thus food sources for all UK bat species populations. Despite the fact that bats do not typically consume aquatic invertebrates in their larval or nymph stages, any modifications resulting from the proposed drought permit could have a subsequent impact on invertebrates in their terrestrial adult phases, which bats utilise.
- Beavers
 - Changes to water levels or flow could affect emergent macrophyte distribution / extent on the river margins which could have subsequent effects on the availability of appropriate food resources for beavers. Beavers have a small foraging distance of 60 m from the water's edge (20 m average).
 - Dam building is triggered by low water levels, so conversely a decrease in water levels could have some positive impact but if water levels drop too low, entrances to lodges could be exposed on existing dams.
- Birds
 - For piscivorous waterbirds and otter, predation of fish may be more effective under low water level and/ or flow conditions as both juvenile and adult fish may become more visible in shallower water and more concentrated as the wetted perimeter decreases.
 - Impacts of the proposed drought permit on insectivorous waterbirds, such as dipper (*Cinclus cinclus*), and grey wagtail (*Motacilla cinerea*) would be primarily through changes in the total abundance and community composition of macroinvertebrates.

- For herbivorous waterbirds, lowered water levels could make aquatic macrophytes more accessible initially but if the water level were to fall below the zone of macrophyte growth there may not be further plant food sources at lower levels.
- For nesting waterbirds, falling water levels could strand floating nests or make nests held above the water accessible to terrestrial predators.
- Common Amphibians
 - The common toad generally prefers deeper water bodies in which to breed such as ponds and reservoirs. An overall change in the ground water level in the catchment could mean that local ponds dry out at critical points in toad breeding cycles.
 - Pollution events such as agricultural runoff, and chemical increases i.e. nitrates and phosphorus in rivers could have an effect for ponds if connected via the water table or are hydrologically connected. A build up in pollutants or chemicals could promote unsuitable conditions amphibian populations such as low oxygen levels, and algal blooms as a result of this. Conditions such as these could also encourage the establishment of invasive non-native species that thrive and outcompete native counterparts.
 - Common toads are unlikely to utilise flowing bodies of water, however, are considered as a precaution in this EAR because they are important protected species associated with aquatic habitats that are known to occur locally.
- Great Crested Newts
 - GCN generally prefer small to medium sized fish-free ponds for breeding and do not breed in rivers. Potential pathway routes of impact are therefore not expected within the study waterbodies themselves, however, an overall change in the ground water level in the catchment could mean that local ponds dry out at critical points in the aquatic phase of the life cycle.
 - GCN generally require consistent moderate to high water quality. Although they may use ponds of different conditions, GCN can be sensitive to changes in the water quality. As long as the pond has adequate oxygen, low nitrate levels and, in the case of breeding ponds, enough macrophytes appropriate for laying eggs, they can withstand short-term low water quality (Peak District National Park Authority, 2011). Longer term impacts on water quality will impact prey availability and their ability to survive in their aquatic phase.
 - GCN are considered in this EAR because they are important protected species associated with aquatic habitats that are known to occur locally.
 - Cumulative effects of water quality and water levels as a result of the implemented drought permit could lead to decreased resilience of any metapopulations already present in the vicinity of the study area and may increase the probability of invasive non-native species establishing
- Otters
 - The primary means by which the proposed drought permit might impact otters is through a change in food supply and water quality.
 - Fish species, such as salmon (*Salmo salar*), brown trout (*Salmo trutta*), and eels (*Anguilla anguilla*), comprise a significant proportion of an otter's diet, and therefore negative impacts on fish populations may adversely impact otters.

- Otters require high quality and unpolluted water and therefore a reduction in the water quality through the concentration of pollutants may adversely impact otter habitat suitability.
- Reptiles
 - For reptile species with a proclivity for water, such as grass snake, changes in water levels could alter abundance of prey such as amphibians and fish. In addition to this, water level changes could make reptiles more accessible to predators such as heron (*Ardea cinerea*) and birds of prey.
 - Changes in water levels could alter the availability and / or suitability of riparian reptile habitat and / or hibernacula.
- Water Voles
 - Changes to water levels or flow could affect emergent macrophyte distribution / extent on the river margins and therefore that could have subsequent effects on the water vole food resources.
 - Falling water levels could make water vole burrows more accessible to terrestrial predators, such as American Mink (*Neogale vison*).
 - Water voles primarily feed on aquatic vegetation such as reeds, sedges, and grasses. Poor water quality can reduce the abundance and condition of these habitats, leading to a scarcity of food resources for the populations. Nutrient pollution (e.g., excess nitrogen or phosphorus), can lead to oxygen depletion in water bodies and prevent habitat growth.
 - The non-native American mink, like with all invasive species, are extremely adaptable to change, allowing them to thrive and outcompete their native co-habitants. If this should occur for a prolonged period of time, water vole could struggle to recolonise once non-native populations have established.
- White-clawed crayfish
 - The main mechanisms via which the proposed drought permit might impact WCC are through a reduction in river flow or habitat cover, which could make them more vulnerable to predation.
 - Crayfish are more vulnerable to predators when there is a lack of cover from rocks and crevices. Through decreases in wetted width and water depth, a shift in water level may affect the amount of cover available, especially on the margins (Holditch, 2003). Other predators, such as larger fish or invasive species like the American signal crayfish (*Pacifastacus leniusculus*), might have easier access to crayfish in these reduced habitats.
 - WCC require high levels of dissolved oxygen and excessive nutrient enrichment is therefore a threat to crayfish (Holditch, 2003) due to increased algae and associated increases in biochemical oxygen demand (BOD). At low flows the dilution potential is significantly reduced comparative to normal conditions, which increases the risk of harming vulnerable species such as WCC. Although sub-lethal pollution may not cause mortality it can still result in lower recruitment or a high incidence of disease (Peay, 2003). Increases in the concentration of suspended solids could clog the respiratory structures of crayfish (Peay, 2003). Increased water temperature could lower oxygen levels, which are critical for crayfish survival. Insufficient oxygen can stress the crayfish, make them more susceptible to disease, and potentially cause mortality.

- The non-native signal crayfish are more tolerant of poor water quality with research suggesting they had a greater overall thermal tolerance, so are more resistant to changes in environmental temperature, such as in waters affected by thermal discharges or in waters affected by drought and reduced flow (Firkins, 1993). If this should occur for a prolonged period of time, WCC could struggle to recolonise once non-native populations have established.

G.1.3 Sources of information and methods

The distribution and abundance of protected species in the study area was assessed using information from various sources including:

- Leicestershire and Rutland Environmental Records Centre (LRERC); and,
- Derbyshire Biological Records Centre (DBRC);
- Staffordshire Biological Records Centre (SBRC);
- DEFRA Magic Maps;
- British Trust for Ornithology Wetland Bird Survey data (BTO WeBS); and
- Citations for relevant SSSIs.

These data were screened systematically to identify any additional protected species that had been recorded in the study area within the last 10 years, and which could potentially be affected by the proposed drought permit. The assessment therefore focused on the following:

- Bats;
- Beavers;
- Birds (inclusive of waders, wildfowl, riverine and gulls);
- Common amphibians;
- GCN;
- Otters;
- Reptiles;
- Water voles; and
- WCC

Referring to the predicted magnitude and duration of changes in hydrogeology, hydrology, hydromorphology, and water quality described in Appendices A, B, C and D respectively, potential impacts both directly and indirectly on these protected and notable species were assessed qualitatively using professional judgement.

The impact assessment was conducted in line with Guidelines for Ecological Evaluation and Assessment (CIEEM, 2024).

G.1.4 Baseline

Bats

There were over 1000 records of bats within the study area identified by the local records centres (LRERC & DBRC), which had been recorded within the last 10 years. Individual species records included common pipistrelle, soprano pipistrelle, Nathusius's pipistrelle (*Pipistrellus nathusii*), noctule bat, Natterer's bat (*Myotis nattereri*), whiskered bat (*Myotis mystacinus*), Brandt's bat (*Myotis brandti*), daubenton's bat (*Myotis daubentonii*), brown long-eared bat, serotine bat (*Eptesicus serotinus*), Leisler's bat (*Nyctalus leisleri*), barbastelle bat and lesser horseshoe bat. Several of these records were identified within close proximity to the Ladybower Reservoir. Considering the local biological records in the survey area, for the purpose of this assessment, it is assumed that bats currently utilise all water bodies within the study area.

There were 152 records of bat roosts within the study area returned by LRERC & DBRC which had been recorded within the last ten years.

Beavers

A single potential record of beaver was identified within the search area by DBRC. No records were identified by LRERC. The record was from the River Derwent, approximately 55 km downstream from the Ladybower Reservoir, dated April 2025. This record is, however, classified as 'unconfirmed' by Derbyshire Biological Records Centre as it was submitted by a member of the public and not an ecological professional. The record states that it could also have been a large otter, and not a beaver. In addition, the nearest re-introduction location for beavers is Willington Wetlands, near Repton, which lies on the River Trent. Although the River Trent is hydrologically connected to the River Derwent, the record is approximately 36 km in distance from Willington Wetlands, and in a fairly urban location on the south-eastern periphery of Derby. Given this, and the uncertain legitimacy of the record, it is unlikely that beavers are present in the River Derwent and have been **scoped out of further assessment**.

Birds

Information on the breeding and overwintering birds using the River Derwent has been identified primarily using BTO WeBS data.

The WeBS data indicates a typical waterbird assemblage present within the study area which includes the following native species recorded between 2019/20 to 2023/24 (the most recent five years of WeBS data): greylag goose (*Anser anser*), white-fronted goose (*Anser albifrons*), mute swan (*Cygnus olor*), mallard, tufted duck (*Aythya fuligula*), shelduck (*Tadorna tadorna*), shoveler (*Anas clypeata*), gadwall (*Mareca strepera*), wigeon (*Anas penelope*), teal (*Anas crecca*), pochard (*Aythya ferina*), goosander (*Mergus merganser*), red-breasted merganser (*Mergus serrator*), little grebe (*Tachybaptus ruficollis*), grey heron (*Ardea cinerea*), great white egret (*Ardea alba*), little egret (*Egretta garzetta*), cormorant (*Phalacrocorax carbo*), water rail (*Rallus aquaticus*), moorhen (*Gallinula chloropus*), coot (*Fulica atra*), oystercatcher (*Haematopus ostralegus*), lapwing (*Vanellus vanellus*), snipe (*Gallinago gallinago*), woodcock (*Scolopax rusticola*), common sandpiper (*Actitis hypoleucos*), common gull (*Larus canus*), black-headed gull (*Chroicocephalus ridibundus*), lesser black-backed gull (*Larus fuscus*) and kingfisher (*Alcedo atthis*).

Common Amphibians

Over 200 records of common amphibians within the study area were identified by the biological records centres (LRERC, DBRC & SBRC) within the last ten years. 88 records were of common toad which is listed as a priority species under the NERC Act (2006). Several records were from, or directly adjacent to the Derwent. Unlike common frogs, smooth newts and palmate newts, common toads prefer to breed in large, deep bodies of water, such as large ponds, lakes and reservoirs, and tend to migrate back to the same body of water each spring to breed. Therefore, common toad has been included in this impact assessment.

Great Crested Newt

GCN have been recorded in the downstream extent of the Derwent study area; 68 records were supplied by LRERC and DBRC within the past 10 years. No records were returned by SBRC. All records were from ponds

within the study area and not associated with any watercourses directly. These ponds will, however, be hydrologically connected through groundwater levels. If river levels drop, so will ground water, and ponds could dry out more frequently, for longer periods of time, or at the wrong time of year for newt breeding cycles. This is consistent with the knowledge that moving water is considered unsuitable for this species. It should be acknowledged that data supplied by local biological record centres aren't always accurate and exact locations are often not precise, so cannot be determined with full confidence. However, those records detailed which have 10 figure national grid references (NGR), should theoretically be accurate to 1m. With all this in mind, the likelihood of impact to this species in regard to the drought permit is considered unlikely, but they have been included in the impact assessment on a precautionary basis.

Otters

One hundred and forty-five records of otter within the last 10 years were identified within the study area by DBRC. A low number of historical records were returned by LRERC, and no records were returned by SBRC. No records were identified directly within the Derwent. The most recent record was in 2025, located downstream along the River Derwent, approximately 6.5 km from the Ladybower Reservoir. All records identified were located within the River Derwent or its tributaries. There were also two records of possible otter holts, both associated with Markeaton Lake located approximately 48 km south of Ladybower Reservoir, dated 2015. Although not a primary reason for site selection, otter is listed as an annex II species present as a qualifying feature within the River Derwent Special Area of Conservation (SAC). The River Derwent and Bassenthwaite Lake represent good quality otter habitat in north-west England. Together, the lake and river represent a wide range of suitable conditions for otters in a relatively upland environment. Considering the local biological records in the study area, and that otters have increased their range across UK river catchments in recent years, for the purpose of this assessment, a precautionary approach has been adopted, which assumes that otters are currently present on all water bodies within the study area.

Reptiles

Over 200 records of reptiles within the last 10 years were identified within the study area by DBRC and SBRC. No records of reptiles were returned by LRERC. The most recent record is of a grass snake (*Natrix helvetica*) located within the town of Matlock, appropriately 26 km south of the Ladybower Reservoir. None of the records of adder (*Vipera berus*) and the majority of slow worm (*Anguis fragilis*), records were not considered to be associated with a water body or watercourse. A larger proportion of grass snake records were considered to be associated with the River Derwent, and it is known that grass snakes prefer habitat with access to water. Grass snakes have been included in this impact assessment, adder, common lizard and slow worm have also been included on a precautionary basis.

No records of the scarcer reptile species (smooth snake *Coronella austriaca* and sand lizard *Lacerta agilis*) were identified by either of the biological records centres. The known distribution of these species, however, is limited to the English counties of Dorset, Devon, Hampshire, Surrey and West Sussex for smooth snake and small isolated areas of Dorset, Hampshire, Surrey and Merseyside for sand lizard. Sand lizard have been reintroduced into other areas in the South-east, South-west, Lancashire, and Wales, although these also do not overlap with the drought permit locations. As a result, neither of these species are considered further regarding the drought permit impact. Common reptiles, inclusive of grass snake, common lizard, slow worm, and adder (*Vipera berus*) (although no records were identified within the study area), have been included in the assessment on a precautionary basis.

Water voles

89 records of water voles within the last 10 years were identified within the study area by DBRC and SBRC. Multiple records were associated with the River Derwent. The most recent records were dated 2025 and located upstream of the Derwent Reservoir. Due to the number of records returned within the study area, water voles have been included in this assessment.

It should be noted that multiple records of American mink were identified within the study area. American mink, considered an INNS, has largely contributed to the rapid decline of native water voles in the UK since the mid-1900s.

White-clawed crayfish

Fourteen records of WCC within the last 10 years were identified within the study area by DBRC, the most recent of which is dated October 2024 in Chatsworth Pool (c. 400 m from the River Derwent). No records of WCC were returned by LRERC or SBRC. None of the records were associated with the Derwent or Ladybower Reservoirs or the River Derwent. All records were associated with water bodies or smaller watercourses within the study area, including Chatsworth Pool, the River Ecclesbourne, Bar Brook, Warney Brook, Pendleton Brook and Dam Brook all of which are hydrologically connected to the River Derwent. No designations include WCC as a designation feature. Due to the multiple recent records within the study area, white-clawed crayfish have been included in the assessment.

It should be noted that multiple records of the invasive signal crayfish (*Pacifastacus leniusculus*) were identified within the study area. Signal crayfish are an INNS that have largely contributed to the rapid decline of native, WCC in the UK since the late 1900's, through competition for food resources and shelter, and spread of disease.

G.1.5 Impact assessment

Bats

A change in river flow is not anticipated to have an effect on bat populations should they be using the corridor for commuting and foraging purposes. Similarly, changes in marginal exposure, and wetted area, is not anticipated to have any impact on bat populations. This is because insect prey availability is not anticipated to decrease beyond the tolerance of any bat species, given that the macroinvertebrate community in the study area is of low sensitivity to the environmental change (Appendix E). Overall, the significance of impact of the drought permit scenario on macroinvertebrates is **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) for all water bodies assessed, and no changes in WFD status for the macroinvertebrate biological element are predicted. As with hydrological changes, a reduction in wetted area, and a change in marginal exposure can cause adverse effects to macroinvertebrate populations. Hydraulic analysis undertaken modelled reductions in depth or velocity are not large in absolute terms and the independent transect calculations suggest there is unlikely to be any significant impact on the character, diversity or scale of habitat characteristics or of underlying physical processes (Appendix C). A lower water level can decrease the number of insects that bats feed on, leading to food scarcity and possible increased competition for resource. Although a slight contraction is anticipated, no subsequent impact is anticipated on macroinvertebrates and thus impact to bat food resource is not expected.

If water quality declines (e.g., due to pollution, chemical increase i.e. nitrates, or low oxygen levels), the population of aquatic insects may decrease, leading to fewer food sources for bats. This would encourage bats to locate areas of greater food supply in other areas in the surrounding environment and could result in a decreased population size in the study areas. Under the Ambergate DP scenario, a **minor** change to the water quality pathway (phosphate) is predicted for the River Derwent (Bottle Brook to Trent) water body, relative to a baseline drought scenario. (Appendix D). The macroinvertebrate communities of these water bodies are expected to be as evidenced in the long-term data record i.e. they are considered to be of low sensitivity (Appendix E).

Bats are considered to be of **Medium** sensitivity, but the magnitude of effect of the proposed drought permit on them will be **Negligible**, and so the proposed intervention will have a Minor* (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) significance impact on bats.

Birds

Wading birds – Of the wader species noted in the baseline section, there is the potential for oystercatcher and common sandpiper to feed on aquatic invertebrates within watercourses and around the edges of the reservoir, and these species could breed where there are suitable areas of gravel for nesting. Breeding and foraging areas for these species are likely to have hydrological connectivity with the rivers within the study area. There is also the potential for the other wader species listed within the baseline section to breed or forage within suitable habitats adjacent to the study area which have hydrological connectivity, however they are unlikely to breed or forage directly within the study area.

The sensitivity of breeding waders to low flows is considered to be **Low** and any potential impacts would be of negligible significance as the potential for impacts is limited, and the drought permit is short-term in nature. Outside of the main breeding season the sensitivity of wading birds is also considered to be **Low** from any changes in water levels and any potential impacts can also be excluded as being of negligible significance with large numbers of these birds dispersing to coastal habitats, to coastal farmland or, in the case of common sandpiper, migrate to Africa. The impacts on wetlands in the floodplain, even if there is hydrological connectivity with the river, are likely to be negligible. Even if such wetlands were in hydrological connectivity with the rivers in study area, the drought permit is predicted to have a negligible impact on river water levels and therefore a negligible impact on any adjacent wetlands. The impact significance is therefore considered to be negligible but categorised as **Minor*** in the absence of a negligible category.

Wildfowl and gulls - Wildfowl such as mute swan and mallard can breed along riverbanks. Such birds could conceivably be affected by low flows if their nest sites become more exposed and vulnerable to predators as water levels fall.

Many species of wildfowl feed on aquatic plants, however minor impacts to macrophytes and phytobenthos communities are unlikely to affect food resource for wildfowl species. Lowered water levels as a result of a drought can be beneficial to feeding wildfowl as plants can become more accessible. However, if drought conditions are prolonged, plants can become exposed, dry out and die, which could lead to a reduction in food availability.

As wildfowl are considered to have a Low sensitivity to the potential changes in water level estimated for this drought permit and the proposed drought permit is not anticipated to cause any significant loss of macrophytes the magnitude of any impact is **Negligible**. In the absence of a negligible category, however, the impact significance has been categorised as **Minor**.

Foraging habitat of any overwintering geese are likely to be on cropland and improved grassland however it is unlikely that there would be any impacts through implementation of the drought permit. Watercourses are unlikely to be used by large numbers of roosting geese, and the WeBS data for Ladybower Reservoir site has no records of any native geese species. Therefore, no impacts on geese are predicted.

Riverine birds - Piscivorous birds such as kingfisher may benefit from any resulting low flows and reduced wetted perimeter as this results in a concentration of fish into smaller and/ or shallower areas of the channel. If a drought is prolonged, then fish stocks may become depleted resulting in a reduction in food for piscivorous birds. The proposed drought permit is predicted to have at most **minor** impacts on any fish species in most waterbodies, in comparison with the baseline scenario. Therefore, it is unlikely that there will be a significant impact on food availability for piscivorous birds.

Many riverine birds (e.g. dipper, grey wagtail and sand martin (*Riparia riparia*) feed on invertebrates, which are likely to remain present in significant numbers in all but the most extreme situations when the rivers are almost dry. This is not predicted to occur under the proposed drought permit and is therefore unlikely to significantly impact upon these species. As kingfisher breed in nest holes above the water level, reduced water levels would not impact availability of nest sites. The overall impact significance is therefore considered to be negligible but categorised as **Minor** in the absence of a negligible category.

Sawbills, such as goosander, which feed on fish (particularly brown trout *Salmo trutta*) (The Scottish Government, 2022), may benefit from any resulting low flows and reduced wetted perimeter as this may result in a concentration of fish into smaller and / or shallower areas or channel. The drought permit is predicted to have a negligible impact at other rivers in the study area. As sawbills are considered to have a Low sensitivity to the potential changes in water level estimated for this drought permit, and can feed on a variety of fish species, then it is likely that there will a negligible impact on food availability for these birds. In the absence of a negligible category, however, the impact significance has been categorised as **Minor**.

Common Amphibians

As mentioned previously, common toads prefer to breed in deeper bodies of water. Similarly, smooth and palmate newts prefer static bodies of water during their breeding season. Changes in water level or flow are not anticipated to effect common amphibian populations directly due to the unlikely habitation of rivers. Potential breeding ponds will, however, be hydrologically connected through groundwater levels. This could have an adverse effect for pond permanence for those waterbodies that are present within close proximity to the study area. Ponds could dry out more frequently, for longer periods of time, or at the wrong time of year for breeding cycles. Reducing river flow, and occurrence of floods, could cause a drop in the water table downstream (Glazer & Likens, 2012). Hydrogeological changes, such as groundwater level reductions, have been scoped out as pathway of impact (See Introduction, Section 1.3 'Scope of Assessment' and Appendix A for details). The Ambergate drought permit is not expected to have any measurable impact on groundwater levels. Assuming the drought permit is not operating for more than 6 months the effects on baseflow are considered to be insignificant and as a result subsequent effects are unlikely to noticeably impact suitable breeding pond habitats to the point where populations are at risk.

Modelled reductions in depth or velocity are not large in absolute terms and the independent transect calculations suggest there is unlikely to be any significant impact on the character, diversity or scale of habitat characteristics or of underlying physical processes (Appendix C). In a worst-case scenario could result in low levels of pond permanence, and thus aquatic habitat availability. However, the effects on common amphibians are anticipated to be minor to negligible, with impacts decreasing further downstream. Predicted changes in water quality and any associated impacts on macroinvertebrates are unlikely to be noticeable/measurable.

Common amphibians are considered to be of **Low** sensitivity, but the magnitude of effect of the proposed drought permit on them will be **Negligible**, and so the proposed intervention will have a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) significance impact.

Great Crested Newts

As with common amphibians, GCN prefer to breed in deeper bodies of water, and are not typically found in moving waterbodies. Therefore, the same potential adverse effect in relation to pond permanence, referred to above for common amphibians, can be observed for GCN.

The water level changes predicted under the proposed drought permit are unlikely to cause significant impacts on GCN. It is unlikely that the water levels and wetted width of the watercourses would reduce to a degree that would have an effect on GCN distribution. Given that no ponds have been identified in hydraulic connectivity with rivers in the study area at low flows, the predicted changes to water quality and water levels are unlikely to significantly influence suitable breeding pond habitat to a point where populations of GCN are threatened. The Derwent Valley Reservoir drought permit is not expected to have any measurable impact on groundwater levels.

Great crested newts generally require consistent moderate to high water quality. Although they may use ponds of different conditions, GCN might be sensitive to changes in the water quality. Cumulative effects of water quality and water levels as a result of the implemented drought permit could lead to decreased resilience of any metapopulations already present in the vicinity of the study area and may increase the probability of INNS

establishing. However, the predicted changes to water quality and water levels (Appendix C and D) are unlikely to significantly influence suitable breeding pond habitat to a point where populations are threatened.

Based on the biological records in the area, limited tolerance to change, and the influence of water quality and water levels on potential breeding locations that are hydrologically connected GCN are considered to be of **Medium** sensitivity, but the magnitude of effect of the proposed drought permit on them will be **Negligible**, and so the proposed intervention will have a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) significance impact on GCN.

Otters

Otters prey predominantly on fish, with amphibians (mainly frogs) and crayfish also taken. However, there is no evidence of fish species selection with otters usually taking fish species in approximate proportion to their abundance (Chanin, 2003). Otters may take eels, very large fish, or very small fish (often in large numbers), although small fish (less than 30 mm in length) are seldom consumed (Chanin, 2003). In the short term, otters may benefit from lower flows associated with the drought permit, as well as any reduction in depth and wetted width, as this may result in a concentration of fish into smaller and / or shallower areas or channel. Referring to the assessment of impacts on fish (Appendix F), it is unlikely that there will be a significant impact on food availability for otters in any of the water bodies in the study area should they be present. Adopting a highly precautionary assessment, potential effects on fish associated with increases in ammonia and phosphate concentrations, are considered to extend over a moderate scale but would be short term in duration. It is thought to align more with a **Minor** overall impact significance owing to natural flow accretion downstream of the reservoir, and as a result no significant impacts are anticipated on movement or migration of fish species during the proposed drought permit.

Any changes in water quality associated with the drought permit are unlikely to cause direct harm to otters due to their ability to withstand environmental pressures and ability to disperse.

Otters are considered to be of **Medium** sensitivity. Although only minor changes to water quality and fish is anticipated, there are recent records of otters in the study area and listed as an annex II species qualifying feature on the River Derwent SAC, so a precautionary approach should be undertaken. Therefore, for all study waterbodies, the magnitude of effect of the proposed drought permit on otter will be **Minor**, and so the proposed intervention will have no more than a **Minor** significance impact on otter.

Reptiles

Common reptiles have been considered in this impact assessment on a precautionary basis only, with grass snake most likely to utilise the watercourses for foraging and commuting purposes. Slow worm, common lizard, and adder are also considered in the impact assessment, however, are not anticipated to utilise the study area as frequently as grass snake. A change in river flow is not anticipated to effect reptile populations directly and the small changes predicted for habitat and water quality are considered unlikely to negatively affect reptiles.

The reduction in water levels under the proposed Ambergate drought permit, and its downstream water bodies, is unlikely to be of significance to reptiles if they are present due to their primary terrestrial presence and hydrological presence on an opportunistic basis only.

Reptiles are considered to be of **Low** sensitivity, but the magnitude of impact of the proposed drought permit on them will be **Negligible**, and so the proposed intervention will have a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) significance impact on reptiles.

Water voles

For the purpose of this assessment, a precautionary approach has been adopted. The main risk to water voles is when water levels rise, flooding their burrows and displacing the animals (Strachan, 1998). Considering the magnitude of impact of the drought permit on flow in conjunction with water vole sensitivity to flow rates, it is

unlikely that they will be significantly affected by the drought permit. Water voles tend to favour waterbodies of still to moderate flow rate and would be more at risk if flow rate was increased significantly (Strachan, 1998).

There is no clear mechanism by which a reduction in wetted width, depth etc., which retains a significant portion of the linear habitat, could adversely affect water vole. Conceivably, if a drought permit were in place for a prolonged period, water voles could begin to establish burrows at lower levels on the bank in response to lower water levels. If this were to occur it could leave them more vulnerable to flooding when higher water levels do return. However, the predicted changes in water level that could cause these adverse effects are anticipated to be low to negligible, with impacts decreasing further downstream.

Therefore, the changes to water quality predicted to occur under the proposed drought permit are unlikely to have a significant impact on water vole. The small scale of effect and short-term duration of the proposed drought permit is predicted to result in a negligible magnitude of effect on macrophyte communities. As a result, food resource for water vole is not anticipated to decrease as a consequence of the drought permit.

Should a drought permit remain in place over an extended period, the American mink is likely to tolerate associated changes in hydrological conditions, such as decline in water quality, reduced river flow and water levels, due to its ecological plasticity. This tolerance may further hinder the recovery and recolonisation potential of the water vole. However, the anticipated scale of these impact pathways remains negligible to minor and is unlikely to significantly affect American mink population trajectories that exist beyond this drought permit scenario.

Due to the current state of UK population levels and rapid decline due to various stressors, the sensitivity of water vole is considered to be **High**. Although only minor changes to water quality is anticipated, there are recent records of water vole in the study area, so a precautionary approach should be undertaken. Therefore, for all waterbodies the magnitude of effect of the proposed drought permit on water vole will be **Minor**, and so the proposed intervention will have no more than a **Minor** significance impact on water voles.

White-clawed Crayfish

WCC populations are considered to be rapidly declining and globally endangered (Peay, 2003), making them a highly sensitive receptor. As noted above, WCC have been considered in this impact assessment on a precautionary basis only. Low river flows or lack of cover make crayfish more susceptible to predation. A reduction in flow could have an impact on the availability of cover, particularly in the margins (Holditch, 2003), through reductions in wetted width and water depth.

Other macroinvertebrates form a proportion of WCC diet, being a primarily carnivorous species. A reduction in food resources as a result of changes in habitat and water quality could occur. However, a minor significance of impact on the macroinvertebrate communities of all water bodies is predicted under all drought permit scenarios (Appendix E). Macroinvertebrate data indicates that the community response to the Ambergate DP is negligible: the magnitude and significance of effect is negligible as hydraulic change in this reach was considered to be well within the range of natural variation. As a result, insect prey availability will likely not be reduced and food resource for WCC will not be greatly impacted.

Slower-moving water can have negative influences on water quality which would in turn have a detrimental effect on crayfish populations. At low flows the dilution potential is significantly reduced comparative to normal conditions, which increases the risk of harming vulnerable species such as WCC. Although sub-lethal pollution may not cause mortality it can still result in lower recruitment or a high incidence of disease (Peay, 2003). Increases in the concentration of suspended solids could clog the respiratory structures of crayfish (Peay, 2003). Under the Ambergate DP scenario, a **minor** change to the water quality pathway (phosphate) is predicted for the River Derwent (Bottle Brook to Trent water body, relative to a baseline drought scenario). Implementation of any of the proposed River Derwent drought permit, however, is not anticipated to result in any significant change in water quality (Appendix D) beyond the tolerance of this species.

Similar concerns surrounding invasive species colonisation in water vole, can be observed for WCC. Similarly, the anticipated scale of these impact pathways remains negligible to minor and is unlikely to significantly affect signal crayfish population trajectories that exist beyond this drought permit scenario.

Due to the current state of UK population levels and rapid decline due to various stressors, the sensitivity of WCC is considered to be **High**. Only minor changes to water quality is anticipated, and negligible effects to macroinvertebrates, there are recent records of WCC in the study area, so a precautionary approach should be undertaken. Therefore, for all study waterbodies, the magnitude of effect of the proposed drought permit on WCC will be **Minor**, and so the proposed intervention will have a **Minor** significance impact on WCC.

G.1.6 Summary

Considering predicted changes in river flow, habitat and water quality, as well as associated effects on other ecological receptors such as macroinvertebrates and macrophytes, the following sensitivities, magnitude of impact, and significance of impact are anticipated for protected species. A summary of the predicted impacts on protected species included in this assessment under the proposed Ambergate drought permit are presented in G.1.

Table G.1 Summary of predicted impacts on protected species in the River Derwent

Water body	Protected species	Impact magnitude	Receptor sensitivity	Impact significance	Confidence level
The River Derwent from Amber to Bottle Brook (GB104028052310)	Bats	Negligible	Medium	Minor*	Medium
	Birds – All species	Negligible	Low	Minor*	Medium
	Common Amphibians	Negligible	Low	Minor*	Medium
	GCN	Negligible	Medium	Minor*	Medium
	Otter	Minor	Medium	Minor	Medium
	Reptiles	Negligible	Low	Minor*	High
	Water vole	Minor	High	Minor	Medium
	WCC	Minor	High	Minor	Medium
The River Derwent from Bottle Brook to Trent (GB104028053240)	Bats	Negligible	Medium	Minor*	Medium
	Birds – All species	Negligible	Low	Minor*	Medium
	Common Amphibians	Negligible	Low	Minor*	Medium

Water body	Protected species	Impact magnitude	Receptor sensitivity	Impact significance	Confidence level
	GCN	Negligible	Medium	Minor*	Medium
	Otter	Minor	Medium	Minor	Medium
	Reptiles	Negligible	Low	Minor*	High
	Water vole	Minor	High	Minor	Medium
	WCC	Minor	High	Minor	Medium

*=impact predicted to be negligible but categorised as Minor in the absence of a negligible category

G.2 Uncertainties

It should be acknowledged that data supplied by local biological record centres are not always accurate and exact locations are often not precise, so cannot be determined with full confidence. However, any records detailed as 10 figure national grid references (NGR) should theoretically be accurate to 1 m, 8 figure NGR accurate to 10 m, 6 figure NGR accurate to 100 m, and so forth.

The assessment has been based on the sensitivity of each species in relation to the various pathways and professional judgement. Thus, a **Medium** level of confidence is considered appropriate based on current available data for bats, common amphibians, GCN, otters, water voles, and WCC. A **High** level of confidence is considered appropriate for reptiles.

Further sources of information would help to improve confidence in the assessment of wading birds, wildfowl and gulls and riverine birds during the breeding season, i.e. spring through autumn. Therefore, in the absence of these data, **Medium** confidence has been assigned to the assessment of impacts on these receptors during the breeding season and **High** outside of breeding season.

G.3 References

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³ Contains Wetland Bird Survey (WeBS) data from Waterbirds in the UK 2023/24 © copyright and database right 2025. WeBS is a partnership jointly funded by the BTO, RSPB and JNCC, with fieldwork conducted by volunteers

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H INNS

H.1 Background

The latest drought planning guidance (EA, 2020) recommends that environmental assessment explicitly addresses potential impacts of the drought permit on the risk of spreading INNS. This assessment takes a species-based approach to evaluate how potential pathways of impact from the drought permit may influence the spread of aquatic and riparian INNS currently recorded in the affected water bodies. As other INNS could be introduced to these water bodies at any time, both temporally and geographically, the species considered should be viewed as indicative of how future INNS might also respond to the drought permit

This assessment focusses on potential effects of the drought permit (summarised as: the maximum permitted abstraction with a reduction in Hands-off Flow (HoF) from 680 MI/d to 500 MI/d. This will only apply to the lower Derwent (i.e., downstream of Ambergate).

H.1.1 Potential routes of impact

The drought permit could potentially affect the fitness (i.e. abundance, population health and/or capacity for spread) of INNS in several ways, including:

- i. a reduction in river flow either reducing the potential for the propagules of certain species, in particular macrophytes, to be dispersed downstream, or conversely increase the potential for motile species (e.g. signal crayfish) to migrate upstream;
- ii. a reduction in wetted area in downstream rivers, increasing density of INNS present and presenting potential suitable habitat for the temporary colonisation of exposed bankside by riparian species; and
- iii. changes in water quality in downstream rivers, which may affect the fitness of some INNS.

H.1.2 Source of information and methods

The impact (either negative or positive) of the drought permit on the potential of INNS to spread is considered for aquatic and riparian species (excluding mammals and water fowl) that are either:

- classified as High or Moderate impact by the WFD UK Technical Advisory Group (UKTAG)⁴,
- listed under Schedule 9 of the Wildlife and Countryside Act 1981 (WCA), or
- listed under the Invasive Alien Species Order 2019 (species of Union Concern).

For the impact assessment, all species detected were designated a sensitivity category. For each species, an individual sensitivity score is assigned to the three pathways of impact (hydrology, hydraulics, and water quality). A modal average of the three sensitivities is used to determine the overall species sensitivity. Should no mode be recognised, the median will be used.

Sensitivity categories alone do not inherently consider the direction of change to INNS fitness (i.e. whether the biological response is beneficial or detrimental), instead typically representing a categorical scale for negative effects on receptors. For each pathway, the INNS Significance of Impact scores are also provided with a direction used to infer whether change to fitness is beneficial or negative.

⁴ WFD UK TAG, 2021. Classification of aquatic alien species according to their level of impact – working paper version 8.

For each species, sensitivity categorisations were compared to the predicted magnitude of impact of the drought permit on each of the pathways described in Appendices A, to determine the overall likelihood of significance.

The INNS Assessment Area has been defined as the following two Study Areas: Derwent Valley Reservoirs and the River Derwent. Table H.1 outlines the water bodies comprising these INNS Study Areas. These are also presented in

Figure H.1. Note that the use of buffers may mean that the same record may fall into multiple study areas. The assessment of the impacts of the Ambergate drought plan incorporates INNS records from upstream water bodies. For the purpose of this assessment we assume that any INNS recorded within the study area are present at within the zone of influence.

Table H.1 Water bodies included in the INNS Study Areas.

Study Area	Water Body	Water body ID	Buffer Distance
Derwent Valley Reservoirs	Ladybower Reservoir	GB30432459	1km
	Howden Reservoir	GB30432299	250m
	Upper Derwent Reservoir	GB30432359	250m
	Derwent from Source to Westend	GB104028057960	250m
	Westend Catchment (trib of Derwent)	GB104028057950	250m

	Alport Catchment (trib of Ashop)	GB104028057940	250m
	Ashop from Source to Alport	GB104028057930	250m
	Ashop from Alport to Derwent	GB104028057910	250m
	Highshore Clough Catchment (trib of Derwent)	GB104028057900	250m
	8 additional tributaries	N/A	250m
	Derwent from Westend to Wye (downstream of		
River	Ladybower Reservoir)	GB104028057880	250m
Derwent	Derwent from Wye to Amber	GB104028052390	250m

INNS records were downloaded from the following sources:

- National Biodiversity Network (NBN) Atlas [accessed 06/06/2025] using open access licenced data only(CC-BY, CC0, OGL⁵). Unconfirmed and fossil records were excluded. Dataset references can be found in Section H.4.
- The EA's Ecology & Fish Data explorer [accessed 06/06/2025] using freshwater fish, river invertebrates, and river macrophyte data from between 2000 and 2025.
- The Derbyshire Biodiversity Record Centre [requested 09/06/2025]. Note that data was provided in point and 1km grid format, both of which have been included in analysis.
- The Sheffield Biological Records Centre [requested 17/06/2025].

Whilst APEM has endeavoured to provide accurate and reliable information, we are reliant on the accuracy of the records submitted by third parties (i.e. record centres, wildlife trusts etc.). APEM will quality assure the records where possible but cannot be held responsible for records later shown to be inaccurate.

INNS records have been analysed as provided upon download from the data provider (NBN Atlas, EA, and LRCs). There is likely to be some inherent inaccuracies in the spatial data provided which, whilst being partially accounted for in the water body buffers, may lead to the inclusion of species that are not present or the exclusion of those that are. Furthermore, the inclusion of a specific species within this assessment is reflective of records or observations at a particular point in time, i.e. the time of assessment. INNS assemblage may change over time, either in response to management and control efforts, or natural change to extant populations. Further, absence of records should not be seen as definitive proof of the absence of INNS within a specific area.

⁵ Contains public sector information licensed under the [Open Government Licence](#) (OGL) v3.0, [Public Domain Dedication](#) (CC0) v1.0, [Creative commons with attribution v4.0](#) (CC-BY).

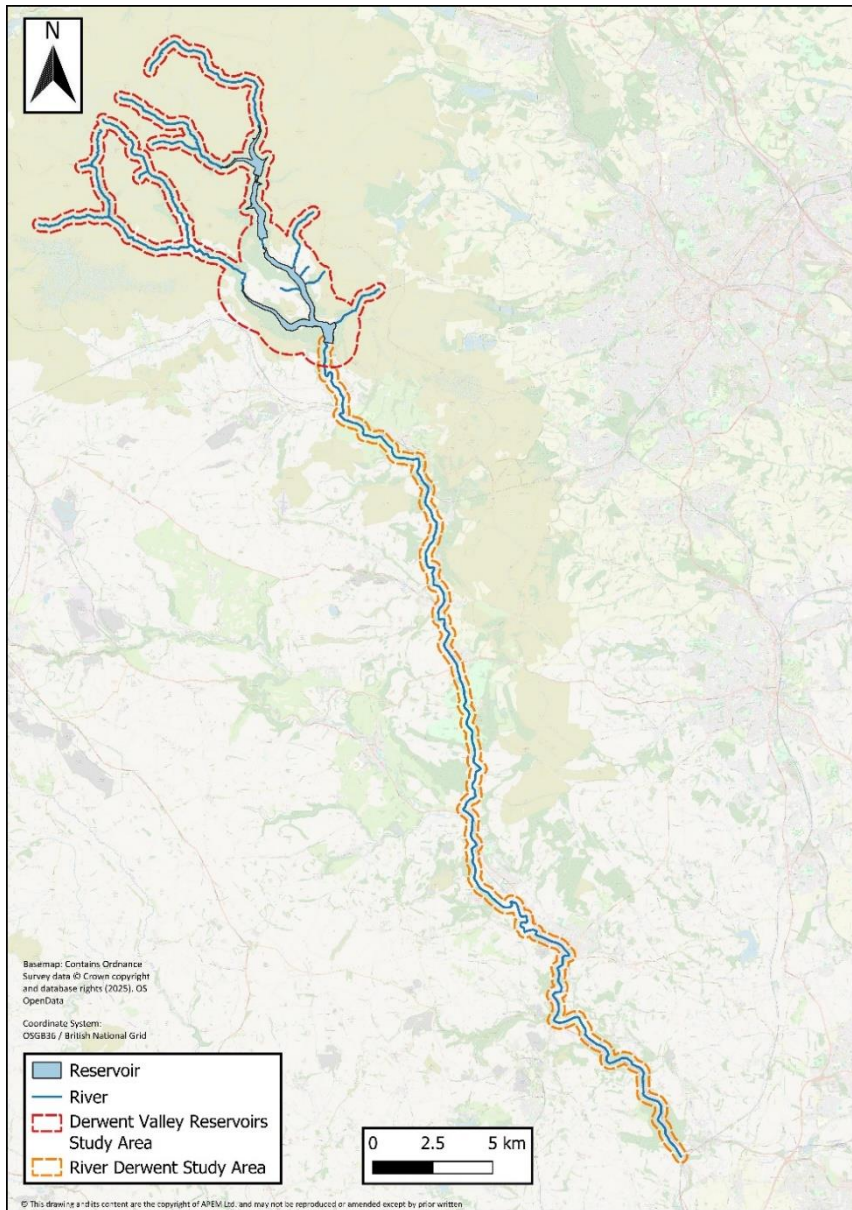


Figure H.1 INNS Assessment Area.

H.1.3 Baseline

INNS record within the Derwent Valley Reservoirs and River Derwent Study Areas are documented in Table H.2. Presence is indicated by an 'X' and the year of most recent record.

Table H.2 INNS recorded in the Derwent Valley Reservoirs and River Derwent Study Areas.

Species	Water body		Categorisation
	Derwent Valley reservoirs	River Derwent	
American skunk-cabbage (<i>Lysichiton americanus</i>)		X (2024)	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern.
Canadian waterweed (<i>Elodea canadensis</i>)		X (2013)	WFD UKTAG Moderate Impact; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Chinese mitten crab (<i>Eriocheir sinensis</i>)		X (2015)	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Common / mirror carp (<i>Cyprinus carpio</i>)		X (2011) ⁺	WFD UKTAG High Impact .
Curly waterweed (<i>Lagarosiphon major</i>)		X (2023)	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Demon shrimp (<i>Dikerogammarus haemobaphes</i>)		X (2022) ⁺	WFD UKTAG High Impact .
Entire-leaved cotoneaster (<i>Cotoneaster integrifolius</i>)	X (1995)	X (2019)	Wildlife and Countryside Act (1981) Schedule 9 Listed.
Giant hogweed (<i>Heracleum mantegazzianum</i>)		X (2005)	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Giant knotweed (<i>Fallopia sachalinensis</i>)		X (1976) ⁺	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Giant rhubarb (<i>Gunnera tinctoria</i>)		X (2014) ⁺	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Himalayan balsam (<i>Impatiens glandulifera</i>)	X (2011)	X (2024)	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Himalayan cotoneaster (<i>Cotoneaster simonsii</i>)	X (2012)	X (2022)	Wildlife and Countryside Act (1981) Schedule 9 Listed.

Report Reference:

Report Status: Final

Species	Water body		Categorisation
	Derwent Valley reservoirs	River Derwent	
Hollyberry cotoneaster (<i>Cotoneaster bullatus</i>)		X (2017) ⁺	Wildlife and Countryside Act (1981) Schedule 9 Listed.
Japanese knotweed (<i>Fallopia japonica</i>)	X (2024)	X (2024)	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Japanese rose (<i>Rosa rugosa</i>)		X (2019) ⁺	Wildlife and Countryside Act (1981) Schedule 9 Listed.
Jenkins spire snail (<i>Potamopyrgus antipodarum</i>)	X (2020)	X (2024)	WFD UKTAG Moderate Impact.
Least duckweed (<i>Lemna minuta</i>)		X (2024) ⁺	WFD UKTAG Moderate Impact.
Monkeyflower / Hybrid Monkeyflower (<i>Mimulus guttatus</i> / <i>Cotoneaster bullatus</i>)		X (2023) ⁺	WFD UKTAG Moderate Impact.
Montbretia (<i>Crocasmia pottsii</i> x <i>aurea</i> = <i>C. x crocosmiiflora</i>)	X (2008)	X (2024)	WFD UKTAG Low Impact; Wildlife and Countryside Act (1981) Schedule 9 Listed.
New Zealand pigmyweed (<i>Crassula helmsii</i>)	X (2022)	X (2022)	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Nuttall's waterweed (<i>Elodea nuttallii</i>)		X (2013) ⁺	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern.
Rhododendron (<i>Rhododendron ponticum</i>)	X (2022)	X (2024)	WFD UKTAG High Impact ; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Signal crayfish (<i>Pacifastacus leniusculus</i>)		X (2025)	WFD UKTAG High Impact ; Invasive Alien Species of Union Concern; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Three-cornered garlic (<i>Allium triquetrum</i>)		X (2017) ⁺	Wildlife and Countryside Act (1981) Schedule 9 Listed.
Wall cotoneaster (<i>Cotoneaster horizontalis</i>)	X (2008)	X (2024)	Wildlife and Countryside Act (1981) Schedule 9 Listed.
Water fern (<i>Azolla filiculoides</i>)		X (2014) ⁺	WFD UKTAG High Impact ; Wildlife and Countryside Act (1981) Schedule 9 Listed.
Yellow archangel (<i>Lamiastrum galeobdolon</i> subsp. <i>argentatum</i>)	X (1999)	X (2024)	Wildlife and Countryside Act (1981) Schedule 9 Listed.

* Note that this 2023 record is only recorded as *mimulus*. The most recent record of *M. guttatus* is 2016, and *M. guttatus x leteus* is 2020.

+ Species was only identified in the Derwent (Wye to Amber), not in the Derwent (Westend to Wye).

Within the Derwent reservoirs Study Area, four WFD UKTAG High impact INNS were identified. An additional eleven High Impact INNS were identified within the River Derwent Study Area. The High Impact INNS include seven riparian plants (American skunk-cabbage, giant hogweed, giant knotweed, giant rhubarb, Himalayan balsam, Japanese knotweed, rhododendron), four aquatic macrophytes (curly waterweed, New Zealand pigmyweed, Nuttall's waterweed, water fern), three crustaceans (Chinese mitten crab, demon shrimp, signal crayfish), and one fish (common / mirror carp).

H.2 Impact Assessment

The fifteen documented WFD UKTAG 'High impact' INNS species in the Study Areas are known to be invasive and have caused documented harm in habitats where they have become established. These are considered in relation to potential impact mechanisms below.

H.2.1 River Derwent

Note that the following 'High Impact' INNS were only identified within the River Derwent (Wye to Amber) water body: common / mirror carp, demon shrimp, giant hogweed, giant rhubarb, Nuttall's waterweed, and water fern. All pathways are predicted to be Negligible within this water body, so these INNS are expected to receive negligible / neutral impacts upon fitness and have therefore been excluded from the analysis below.

Reduction in flow and velocity

Aquatic macrophytes (curly waterweed, New Zealand pigmyweed) are commonly found in lentic or slow flowing ecosystems such as ditches, ponds and canals. Therefore, a reduction in flow - and velocity - would have a small beneficial impact on these species' fitness.

Signal crayfish and Chinese mitten crab are adapted to a wide variety of flows. However, a reduction in flow may increase the likelihood of upstream spread by facilitating easier movement or initiating overland dispersal. Chinese mitten crab also prefer low flow rivers and are found in many habitats, including stagnant and dynamic water systems like small streams, rivers, canals and lakes and usually burrow in areas with fluctuating water levels. Adults favour areas where floating vegetation grows thickly. Therefore, should aquatic macrophytes benefit from reduced flows, Chinese mitten crabs may as well.

It is important to note that whilst a minor reduction in flow is anticipated, flows are predicted to still remain above those that would naturally occur during severe drought.

Because of the low sensitivity, or absence of sensitivity, of the species investigated, the associated risk with INNS is precautionarily considered **Minor, with negative impacts upon riparian plants, and beneficial impacts upon aquatic plants and animals**. Confidence in this conclusion is **Low**.

Reduction in wetted perimeter

A reduction in wetted perimeter would be a (albeit small) negative pressure on signal crayfish and Chinese mitten crab as burrows would potentially become exposed and predation on this species (from predators such as otter and mink) may increase.

Riparian plant species may benefit from disturbance to the bankside habitat, and a reduction in wetted perimeter would expose potential riparian areas for colonisation. However, this impact is likely to only persist until water levels rise again and reverse their expansion, as none of these riparian plant species is aquatic.

Aquatic macrophyte species are likely to receive negative impact to fitness as most species will be intolerant of the increase in exposure to desiccation from reduction in wetted perimeter although conversely, increased light exposure (as a result of a reduced water depth) may provide a benefit. Precautionarily, this has been considered to benefit aquatic macrophytes.

Because of the low sensitivity, or absence of sensitivity, of the species investigated, the associated risk with INNS is precautionarily considered **Minor, with negative impacts upon signal crayfish and Chinese mitten crab, and beneficial impacts upon aquatic and riparian plants**. Confidence in this conclusion is **Low**.

Water quality changes

Small increases in phosphate concentrations, as the river has a reduced ability to dilute pollutants, are likely to occur, alongside decreases in dissolved oxygen and nitrates. This is likely to have mixed, and sometimes conflicting impacts upon species, for example increased concentrations of phosphate may increase fitness and capacity for spread of plant species, whilst increasing ammonia may be phototoxic, impairing nutrient uptake or root development. Impacts upon aquatic plants are increasingly variable, with New Zealand pigmyweed able to tolerate moderate levels of nutrient enrichment, including nitrogen in the form of ammonium. The water quality impacts upon the fitness of plants has been precautionarily summarised as beneficial.

Whilst signal crayfish and Chinese mitten crab are both tolerant of a range of water quality levels, negative impacts upon fitness can be expected as a result of increases in ammonia and decreases in dissolved oxygen.

Because of the low sensitivity, or absence of sensitivity, of the species investigated, the associated risk with INNS is precautionarily considered **Minor, with negative impacts upon signal crayfish and Chinese mitten crab, and beneficial impacts upon aquatic and riparian plants**. Confidence in this conclusion is **Low**.

H.3 Summary

A summary of the predicted impacts on INNS are presented in **Table H.3**. Reduced sensitivity to environmental change is a key characteristic of INNS and they often possess the ability to adapt and survive in a range of conditions. As a result, all of the INNS recorded within the assessment area (with the exception of water fern) have been deemed to have a Low or absence of sensitivity to the pathways of impact.

The drought permit is considered likely to result in a minor impact on the INNS communities of the affected reservoir and river. The direction of this impact (negative or beneficial) varies between species and water body.

Within the River Derwent, it has been precautionarily summarised that INNS will receive a **minor beneficial** impact to fitness as a result of the drought permit.

Confidence in both of these results is **low**.

No species outcome, across all water bodies, exceeds Minor beneficial. Therefore, it is considered unlikely that any changes to INNS fitness in response to the implementation of the drought permit will result in observable or large scale cascading impacts on native flora and fauna during implementation. Particularly where it is assumed that environmental conditions will return to baseline post-implementation, which may naturally mitigate any transitory increases in fitness experienced by INNS.

Table H.3 INNS recorded in the Derwent Valley Reservoirs and River Derwent Study Areas.

Species	Sensitivity	Significance of impact		Confidence level
		Derwent Valley Reservoirs	River Derwent	
American skunk-cabbage (<i>Lysichiton americanus</i>)	Low	-	Minor	Low
Chinese mitten crab (<i>Eriocheir sinensis</i>)	Low	-	Minor	Low
Common / mirror carp (<i>Cyprinus carpio</i>)	Low	-	Minor*	Low
Curly waterweed (<i>Lagarosiphon major</i>)	Low	-	Minor	Low
Demon shrimp (<i>Dikerogammarus haemobaphes</i>)	Low	-	Minor*	Low
Giant hogweed (<i>Heracleum mantegazzianum</i>)	Low	-	Minor	Low
Giant knotweed (<i>Fallopia sachalinensis</i>)	Low	-	Minor*	Low
Giant rhubarb (<i>Gunnera tinctoria</i>)	Low	-	Minor*	Low
Himalayan balsam (<i>Impatiens glandulifera</i>)	Low	Minor	Minor	Low
Japanese knotweed (<i>Fallopia japonica</i>)	Low	Minor	Minor	Low
New Zealand pigmyweed (<i>Crassula helmsii</i>)	Low	Minor	Minor	Low
Nuttall's waterweed (<i>Elodea nuttallii</i>)	Low	-	Minor*	Low
Rhododendron (<i>Rhododendron ponticum</i>)	Not Sensitive	Minor*	Minor	Medium
Signal crayfish (<i>Pacifastacus leniusculus</i>)	Low	-	Minor	Low
Water Fern (<i>Azolla filiculoides</i>)	Medium	-	Minor*	Low

* impact predicted to be negligible but categorised as Minor in the absence of a negligible category.

Uncertainties

The INNS assessment has been summarised as having a **Low** level of confidence for the following reasons:

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- INNS sensitivities and direction of significance of impacts have been determined by professional judgement supported by relevant literature. INNS are, by definition, highly adaptable, generalist species that can occupy different niches, trophic levels or are more resilient to selective pressures. However, limited, often fragmented, research exists on how INNS are expected to respond to pathways of impact, and the detailed environmental conditions of their preferred habitats.
- INNS responses are assessed by comparing the INNS baseline with the impacts of drought permit implementation. Unless explicitly stated, INNS fitness outcomes consider the effects of actions implemented under the drought permit, not the impacts of a natural drought without intervention.
- This assessment has been undertaken using a desk-based methodology only. The records used are reflective of observations at a particular point in time; however, INNS assemblage may change as a result of new introductions, natural changes to extant populations, or management and control efforts. Furthermore, there exist some spatial inaccuracies within the data used which, whilst being partially accounted for in the methodology, are a source of additional uncertainty. Therefore, the presence of a species within a water body should not be seen as definitive proof of current presence, nor should the absence of records be seen as definitive proof of the absence of INNS within a specific area.

H.4 References

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I Other Receptors

I.1 Introduction

I.2 Third-party abstractors

I.2.1 Background

This appendix comprises an assessment of the impact of the proposed ST Drought Permit on protected abstraction rights within the Derwent catchment. This section covers the potential impacts on third-party abstractors from Ambergate drought permit. Third-party abstraction sites downstream of Ambergate DP have been identified in Table I.1.

I.2.2 Baseline

The Environment Agency supplied details of third-party water abstractions in the Derwent catchment (data supplied December 2017 and updated datasets provided in September 2022 and then in September 2025). These abstraction points from the Derwent and its tributaries are given in Table I.1 and Table I.2 and shown on Figure I.1 (green diamonds). The rights comprise a mixture of agricultural, industrial and potable water supply not including abstractions by ST and hydropower sites (for completeness ST abstraction sites are also listed in the tables, although they were not assessed). Most of the abstractions operate year-round but two only operate during the summer (daily abstraction rate is below 1 Ml/d).

Discharge data was also provided by the Environment Agency. None of the third-party discharges were found to have constraints based on the flow or level in the Derwent. They would not be impacted by the DP. One discharge on the River Amber (i.e. within the wider River Derwent catchment) was under review by the Environment Agency at the time of drafting of this report. It is understood that a discharge constraint applied at very low flows is being considered for this site (information not reviewed as part of this 2025 report).

Baseline data were further supplemented in September 2022 and September 2025 following a review of Environment Agency supplied details of surface water and groundwater abstractions on the Derwent and its tributaries. This expanded review was undertaken to identify (1) review the information presented in 2022 and (2) abstraction licences that have HoF requirements linked to the River Derwent, despite not being located on the Derwent itself. These additional abstraction licences are presented separately in **Error! Reference source not found.**

Table I.1 Details of Abstraction Licences listed Upstream to Downstream

Licence Holder (licence no.)	Name	HOF (Ml/d) and other constraints	Use	Type	Comments
ST	SK 33 52 Ambergate - River Derwent	Abstraction to be reduced	Public Potable Water Supply	Single Point, River / Stream	Subject of DP
ST	Ogston Reservoir	Compensation requirement	Public Potable Water Supply	Single Point, Onstream Impoundment	
Environment Agency (MD/028/0040/004)	(SK3308854565) River Derwent At Whatstandwell	None	Transfer Between Sources (Post Water Act 2003)	Single Point, River / Stream	
Milford Mills Hydro Ltd (03/28/42/0021)	SK3490145352 River Derwent At Milford Mill, Belper	Locally prescribed - Before construction of fish pass - Local level restriction 20mm over Upper Milford weir. After construction of fish pass - 69.12 over fish pass, 10mm over Upper Milford weir.	Hydroelectric Power Generation	Single Point	No power generation unless depth of water is equal to or greater than 20mm at SK 34896 45363 (upper Milford weir)
Derwent Hydroelectric Power Ltd (03/28/42/0026/1/R01)	(SK3458548121) RIVER DERWENT AT BELPER, DERBYSHIRE.	S158 agreement attached to the licence	Milling & Water Power Other Than Electricity Generation	Single Point, River / Stream	
Derwent Hydroelectric Power Ltd (MD/028/0040/022)	(SK3407152347) AMBERGATE MAIN WEIR HYDROPOWER	Locally prescribed - Abstraction shall not exceed 1.5 cubic metres per second, unless the rate of flow in the River Derwent as measured immediately upstream of the authorised point of abstraction at National Grid Reference SK 34071 52347, is equal to or greater than 6.9 cubic metres per second and the abstraction shall not cause the flow immediately downstream of the said abstraction point to fall below 5.4 cubic metres per second.	Hydroelectric Power Generation	Single Point / Single Purpose	
Derwent Hydroelectric Power Ltd (MD/028/0040/024)	(SK3421552102) AMBERGATE FISH PASS TO MILL STREAM	None	Fish Pass/Canoe Pass	Single Point / Single Purpose	
Talbot Turf Supplies Ltd (03/28/46/0015/1/R01)	(SK3588739899; SK3574439111) RIVER DERWENT AT ALLESTREE, DERBY	720 Ml/d HOF at Derby Saint Mary's Bridge, 2650 at North Muskham	Agriculture	Single Point / Single Purpose	HOF Station - Derby St Marys 4085

Licence Holder (licence no.)	Name	HOF (MI/d) and other constraints	Use	Type	Comments
ST	SK 44 32 Little Eaton (Nottingham) - River Derwent Draycott Intake - River Derwent	340 at Derby St Mary's. 340 at Church Wilne.	Public Potable Water Supply	Single Point, River / Stream	
ST	SK 35 40 River Derwent At Little Eaton	340 at Derby St Mary's.	Public Potable Water Supply	Single Point, River / Stream	
Talbot Turf Supplies Ltd (03/28/42/0028/1/R01)	(SK3488644151; SK3478243702) MILFORD,DERBY - RIVER DERWENT	720 MI/d HOF at Derby Saint Mary's Bridge, 2650 at North Muskham	Agriculture	Single Point / Single Purpose	HOF Station - Derby St Marys 4086
Derby City Council (03/28/48/0001)	SK3780034800 Alvaston Boating Lake - River Derwent	None	Make-Up Or Top Up Water	Single Point, River / Stream	
Derby And Sandiacre Canal Trust (03/28/48/0015)	SK3977034360 Spondon Factory - River Derwent & Lakes (Point 1)	Location prescribed - SK 438 316 – 340 MI/d	Supply To A Canal For Throughflow	Single Point, River / Stream	
Derbyshire Waste Ltd (03/28/48/0021)	(SK38683427) Land Nr Alvaston - River Derwent	None	Evaporative Cooling	Multiple Points / Single Purpose	
ST	SK 40 33 Spondon - River Derwent	Abstraction shall not exceed 4.320 when mean daily flow is below 340 MI/d at Derby	Transfer Between Sources (Pre Water Act 2003), Water Supply	Single Point, River / Stream	
Derby City Council (03/28/48/0042/R01)	(SK3563136300; SK3564936304) Longbridge Weir - Hep Intake	No abstraction shall take place unless the level of water in the River Derwent above the crest of Longbridge weir at National Grid Reference SK 35650 36311 is equal to or greater than 50 millimetres and the abstraction shall not cause the level at the said reference point to fall below that level. This level shall be known as the 'Longbridge weir prescribed level?.'	Transfer for the purpose of power production.	Single Point / Single Purpose	50mm above crest of Longbridge weir. HOF locally prescribed
Derby City Council (MD/028/0048/004)	(SK3554836312) COUNCIL HOUSE, CORPORATION STREET, DERBY, DERBYSHIRE	None	Non-Evaporative Cooling	Single Point / Single Purpose	
Derby City Council (03/28/48/0035)	(SK36703540; SK37453568; SK37503500; SK36903485) DERBY PRIDE PARK - BOREHOLES	None	Transfer Between Sources (Pre Water Act 2003)		
White Peak Distillery Ltd (MD/028/0040/007)	(SK3403852402) Derwent Works, River Derwent, Ambergate, Derbyshire	None	Non-Evaporative Cooling	Single Point, River / Stream	instantaneous limit 8 l/s

Licence Holder (licence no.)	Name	HOF (MI/d) and other constraints	Use	Type	Comments
Needle (MD/028/0048/017)	(SK4147134110, SK4148734105) Borrowash Mill, River Derwent	No abstraction shall take place unless the water level in the authorised source of supply is equal to or higher than 0.16 metres as measured by the staff gauge located at National Grid Reference SK 41496 34111 and the abstraction shall not cause the water level to fall below the aforementioned level.	Transfer for the purpose of power production.	Single Point / Single Purpose	
Environment Agency (MD/028/0048/006/R01)	(SK4046234006) River Derwent - Original Channel	None	Fish Pass/Canoe Pass	Single Point, River / Stream	
SmartParc SEGRO Spondon Ltd (MD/028/0048/018)	(SK3946834198) POINT A RIVER DERWENT AT BOTTLE BROOK (SK3945234225) POINT B RIVER DERWENT AT BOTTLE BROOK	None	Transfer Between Sources (Post Water Act 2003)	Multiple Points / Multiple Purposes / Multiple Points / Single Purpose	

Abstraction shaded in mauve subject of the proposed Ambergate DP.

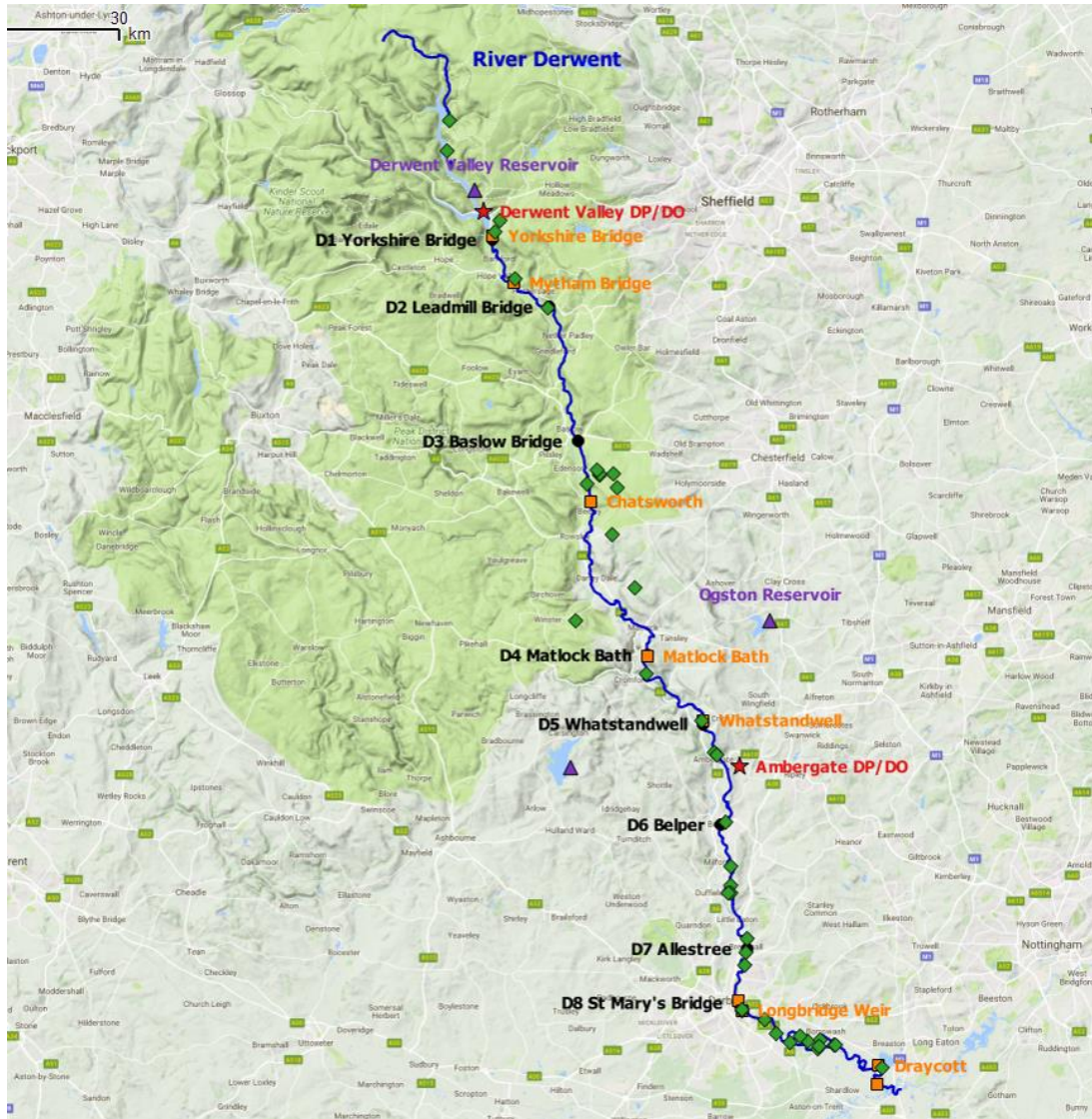


Figure I.1 Protected rights along the River Derwent
Abstraction points (green diamonds), gauging stations (orange squares), assessment points (black), reservoirs (purple triangles) and DP locations (red stars) on the Derwent

Table I.2 Details of additional Abstraction Licences on Derwent tributaries

Licence Holder	Name	HOF (MI/d) and other constraints	Comments
Derby City Council	Cressbrook Mill Leat at Cressbrook Mill	HOF immediately d/s abstraction on River Wye <= 496 litres/second (approximately 43 MI/d).	
Kedleston Park Golf Club Limited (03/28/47/0038/R01)	Kedleston Park Golf Course – Cutler Brook	HOF <=360 MI/d on the River Derwent (Church Wilne)	Abstraction to cease when the flow in the River Derwent is equal to or less than 360 MI per day
Kedleston Park Golf Club Limited (03/28/47/0033)	Kedleston Park Golf Course – borehole	HOF <=360 MI/d on the River Derwent (Church Wilne)	ABSTRACTION SHALL BE REDUCED TO 90 CUBIC METRES PER DAY. ABSTRACTION SHALL CEASE COMPLETELY ONCE ABSTRACTION HAS EXCEEDED 6183 CUBIC METRES FROM THE 1 APRIL OF THAT YEAR.
John Smedley LTD (03/28/40/0042)	(SK3220057800) LEA MILLS - SPRINGS	None	
	(SK3220057500) LEA MILLS - SPRINGS (2)	None	
H J ENTHOVEN & SONS (03/28/40/0046)	(SK2583462389) MILL CLOSE MINE-DARLEY DALE, DERBYSHIRE	None	
Nestle Waters UK Limited (03/28/39/0026/1/R01/03/28/39/0111/R01)	Borehole A at Lightwood, Buxton		
Nestle Waters UK Limited (03/28/39/0026/1/R01/03/28/39/0111/R01)	Borehole B at Lightwood, Buxton		No abstraction shall take place when the flow in the River Derwent as gauged by the Agency at its flow gauging station at Derby St Marys Bridge at National Grid Reference SK 35390 36880 is equal to or less than 720 Megalitres per day as notified by the Agency. The Agency's said gauging of the flow shall be conclusive.
Nestle Waters UK Limited (03/28/39/0026/1/R01/03/28/39/0111/R01)	Portobello borehole	Linkages between licences. Referenced HOF is <= 720 MI/d at St Mary's Bridge, Derwent	
Nestle Waters UK Limited (03/28/39/0026/1/R01/03/28/39/0111/R01)	Rockhead – spring		
Nestle Waters UK Limited (03/28/39/0026/1/R01/03/28/39/0111/R01)	Staden, Buxton – borehole		
The Arkwright Society Limited (MD/028/0040/001)	(SK2924057045) Bonsall Brook at Cromford, Derbyshire	Locally prescribed	No abstraction of water shall take place unless the rate of flow in the Bonsall Brook immediately d/s of SK 29240 57045, is => than 0.17 m3/s and abstraction shall not cause the flow immediately downstream of the said abstraction point to fall below that rate.
THE SENAD GROUP LIMITED (03/28/40/0106)	(SK317530) ALDERWASLEY - SPRING		
	(SK328532) ALDERWASLEY - SPRING (2)	None	
Derbyshire County Council (MD/028/0040/017)	(SK2980756939) BONSALL BROOK AT ARKWRIGHTS MILL	None	
CHEVIN EST LTD (GOLF CLUB) (03/28/42/0025)	(SK3427045110) CHEVIN GOLF CLUB - BOREHOLE	None	

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Licence Holder	Name	HOF (MI/d) and other constraints	Comments
LKAB Minerals Limited (03/28/48/0010)	(SK3840035000) DERBY - BOREHOLE	None	
Tarmac Building Products Limited (03/28/48/0034)	(SK4286031560) BELLINGTON HILL QUARRY - CATCHPIT	None	
R OLDERSHAW LTD (03/28/59/0008/G)	(SK474298) LOCKINGTON GROUNDS,NOTTS - POND	None	
J and J B Dalton (MD/028/0038/004/R01)	(SK1896784235) MINOR AQUIFER AT ASTON HALL FARM, HOPE VALLEY, DERBYSHIRE	None	
Sickleholme Golf Club Ltd (03/28/38/0034)	(SK2140082600) / Golf Course - Upper Hurst Brook	None	
Derbyshire Waste Ltd (03/28/48/0021)	(SK39253470) Land Nr Alveston - Sewage Works Effluent	None	
CAUDWELL'S MILL TRUST LTD (03/28/39/0058)	(SK2556065740) CAUDWELL'S MILL TRUST LTD - RIVER WYE		
	(SK2910072000) CHATSWORTH - BLACKLEACH BROOK		
	(SK2770069200) CHATSWORTH - BLACKLEACH BROOK (2)	None	
Chatsworth House Trust (03/28/38/0057)	(SK2750070100) CHATSWORTH - BLACKLEACH BROOK (3)		
	(SK2663070090) CHATSWORTH - SPRING (1)		
	(SK2663069940) CHATSWORTH - SPRING (2)		
Chatsworth Settlement Trustees (03/28/38/0072)	(SK2645070340) Chatsworth House - The Trout Stream	None	
Leadmill Trout Farm Ltd (03/28/38/0062)	(SK2310080300) LEADMILL - TRIBUTRY HIGHLOW BROOK (MILL CHASE)	None	instantaneous quantity limit 40 l/s
Mr Sebastian Perez (03/28/40/0064)	(SK2880062900) Ladygrove Mills - Sydnope Brook	None	
Hanson Quarry Products Europe Ltd (MD/028/0036/008)	(SK4266329770; SK4404429549; SK4280028407; SK4124628095)	None	
Indurent Strategic Land Ltd (MD/028/0036/019)	(SK4517429400; SK4537529370; SK4522929172; SK4504629172) AREA 1 AT AT HEMINGTON, LEICESTERSHIRE	None	
	(SK4503629110; SK4524229154; SK4525028675; SK4489128675) AREA 2 AT AT HEMINGTON, LEICESTERSHIRE		

Licence Holder	Name	HOF (M/d) and other constraints	Comments
Above Limited (MD/028/0044/001)	(SK3507941960; SK3518241967; SK3518941766; SK3508241764)	A SUMP	None
	COMPRISING DEPOSITS AT STW	DUFFIELD	
Tarmac Trading Limited (MD/028/0049/005)	(SK4772830752; SK4889030750; SK4889029510; SK4773129509)		None
	LOCKINGTON LEICESTERSHIRE	QUARRY,	

1.2.3 Impact mechanisms

The proposed DP could potentially impact protected rights on the Derwent in two ways:

- Mechanism 1 (indirect): causing flows and levels at St Mary's Bridge and other control points to fall below trigger thresholds to reduce or cease abstraction; or
- Mechanism 2 (direct): reducing flows and levels so there is insufficient water available for abstraction.

The first mechanism is indirect and could impact protected rights both upstream and downstream of a DP site if they have control points downstream of a DP. The second mechanism could only impact rights downstream of a DP.

Sites in **Error! Reference source not found.** are all on tributaries of the Derwent (available water will not be affected by changes in flow on the Derwent).

1.2.4 Abstractions/ Discharges downstream of Ambergate

Abstractions downstream of Ambergate could be impacted by the Ambergate DP time via mechanism 1 or mechanism 2.

Impacts via mechanism 1 resulting from Ambergate DP:

Four abstractions in the catchment are controlled at Derby St Mary's Bridge (Talbot Turf Supplies Ltd x2 and NESTLE WATERS UK LIMITED x2). All of the four abstractions controlled at St Mary's Bridge has a high HoF of 720 MI/d. This is higher than the trigger levels for the DP and the site will have ceased to abstract before the DP is triggered. It will not be impacted by the DP.

Local control applies to the following abstractions:

- At Borrowwash Weir (Needle, MD/028/0048/017) - Borrowwash is close to the area of Church Wilne and has been assessed at the same point although it is unclear what proportion of the River Derwent flow will pass the HoF gauge. The flow through the area of Church Wilne does not fall below 360 MI/d for the drought scenario (**Error! Reference source not found.**). is likely the DP will have negligible impact on the abstraction at Borrowwash via mechanism 1. It is also assumed that those abstractions controlled locally will also be subject to negligible impact, given consideration of the small scale of predicted hydromorphology parameter change. This also applies to the locally controlled abstractions at Spondon factory (Derby And Sandiacre Canal Trust) with a threshold of 360MI/d and abstractions linked to Kedleston Park Golf Club Ltd (on Derwent tributaries).
- At Longbridge Weir Derby City Council (03/28/48/0042/R01), The abstraction at Derby has a level control of 50mm over Longbridge Weir. The stage discharge relationship for Longbridge weir is not available but the Environment Agency supplied two spot gaugings at the site. These indicate that 340 MI/d is likely to be considerably more than 50 mm over the weir. It is unlikely any of the abstractions controlled at Derby will be impacted via mechanism 1.

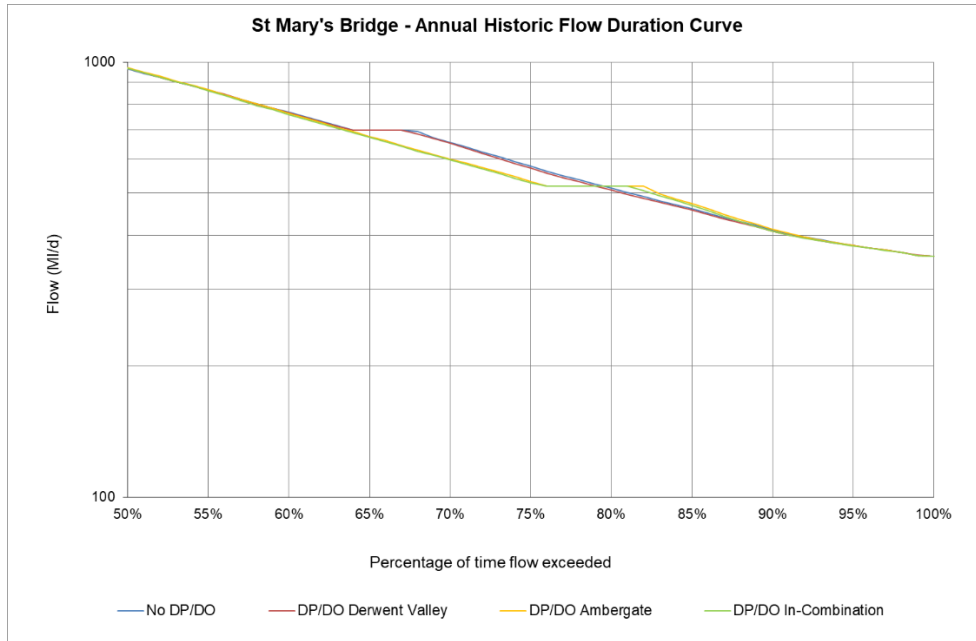


Figure I.2 Annual flow duration curve at Derby St Mary's Bridge

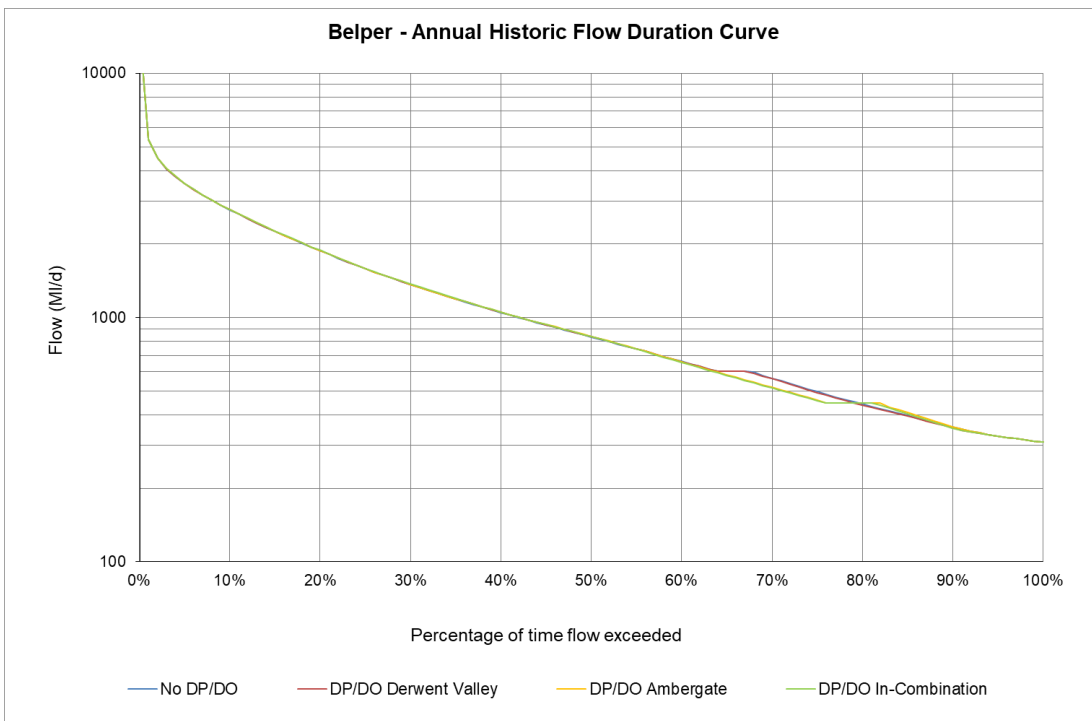


Figure I.3 Annual Flow Duration Curve at Belper

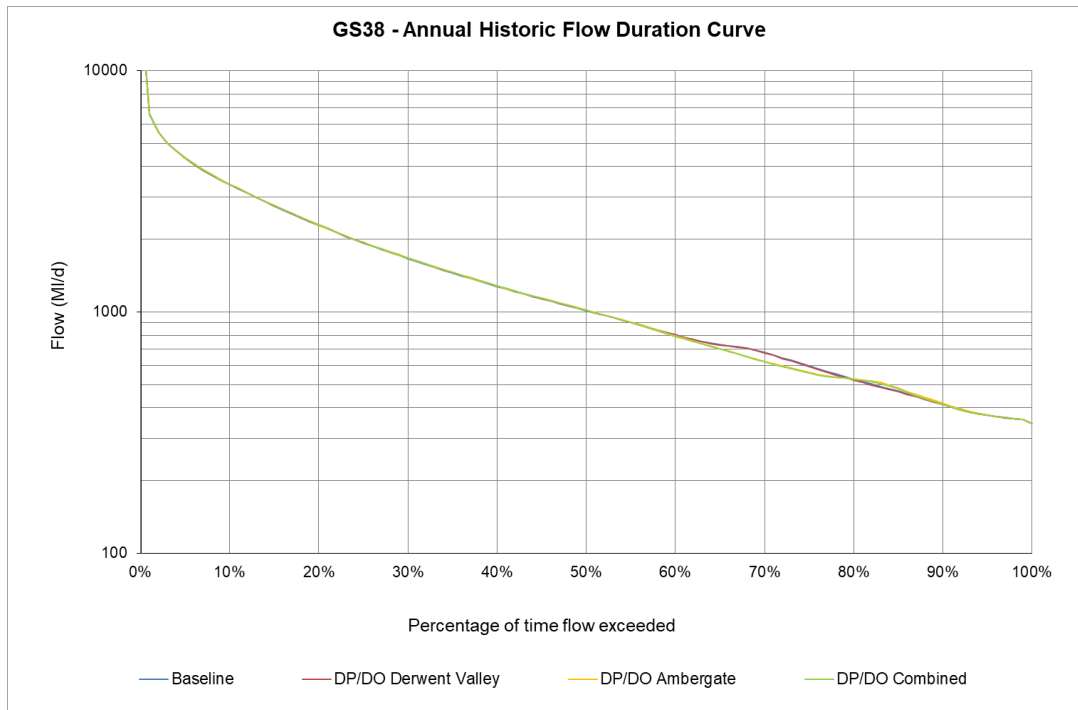


Figure I.4 Annual Flow Duration Curve at Church Wilne

Impacts via mechanism 2 resulting from Ambergate DP

There are numerous other abstractions from the River Derwent in this reach. The majority of this can be attributed to non-consumptive licences over 1000 MI/d for HEP generation (Derwent Hydroelectric Power Ltd and Milford Mills Hydro) and one of the largest at 1,469 MI/d a fish/canoe pass (MD/028/0048/006/R01, value not confirmed in the 2025 EA dataset). In addition, there are 4 other abstractions with daily maximums over 100 MI/d (Talbot Turf Supplies Limited (3x) and Derby and Sandiacre Canal Trust) and one abstraction with no daily maximum.

With Ambergate DP activated, ST will be able to abstract up to 180 MI/d more than without the Ambergate DP at flows below 680 MI/d but above 500 MI/d. Our assessment considered whether the HEP abstraction sites downstream Ambergate DP could be impacted by reduced flows of up to 180 MI/d hence potentially reducing HEP generation. This is assessed below:

- Derwent Hydroelectric Power Ltd (MD/028/0040022): this HEP site has a locally prescribed control as detailed in Table I.1. Abstraction is limited to 1.5 m³/s or 130 MI/d unless flow at the river flow at location SK 34071 52347 is equal or greater than 6.9 m³/s 596 MI/d. Additionally, the abstraction shall not cause the flow immediately downstream of the said abstraction point to fall below 5.4 cubic metres per second or 466 MI/d. In this case, abstraction should cease when river flow is below 466 MI/d which is below the DP threshold of 500 MI/d. The Ambergate DP will not cause cessation of HEP generation however, by considering a precautionary approach, HEP generation may be reduced over a limited number of days due to reduced flows from November to March as explained in Section C, if Ambergate DP is in place.
- Milford Mills Hydro Ltd (03/28/42/0021): this HEP site has a locally prescribed control as detailed in Table I.1. There should be no HEP generation unless depth of water is greater than 20mm at SK 34896 45363 (upper Milford weir). As a proxy, AP6 Belper river depth values were used to check the river depths with and without Ambergate DP. This is shown on Figure C.5. River depths at the location do not drop below 20mm. The Ambergate DP will not cause cessation of HEP generation however, by

considering a precautionary approach, HEP generation may be reduced over a limited number of days, from November to March as explained in Section C if Ambergate DP is in place.

It should be noted that as part of the Ambergate DP application, ST is in touch with the HEP management companies to discuss viable options to compensate for any potential short-term loss.

The other licence abstracting from the Derwent in this reach has a maximum daily abstraction well below the proposed DP compensation flow and no HoF requirement. It will not be impacted by the DP.

The hydrological assessment (Appendix A) has demonstrated that the effect on flows from the Derwent Valley Reservoirs DP diminishes with distance downstream, with the change (from baseline) in the lower river being negligible.

1.2.5 Summary

Protected Rights are subject to the vagaries of river flows and may be impacted by low flows and associated low water levels. The extent to which this may be exacerbated by the implementation of a DP is difficult to quantify without the specific knowledge of how and when individual licence holders use their water.

Adopting a precautionary approach, a minor potential effect is predicted at the HEP sites downstream Ambergate DP. Ambergate DP could potentially reduce flows which could reduce HEP generation. It is not expected that Ambergate DP could cause cessation of the HEP. It should be noted that as part of the Ambergate DP application, ST is in touch with the HEP management companies to discuss viable options to compensate for any potential short-term loss.

No third-party discharges in the catchment are currently controlled by levels or flows on the Derwent and the proposed DPs would have no impact on third party discharges to the river.

The predicted Protected Rights impact assessment results are summarised in **Error! Reference source not found.**

Table I.3 Summary of predicted potential impacts (impact significance) on Protected Rights

		Ambergate DP											
Receptor		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Reach 1	Protected Rights-local receptors	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*
Reach 2	Protected Rights-local receptors	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*
Reach 3	Protected Rights-local receptors	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min
Reach 4	Protected Rights-local receptors	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*
Reach 4	Protected Rights-regional receptors	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*	Min*

NB: Reach 1 = Derwent from Westend to Wye water body (upstream Ambergate DP); Reach 2 = Derwent from Wye to Amber water body (upstream Ambergate DP); Reach 3 = Derwent from Amber to Bottle Brook water body; Reach 4 = Derwent from Bottle Brook to Trent, Min*= impact predicted to be negligible but categorised as Minor in the absence of a negligible category

I.3 Designated Sites

I.3.1 Background

This assessment focusses on designated sites associated with the Ambergate study area.

A search for statutory environmental designations within the Ambergate study area was conducted using MAGIC (<http://www.magic.gov.uk/>). The search was restricted to features located on the banks of the watercourses in the Ambergate study area.

The following layers were interrogated:

- Areas of Outstanding Natural Beauty (AONB);
- National nature reserves;
- National parks;
- Ramsar sites;
- Sites of Special Scientific Interest (SSSI);
- Special Areas of Conservation (SAC); and
- Special Protection Areas (SPA).

These statutory designations are considered to be of National (domestic UK legislation) or International (European and international legislation) Importance.

I.3.2 Potential routes of impact

Sites designated under UK, European and international legislation are considered where they may be designated for their wildlife or geological interest. Designated sites may be impacted via a change in river level leading to exposure of sediments. This has the potential to impact the integrity of the substrate itself and the utilisation of the shoreline by flora and fauna that may be protected under the designation.

I.3.3 Baseline

There are a number of designated sites on or adjacent to the River Derwent, as presented in **Error! Reference source not found.** I.4 to I.5 (arranged by WFD water body).

Table I.4 Designated sites on or adjacent to the River Derwent (Amber to Bottle Brook)

Site Name	Designation	Reason for designation
Duffield Millennium Meadow	Local Nature Reserve	Part of the Lowland Derbyshire Biodiversity Action Plan and includes floodplain grazing marsh and standing open water with associated vegetation.
Derwent Valley Mills	World Heritage Site	Birthplace of the factory system, historical mills
Ogston Reservoir*	SSSI	Wintering site for many wildfowl and a feeding site for wading birds on passage in late summer. Grazed and ungrazed grassland, scrub, woodland and tall herb communities provide peripheral mosaic of semi-natural habitat for a range of breeding birds.

NB: *Ogston Reservoir is itself a WFD lake water body (ID GB30433781) within the Amber catchment; see Section 2 for connectivity discussion.

Table I.5 Designated sites on or adjacent to the River Derwent (Bottle Brook to Trent)

Site Name	Designation	Reason for designation
Darley and Nutwood	Local Nature Reserve	Former municipal refuse tip. Habitats include grassland being invaded by scrub and woodland.
The Sanctuary	Local Nature Reserve	Formerly a gas works tip; 'bird and wildlife reserve'

1.3.4 Impact Assessment

Reference to reasons for designation for all relevant designated sites suggests that most designated sites are not (to a large extent) water dependent i.e. there is no pathway via which changes in river flow/character may affect the designated features. In these instances, the designated sites were discounted from further consideration.

The Masson Hill SSSI is water dependent, designated on account of a series of caverns and solution caves. The scale of predicted DP related hydraulic change is not deemed sufficient to affect groundwater in any respect and potential effects on the Masson Hill SSSI are discounted as a result.

The Cromford Canal is a surface water dependent site. However, the designated features are not dependent on the River Derwent for water supply. Under normal operation it is not hydraulically connected to the River Derwent. The Leawood Pumphouse, which is maintained for heritage purposes, can still lift water from the Derwent into Cromford Canal, however, is only run periodically for heritage steam purposes. The Cromford Canal was scoped out of further consideration.

Review of the following designated sites found them to be (at least in part) water dependent and therefore further consideration is made below:

- Derwent Valley Mills World Heritage Site;
- Ogston Reservoir SSSI.

Derwent Valley Mills World Heritage Site

An assessment of potential effects on the Derwent Valley Mills World Heritage Site has been undertaken as part of the Amenity and Leisure assessment. Whilst the river is an integral part of the Derwent Valley Mills World Heritage Site, it is not central to the amenity use of the site. Any hydraulic change associated with the Ambergate DP relative to a baseline drought scenario would therefore have no effect on the integrity or practical conservation of the World Heritage Site.

Ogston Reservoir SSSI

Ogston Reservoir is located in the River Amber catchment but is augmented by abstractions from the River Derwent at Ambergate and Carsington Reservoir. Under the Ambergate DP scenario, there tends to be a little more drawdown in Ogston reservoir relative to the baseline no DP scenario. The reservoir margins support a mosaic of semi-natural habitats e.g. scrub and herb communities that are utilised by breeding birds, and therefore reservoir level change has the potential to adversely affect designated features. However, consideration of the scale of this predicted change finds that reservoir level change during DP operation relative to baseline is typically small, particularly in relation to inter-annual and inter-seasonal changes under baseline operation. As such, it is considered that the baseline vegetation communities will be resilient to routine and extensive water level fluctuation, in a way that may not necessarily be the norm for marginal communities associated with a more 'natural' standing open water. The variation in reservoir level associated with Ogston reservoir under a baseline scenario, has been found to be greater than 4.5 m for the 1959-60 modelled

stochastic drought. It is therefore considered that implementation of the DP would have a **Negligible** magnitude of effect and a **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category) impact significance on the Ogston Reservoir SSSI.

1.3.5 Summary

Table summarises the predicted impacts on designated sites within each water body.

Table I.8 Summary of predicted impacts on designated sites

Designated sites		Impact magnitude		Impact significance		
		Drought scenario	permit	Receptor sensitivity	Drought scenario	permit
Derwent Mills Heritage Site;	Valley World	N/A		Low	Minor* (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category)	Medium
Ogston SSSI.	Reservoir	Negligible		Low	Minor* (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category)	Medium

1.4 Aesthetics, recreation and navigation

1.4.1 Background

This section describes the impacts on aesthetics, recreation and navigation of abstracting additional water under the proposed drought permit scenario upon the communities and landscape of the Derwent study area during a time of drought. It does not assess the impact of a drought itself which would occur anyway in the absence of the drought permit. Visual impacts relate to the effect on local landscape character, together with the perception of these changes to the baseline environmental conditions on the people (visual receptors) who may experience them. The assessment is based on a review of existing data and the results of other areas of the environmental assessment.

1.4.2 Potential routes of impact

The key considerations in assessing the impact of a drought permit on the visual and amenity value of the River Derwent are:

- The impact to river flow type and therefore the character of the watercourses in the Derwent study area.
- The seasonal timing and frequency of any changes, in particular the impact over spring and summer, when members of the public are most likely to be utilising the landscape around the Derwent study area for recreation.

Navigation may be impacted by reduced volume of water.

1.4.3 Baseline

1.4.4 Angling

A large number of angling clubs have been identified that control waters throughout the Derwent, providing good angling access to large stretches of the river. The river supports a mixed fishery with trout important within the upper and middle reaches. A number of specialist fly fishing clubs operate upstream of the Ambergate abstraction.

Slower velocities and increased depth provide suitable conditions for coarse fishery downstream of Matlock. Both the trout and coarse fisheries are considered to be of good quality. However, due to a decline in natural productivity since the 1990s and the presence of several barriers to fish migration (although this is understood to be an improving situation (Appendix F), both brown trout (*salmo trutta*) and coarse fish species are regularly stocked.

1.4.5 In-stream recreation/navigation

There are two active canoe clubs that use the River Derwent: Matlock Canoe Club based in Matlock and Midland Canoe Club based at Darley Park. Derwent Rowing Club is based at Darley Park.

Canoeing, kayaking and rowing take place all year round and include a slalom course in Matlock. Water levels are not reported to restrict in-stream recreation within the currently accessible reaches.

Access to the river is limited between Yorkshire Bridge and Darley Abbey. There are no official access agreements on the upper or middle reaches of the River Derwent except for a half mile reach between Matlock and Matlock Bath.

There is open access to the River Derwent at Darley Abbey, and there are navigational rights from Darley Abbey Weir downstream as far as the confluence with the River Trent (about 37 km). Private access agreements by local users may exist upstream of Darley Abbey but are quite rare and are kept very private.

Physical habitat 'quality' (a measure of diversity) is as expected for a river of its type and that Walkover surveys and River Habitat Survey (RHS) results (Appendix C) suggest that glide is the dominant flow type in most reaches in the study area. Physical habitat diversity decreases with distance downstream, as expected, and this is exacerbated by channel modifications have created several impounded sections.

1.4.6 Informal recreation

There is public access via footpaths, bridleways, cycle paths and car parks along the whole length of the River Derwent all year round. In particular, the Derwent Valley Heritage Way is an 88 km long-distance path along the Derwent valley from Ladybower Reservoir through to the Derwent Valley Mills World Heritage Site. It enables access along the length of the River Derwent between Ladybower Reservoir and the confluence with the River Trent near Great Wilne. The Derwent Valley Heritage Way is popular with walkers, dog walkers, photographers and bird watchers. There are also other public footpaths and car parks along the whole length of the river and the river is crossed by a cable car at Matlock Bath, which adds to the visual amenity of the attraction.

The River Derwent passes through a number of nationally and internationally designated sites as well as the City of Derby and various towns and villages including Ambergate, Belper, Milford, Duffield, Allestree and Darley Abbey. There are a multitude of visitor centres, car parks and other facilities along the whole length of the river (Derbyshire County Council Website and maps, accessed August 2018).

The Derwent Valley Heritage Way, Derwent Mills World Heritage Site and Peak District National Park attract a large number of visitors from a wide catchment area (>30km) and are important at international, national and regional levels (Derwent Valley Trust and Derwent Valley Mills Websites, accessed August 2018).

1.4.7 Impact assessment

Potential amenity and leisure impacts were assessed based on available baseline information and the predicted changes to pathways (hydromorphology and water quality assessments) and ecological receptors (macroinvertebrates and fish).

Based on the magnitude of hydraulic change, particularly predicted water level changes, DP impacts on informal recreation, navigation, aesthetics, landscape and amenity are considered unlikely at any site.

Predicted impacts of the DP on fish, even those species considered to be most sensitive to changes in flow, are modest, as are effects on habitat which support longer term on population performance. These include, but have not been limited to, riffles which are seasonally important as they perform spawning and nursery functions for a range of species, including brown trout. Based on the fact that all adult lifestages of species considered to be of angling interest are not anticipated to be subject to any more than minor impacts, detectable impacts on angling performance are considered unlikely.

The character of flow at the Chatsworth estate is strongly influenced by weirs. Conceivably, lower flows may just be noticeable on the downward faces of the weirs, but changes are likely to be imperceptible on the ponded flow upstream. The same is true at historical mills at Bamford and Calver. Effects are even less likely at the remainder of historical mills in the Derwent Valley Mills, as flow reductions are much smaller downstream of the River Wye confluence.

1.4.8 Summary

Table summarises the predicted impacts on aesthetics, recreation and navigation within each water body.

Table I.9 Summary of predicted impacts on aesthetics, recreation and navigation in the River Derwent

Water body	Impact magnitude		Impact significance	
	Drought permit scenario	Receptor sensitivity	Drought permit scenario	Confidence level
All	Low	Low	Minor	Medium

I.4.9 Heritage and archaeology

There are nine bridges within the Derwent Valley that are Scheduled Monuments (Table I.10) based on a search of the MAGIC website (accessed August 2018).

Table I.10 Bridges within the Derwent Valley that have Scheduled Monuments status.

Bridge	Location
Grindleford Bridge	424495, 377812
Froggatt Bridge	424374, 376069
Baslow Bridge	425103, 372371
One Arch Bridge	426070, 368442
Rowsley Bridge	425671, 365893
Darley Bridge	427052, 362069
Matlock Bridge	429787, 360177
Cromford Bridge	430013, 357179
Duffield Bridge	435033, 342964

The River Derwent runs through the Chatsworth Estate which also attracts large numbers of visitors. The river passes the front of the stately home and is an important feature in views of the house. There are various walks and picnic spots alongside the river and during the summer months there may also be in-stream recreation including paddling and swimming in the River Derwent at this location.

Derwent Valley Mills (between SK2957 and SK3536) is designated as a World Heritage Site (Derwent Valley Mills Website, accessed August 2018). This international designation confirms the outstanding importance of the area as the birthplace of the factory system where in the 18th Century waterpower was successfully harnessed for textile production. Stretching 15 miles down the river valley from Matlock Bath to Derby, the World Heritage Site contains a series of historical mill complexes, including some of the world's first 'modern' factories. The site attracts large numbers of visitors every year and is a valuable educational resource. Due to its focus on harnessing waterpower for textile production, the River Derwent is a key feature of the world heritage site.

The individual heritage features include a number of historical mills and their associated industrial communities; features are linked together by the Derwent Valley Heritage Trail.

The Little Chester Roman Site (SK3537) near Derby is also designated as a scheduled monument, although it is not considered to be a visitor attraction and the aesthetic and hydraulic properties of the river are of low importance to its designated status.

1.5 Impact assessment

Potential amenity and leisure impacts were assessed based on available baseline information and the predicted changes to pathways (hydromorphology and water quality assessments) and ecological receptors (macroinvertebrates and fish).

Based on the magnitude of hydraulic change, particularly predicted water level changes, DP impacts on informal recreation, aesthetics, landscape and amenity are considered unlikely at any site.

Angling clubs and fishery interests have previously expressed concern regarding the current flow regime on the Derwent and 'lack of flow' (ESI & APEM 2012). That report further noted that damage to fishing quality or habitat could potentially result in claims for loss of amenity or similar (EA Fisheries Officer, pers. comm. June 2011). However, this concern has been primarily expressed with regard to baseline operation and not DP operation. Predicted impacts of the DP on fish, even those species considered to be most sensitive to changes in flow, are modest, as are effects on habitat which support longer term on population performance. These include, but have not been limited to, riffles which are seasonally important as they perform spawning and nursery functions for a range of species, including brown trout. Based on the fact that all adult lifestages of species considered to be of angling interest are not anticipated to be subject to any more than minor impacts, detectable impacts on angling performance are considered unlikely.

The character of flow at the Chatsworth estate is strongly influenced by weirs. Conceivably, lower flows may just be noticeable on the downward faces of the weirs, but changes are likely to be imperceptible on the ponded flow upstream. The same is true at historical mills at Bamford and Calver. Effects are even less likely at the remainder of historical mills in the Derwent Valley Mills, as flow reductions are much smaller downstream of the River Wye confluence.

1.6 Summary

The amenity and leisure features identified as occurring within or immediately adjacent to the River Derwent are considered unlikely to be affected by the DP.

Within the study area, the heritage features considered to be most sensitive to amenity and leisure impacts are:

- River Derwent at Chatsworth Estate (upstream of the Ambergate DP); and
- Derwent Valley Mills World Heritage Site.

These can be considered to be of **international** value (world heritage site). Given the hydrology impacts will downstream of heritage sites the resultant predicted impact significance on amenity and leisure receptors may be summarised for all locations as **Minor*** (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category).

Table I.11 Impact significance for amenity and leisure of River Derwent

Receptor	Impact magnitude	Sensitivity / value	Impact significance
River Derwent amenity and leisure	Negligible	International	Minor* (*impact predicted to be negligible but categorised as Minor in the absence of a negligible category)

I.7 Certainty

The amenity and leisure assessment benefits from detailed study assessment of pathway mechanisms, but none of the Assessment Points (APs) have been specifically located to assess amenity and leisure effects. In place of observations, the assessment therefore draws inference from expected behaviour, given the nature of the sites. Confidence in the assessment is Medium.

I.8 References

Derwent Valley Mills Website and Derwent Valley Trust Website, accessed August 2018

Derbyshire County Council Website and maps, accessed August 2018

ESI & APEM (2012). Drought Permit environmental assessment report: River Derwent at Ambergate and Derwent Valley Reservoirs. Report reference 60083j R1, April 2012.

Matlock Canoe Club Website, Midland Canoe Club Website and Derwent Rowing Club Website, accessed August 2018

Derby Cityscape Masterplan (2005) Available online: [Derby Cityscape Masterplan](#)

MAGIC Website: <http://www.magic.gov.uk/> (accessed August 2018)

Ricardo (2023). Derwent 2023 Fisheries Report. AMP7 Drought Monitoring. Ref: 3500010039.