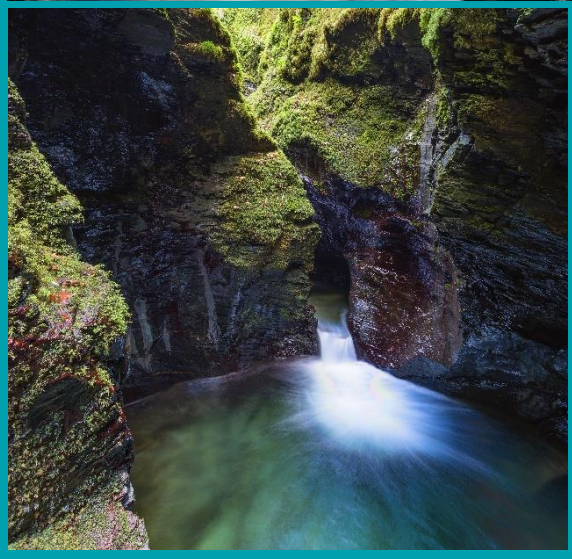
West Country Water Resources Group

Environmental Destination

Annex D: Tamar pilot catchment plan to increase future water supply and low flow environmental resilience



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Report for

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1. Overview

This document is one of five technical annexes that lay out plans for holistic measures that may be implemented in five West Country Water Resources (WCWR) pilot catchments to increase water supply and environmental low flow resilience. These set out steps towards an Environmental Destination for 2050 in each catchment, in response to the water resources-related 'Environmental Ambition' challenge set by the Environment Agency as part of its National Framework for Water Resources (March 2020).

1.1 This pilot catchment plan

This pilot catchment plan sets out the measures best suited to achieve future water resources resilience and environmental improvement in the **Tamar Catchment**, in response to the challenge to meet environmental flow objectives, even as flows are expected to fall due to climate change.

Full details of the project context, scope, data sources and stakeholder engagement are given in the main report.

1.2 Contents of this annex

After this introduction,

- **Section 2** provides a summary of the catchment and the pressures on it.
- **Section 3** details the Environment Agency-suggested Environmental Ambition abstraction reductions that may be needed to improve river flows. It also provides an indication of how the flow regime is projected to change as the climate shifts into the future.
- **Section 4** describes the current projects underway in the catchment and summarises the strategic action plan of water company measures that could be implemented in a phased approach to increase water supply resilience. Projects currently focused on land management, habitat creation, restoration, re-wilding and diffuse water quality improvements are also included because these should improve ecological resilience through droughts, even though they will not make much difference to the flow regime.
- References are given in **Section 5.**

Figures are provided as a slide pack and at the back of this Annex in **Section 0**.

2. Catchment summary

The Tamar catchment is a rural catchment underlain by predominantly impermeable bedrock with low groundwater reserves. There is additional pressure on the Tamar catchment during the summer months due an influx of tourists to the region. This section describes the catchment context with respect to the rivers that drain it, the interaction of surface water with groundwater, the pressures from abstraction, and from diffuse and point sources of pollution.

2.1 Why the Tamar pilot?

The **Tamar catchment** has a relatively flashy, runoff-dominated response to rainfall – there is little groundwater storage buffer to reduce flood peaks or improve the natural resilience of summer baseflows. So medium to low flows are projected to fall significantly through to 2050 and beyond because of climate change, with some increase in the severity and frequency of higher flood flow events also likely. The summer seasonal peak in water demand associated with tourism is a significant pressure. The Environmental Ambition challenge calculations are still under review but suggest that large scale reductions in public water supply abstraction impacts on medium and lowish flows would be needed to stay within acceptable limits. Options for enhancing the pumped storage associated with Roadford Reservoir and connecting it better with Wimbleball Reservoir to the east are under consideration, as are alternative winter refill patterns for Burrator Reservoir. To the west, significant reductions in abstraction from the River Camel SAC are also being considered. There is also a significant hydro-electric power scheme which depletes flow in the River Tavy which is currently under WINEP review.

Plymouth – a major water demand centre where population growth is expected - is located around the Sound at the bottom of the catchment. It will be important to join-up these water resources-focused plans alongside ongoing interventions to improve water quality and ecological resilience to low flows through land use, soil and drainage management.

2.2 The current state of the catchment

Geography, geology, rivers and environmental designations

The River Tamar catchment rises on Woolley Moor and flows southwards from just 4 miles off the Atlantic Ocean coast southwards towards Plymouth Sound (**Figure D2.1**). Its tributaries include the Deer, Claw, Ottery, Carey, Kensey, Inny, Lyd, Thrushel, Wolf, Tavy, Lynher, Meavy, Plym and Yealm. The Tamar catchment encompasses the city of Plymouth, and the towns of Tavistock, Launceston and Holsworthy, however, much of the catchment is rural, and undeveloped (**Figure D2.2**). Estimates provided by the Environment Agency back in 2012 suggest just 4% of the catchment was urbanised when the area had population of just over 341,000 (EA, 2012b).

The Tamar catchment is underlain primarily by Mudstones, Siltstone and Sandstone bedrock of the Holsworthy and Teign Valley Group in the upper catchment giving way to the mudstones, siltstones and sandstones of the Upper Devonian (**Figure D2.1**). To the east and west of the Tamar catchment there are outcrops of Granite on Dartmoor and Bodmin Moor. The largely impermeable bedrock is mostly at outcrop but along the river corridors the bedrock is overlain by alluvial silts and clays and terrace deposits (**Figure D2.1**).

The underlying geology means the catchment is very "flashy" with a quick response to rainfall events (EA, 2012a). There has been a significant reduction in the area of wetlands across headwater springs and the floodplain through the last century. Naturally low flows can occur during the summer months as a result of the low baseflow component from a lack of significant groundwater reserve. The long-term average annual rainfall across Devon and Cornwall is around 1100 mm/a and rainfall across the area varies with higher totals over Bodmin Moor, Dartmoor and Exmoor (EA, 2017). In 2012, the Environment Agency summarised annual rainfall ranges from more than 2,000 mm/a on the edge of Dartmoor to less than 1,000 mm/a on the coastal lowlands (EA, 2012a).

Designated sites in the catchment include Special Areas of Conservation (SAC), Special Sites of Scientific Interest (SSSI) and Ramsar sites (**Figure D2.2**) as well as a number of SPAs, and LNRs. Of note is the Dartmoor SAC to the east of the catchment. Dartmoor is the southernmost blanket bog in Europe and is also designated for northern Atlantic wet heaths with Erica Tetralix and European dry heaths (JNCC[1]). The Tamar catchment encompasses the South Devon, Tamar Valley and Cornwall AONBs (Areas of Outstanding Natural Beauty).

Abstraction pressures

Abstraction within the Tamar catchment is predominantly from surface water sources for water supply, agricultural and industrial use as energy production (**Figure D2.3**). There are a number of South West Water abstractions, the majority of which are associated with water resources Heavily Modified Water Bodies (HMWBs) (Roadford Lake, Burrator Reservoir, Upper and Lower Tamar Lakes), the downstream river intakes on the Tamar at Gunnislake, and on the Tavey at Lopwell Dam. There are also two river abstractions on the River Yealm and Withey Brook.

As seen in the surface water abstraction plot in **Figure D2.4a** there are also some very large hydro-electric power generation abstractions, but these are largely non-consumptive (except at Abbey Weir, as discussed in **Section 4**). **Figure D2.4a** shows that in terms of recent actual abstraction (apportioned for non-consumptive licences) almost three quarter of surface water abstraction is for public water supply (123.9 Ml/d), and a quarter to energy production (42.7 Ml/d). There are only small amounts of abstraction for agricultural and industrial uses. Total recent actual abstraction from the catchment is approximately 170 Ml/d.

There are many considerably smaller groundwater abstractions for agricultural and industrial uses, the largest groundwater abstractor in the catchment is Dairy Crest. As seen in **Figure D2.4b** recent actual groundwater abstraction is less than 1 Ml/d.

ARUP are also conducting a study to enhance the understanding of the current and future needs of non-PWS abstractions for agriculture, private water supplies, and mineral abstraction. As part of this assessment, ARUP have calculated the non-public water supply demands of the catchment,

[1] https://sac.jncc.gov.uk/habitat/H4010

including generating figures for the number of animals in the catchment which have water demands. The preliminary results from the ARUP 2022 study are shown in **Figure D2.4a** and indicate non-public water supply demands from the catchment are approximately 28 Ml/d, most of which is expected to be non-consumptive (i.e. water locally returned to the catchment).

Although relatively small, these non-public water supply water users still need to be aware of the changes in resource availability expected due to climate change, as set out in **Section 3** – so that they can plan and adapt.

The Tamar catchment is also a prime spot for tourism, which brings water related challenges as demand increases significantly during the dryer summer months. The two most significant demands on the Tamar catchment are supply into North Devon as well as supply to Plymouth. North Devon supply is supported by Roadford reservoir, whilst Plymouth is predominately supplied by the Mayflower treatment works, which utilises water from Burrator reservoir, Lopwell Weir (Tavy) and then the Tamar (Gunnislake intake) in that order of preference, based on water quality pressures.

There are no drinking water safeguard zones in the Tamar catchment (**Figure D2.2**).

Water resource availability

Environment Agency published maps of water body water resource availability at a range of flows are shown in **Figure D2.5** (Cycle 2, Environment Agency 2021[2]). Green indicates where there is more water than required to meet the needs of the environment, yellow indicates where licensed flows fall below the Environmental Flow Indicators (EFI) or there is no more water available for licensing at these flows, and red indicates where there is no more water available under any flow conditions. The last abstraction licensing strategy for the Tamar catchment was published back in 2012.

The Environment Agency have assessed that in high and moderate flows (Q30 and Q50), there is restricted water available or no water available in the Upper Tamar Lakes, River Wolf (Roadford Reservoir), River Tavy and River Meavy (Burrator Reservoir) catchments (**Figure D2.5**). Under low flows (Q70), the whole Tamar catchment, the River Tavy and the River Meavy are assessed as either restricted or no water available. The results under Q95 change, and most the catchment has flows above the EFI because of low flow compensation releases from the reservoirs and licence constraints on river intakes, except in the Tavy, Meavy, Plym and Yealm catchments.

Flood risk

The Tamar catchment has a history of fluvial, pluvial and tidal flooding. In the upper reaches, the main cause of flooding is the impervious bedrock and steeper catchments causing rapid run-off and a flashy response is characteristic. In some of the towns across the Tamar catchment, flooding is caused by inadequate drainage systems, and in the lower catchment, a mix of high tides and heavy rainfall can cause tidal flooding, as well as inundation caused by spring tides. The Environment Agency note to the west of the Tamar, river flooding is often caused through a

[2] https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/WaterResourceAvailabilityAndAbstractionReliabilityCycle2&Mode=spatial

combination of structure blockages and excessive surface water flows which results in rapid and often very localised flooding (Environment Agency, 2012).

Waste water treatment works discharges and water quality pressures

The heavy agricultural land use in the catchment has led to water quality issues including phosphates, sediments, nitrates and pesticides. Much of the Tamar is designated as a priority catchment under DEFRA's Catchment Sensitive Farming Programme.

South West Water operates the sewage treatment works from small towns and villages in the catchment which return mains water to the river but these discharge rates are relatively small. Waste water from the city of Plymouth is treated and discharged to Plymouth Sound. These discharges are consented and regulated by the Environment Agency. Considerable improvements in discharge water quality have been achieved over the past 30 years and investment is ongoing as clean-up standards continue to be tightened. As the sewer systems often combine household effluent with urban drainage runoff, occasional storm overflow of untreated water remains a focus for improvement.

The larger works which discharge into the Sound are labelled on **Figure D2.3** because these may represent potential opportunities for re-cycling or re-use to reduce the loss of reliable flows to the sea.

There are also large consented discharges from mineral workings (e.g. for china clay) into the River Plym and Tory Brook which flow into Plymouth Sound from the south west slopes of Dartmoor.

Future population pressures

In the Tamar catchment, future population growth expected to be focused around Plymouth which may increase from ~263,000 by around 4% (to ~274,000) in 2034.

Water Framework Directive (WFD) status

A map of the overall WFD (Cycle 2, 2019) status of water bodies across the catchment is shown on **Figure A2.6**. This combines both the chemical and ecological status reported by the Environment Agency for the water bodies. The recent recognition of new types of pervasive pollutants which affect many rivers across the country is tending to dominate overall WFD status. So when focusing on water resources, abstractions and river flows it is more helpful to consider ecological status.

River flow and morphological condition (i.e. the naturalness of channel profiles, the existence of weirs and barriers etc.) are considered as supporting elements in the assessment of ecological status - which is primarily based on monitoring the health, diversity and abundance of plants, bugs and fish in rivers, lakes and estuaries. The WFD water body ecological status of Tamar water bodies (Cycle 2, 2019) is mapped on **Figure A2.7.**

There are several key reasons for the failure to achieve good status mapped in both **Figures A2.6 and A2.7** which have nothing to do with abstraction pressures:

- In the catchments in the upper Tamar (Lamberal Water, Tamar (Small Brook to Lamberal Water), Tamar (Small Brook to River Deer), Derril Water and Carey) there are issues with macrophytes and fish due to diffuse and point pollution caused by

agricultural land management (poor livestock, soil and nutrient management and riparian/ in-river activities), flow issues caused by land drainage and natural conditions (drought).

- In addition, in some of these water bodies there are also problems with Phosphate (Derril Water and Tamar (Small Brook to River Deer) and Carey) caused by agricultural management and sewage discharges.
- In the River Claw catchment, issues are highlighted associated with fish only as a result of agricultural management causing diffuse and point source pollution as well as the natural conditions. In the River Tavy.

Environment Agency catchment data[3] are summarised in Error! Reference source not found. for selected water bodies of particular interest to this plan which is focused on future water resource and environmental low flow resilience. In these water bodies the Environment Agency's Environmental Ambition modelling has predicted river flows could fall below regulatory thresholds by 2050, so the impacts of public water supply abstraction may need to be reduced. These calculations incorporate projections of future changes in river flows expected due to climate change, plus the potential impacts of fully licensed abstraction, as discussed further in **Section 3**). The focus water body locations are labelled on **Figures D2.6** and **D2.7.** The abstraction points include the River Tavy at Lopwell Dam, the River Tamar at Gunnislake, the Withey Brook at Bastreet, the Burrator Reservoir and Dendles Wood on the River Yealm. It should be noted that whilst there is no Q95 environmental flow deficit predicted on the Tamar, there is a significant deficit modelled under e Q70 flow conditions.

Table 2.1 2019 (Cycle 2) EA Data for selected water bodies of particular interest in the catchment

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydrological Regime	Chemical substances	RNAG
Lower River Tamar GB108047007860	Moderate ecological status	Moderate (macrophytes and phytobenthos combined moderate)	Good	Supports good	Fail (Mercury, PFOS & PBDE) Specific pollutants – copper moderate	Point and diffuse sources: Poor soil management, poor livestock management, riparian/ in-river activities, sewage discharge, poor nutrient management (macrophytes and phytobenthos combined) Point and diffuse source: abandoned mine (copper)
Withey Brook GB108047007680	Moderate ecological status	Moderate (fish moderate)	Moderate (pH moderate)	Does not support good	Fail (Mercury & PBDE)	Flow issues: Surface water abstraction (hydrological regime) Natural: barriers ecological discontinuity (fish)
Lower Tavy	Moderate ecological status	Good	Moderate	Does not support good	Fail (Mercury & PBDE)	Flow issues: surface water abstraction (hydrological regime)

[3] https://environment.data.gov.uk/catchment-planning/ManagementCatchment/3089 accessed 09/11/21

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydrological Regime	Chemical substances	RNAG
GB108047007840			(Phosphate poor)			Point source pollution: sewage discharge (phosphate)
Burrator GB30846279	Moderate ecological status	Good	Moderate (Phosphate moderate	N/A	Fail (Mercury & PBDE)	Physical modification: reservoir impoundment (phosphate) Diffuse pollution: poor livestock management (phosphate) and Flow: surface water abstraction (hydrological regime)
Meavy catchment* GB108047003660	Moderate ecological status	Moderate (fish and invertebrates moderate)	Moderate (pH moderate)	N/A	Fail (Mercury & PBDE)	Natural: mineralisation and barriers to ecological discontinuity Flow: regulating reservoir flow regime
Upper River Yealm GB108047004050	Moderate ecological status	Moderate (Fish moderate)	High	Supports good	Fail (Mercury, PDBE	Flow: surface water abstraction Natural: mineralisation and barriers to ecological discontinuity Physical modification: barriers to ecological discontinuity (urban and transport)

RNAG Reasons for not achieving good, PDBE Polybrominated diphenyl ethers, Perfluorooctane sulphonate (PFOS)
* Meavy flows into the Burrator reservoir

2.3 Existing water company water resource management planning (WRMP) options in the Tamar

South West Water's previously published strategy centres on demand management, focused on reductions in per capita consumption rates, as presented in the Water Resource Management Plan (South West Water, 2019). This includes a reduction in distribution losses/ management of leakage (15% reduction in 5 years), enhancing metering and providing water efficiency services. Preferred options are detailed in **Table 2.2**.

A number of feasible supply-side options have also been explored by the water companies for this catchment, including new distribution and production management and new resource schemes. Although these were not identified as preferred options in the 2019 plan, as detailed in **Table** 2.3**,** both the Northcombe treatment and Gatherley pumped storage options associated with Roadford are currently being implemented.

Other feasible demand-side options have also been explored but have not been taken forward as preferred options at this stage, as detailed in **Table 2.4**.

Table 2.2 Preferred options in the 2019 WRMP, relevant to the Tamar catchment (from South West Water)

Option	Code	Type of option	Earliest potential start date	WAFU Ml/d	Detail
Innovation Colliford WRZ	LC1-LC10	Reduce distribution losses	2020-21	11.2*	Schemes supporting ALC - reduction in leakage by 15%
Innovation Roadford WRZ	LR1-LR10	Reduce distribution losses	2020-21	11.2*	Schemes supporting ALC - reduction in leakage by 15%

WAFU – water available for use
*Calculation for the whole of Colliford and Roadford WRZs which only covers part of the Tamar catchment.

Table 2.3 Supply-side options reviewed in the development of the 2019 WRMP, relevant to the Tamar catchment, which are now being carried forward (from South West Water, 2019)

Option	Code	Type of option	Earliest potential start date	WAFU Ml/d	Detail
Northcombe WTW capacity increase to 60 Ml/d	R2	Distribution/ production management	2024	10.0	This option would involve a pumped storage scheme for Roadford Reservoir based on an intake on the River Tamar at Gatherley. A pipeline would connect the new intake to the existing Lyd/Thrushel pipework and transfer water to Roadford Reservoir and/or directly to Northcombe WTW. Although the main abstraction would be from the River Tamar, there would also probably be a small abstraction from the River Thrushel / Lyd mainly for water quality reasons. This scheme makes more effective use of reservoir storage. This is a scheme that could take account of the potentially slightly higher winter flows that could result from climate change.
Roadford / Northcombe pumped storage from Gatherley (River Tamar)	R4	Resource Scheme	2025	14.0	This scheme will enable more Roadford water to be treated at Northcombe WTW. This scheme should be considered in conjunction with the Rivers Taw and Torridge study and Roadford pumped storage resource management option.

WAFU – water available for use

Table 2.4 Demand-side options reviewed (but not preferred) in the development of the 2019 WRMP across water company supply zones South West Water, 2019)

Option	Code	Type of option	Earliest potential start date	WAFU Ml/d	Detail
Customer Side options	Cu20, CU21, CU26, CU54, CU60, CU62 and CU66	Reduce water demand	2020-21	20.8*	Retrofit and advice service. Metering and leaky loos, social housing refit, holiday home rental water efficiency, reduced infrastructure charge, community incentives, social norms feedback on bills and non-household retailer water efficiency.

*Calculation for the SWW supply area which only covers part of the Tamar WFD.

There is a potential demand reduction across the WRZ's that cover the Tamar catchment of 22.4 Ml/d utilising the preferred options considered in the WRMP. The not preferred supply side options total 24 Ml/d, with the not preferred demand side options potentially saving 20.8 Ml/d which could benefit the Tamar catchment. Mains leakage reductions in the Plymouth area would be expected to reduce demand on public supply abstractions from the Tamar and Tavy but may be partly offset by population growth unless significant reductions in per capita consumption can be realised.

It is important to note that leakage from the public water supply system represents a return of water to the catchment. This is often associated with household connections rather than large leakage events from main supply pipes which are readily identified and quickly fixed. Leakage rates tend to be higher in winter when pressures are higher and temperatures lower than in summer. Reductions in leakage, whilst reducing the rates of abstraction required for supply, may make less difference to total inflows to Plymouth Sound, particularly during summer months.

Similarly, reductions in per capita consumption will be more difficult to realise during warmer summers when demand usually increases, rather than during winter periods. And if demand reductions are achieved, they may be associated with lower rates of treated wastewater discharge which could reduce low flow resilience downstream of cities and towns.

3. Environmental Ambition challenge

This section summarises the predicted 2050 flow environmental deficits and surpluses in the catchment and the potential future reductions in public water supply abstraction impacts highlighted by the Environment Agency's Environmental Ambition screening modelling, as set out in the National Framework for Water Resources (March 2020).

The Environment Agency's modelling indicates the additional water that may be needed by 2050 to meet:

- Environmental river flow targets based on existing (Business as Usual, BAU) or enhanced (ENH) thresholds;
- Future predicted (FP) demands for public water supply and other water uses, and also worst-case, fully licensed (FL) demand assumptions,
- in the context of natural Q95 low flow conditions which have been simply factored down from current estimates for 2050 based on a climate change projection.

The Environment Agency provided the WCWRG with WFD river water body scale National Framework estimates of 2050 environmental flow surpluses or deficits to highlight the water bodies of concern (as summarised in **Section 2** and presented in more detail below). An indication of the individual abstraction reductions which might be needed to meet the 2050 existing or enhanced environmental flows was also tabulated for the regional water resources groups and water companies to consider.

Whilst the main theme of the Environmental Ambition challenge is therefore framed in terms of 'potential abstraction reductions needed to meet river flow targets' and improve environmental low flow resilience, this implies that alternative sources of water will need to be found from elsewhere to maintain public supply resilience. At the same time, water companies must demonstrate that their demand suppression and supply systems are robust enough for a 1 in 500-year drought event.

Section 3.1 presents mapped and tabulated summaries of the water bodies with Environment Agency projected flow deficits. The climate change assumptions made in these projections are reviewed based on the latest suite of UKCP18 modelling data in **Section 3.2** which suggests that significant low and median flow reductions should be expected throughout the century. The potential licence reductions being scrutinised according to the Environment Agency's analysis are listed in **Section 3.3**, and compared with published water company WRMP options in **Section 3.4.**

3.1 Predicted 2050 flow deficits and surpluses

Environmental Flow Indicator (EFI) targets are defined by the Environment Agency to indicate the river flow required to support Good Ecological Status under the EU Water Framework Directive (WFD). The EFI allows a percentage deviation from natural flows at a specific location, defined based on the Abstraction Sensitivity Band (ASB) of the site – a nationally consistent abstraction

pressure screening approach intended to highlight areas where further ecological impact investigations should be carried out. All of the river water bodies in the Tamar have a default, highest sensitivity i.e. ASB3, so there should be no rationale for further tightening in the Environment Agency's 'Enhanced' environmental ambition scenario. However, the enhanced scenario apparently does incorporate Natural England (CSMG) standards for rivers flowing into Plymouth Sound which includes lower reaches of the Tavy and Tamar, and also for Dartmoor Streams. These enhancements are understood to be due to the presence of salmon and trout, with higher flow constraints being tightened.

The predicted fully licensed 2050 flow surpluses and flow deficits for the Tamar catchment waterbodies under Q95 low flow conditions are mapped in **Figure D3.1**, under the EA's **enhanced** 2050 scenario, which is 'worst case' for planning purposes. It can be seen from **Figure D3.1** that for most of the water bodies within the Tamar catchment, flow surpluses or flows close to the enhanced environmental flow target are predicted (mapped in green with Q95 flow surpluses labelled in Ml/d). However, 2050 Q95 flow deficits are predicted by the Environment Agency for five water bodies, relating to both non-PWS and PWS abstraction:

- Withey Brook;
- River Tavy;
- Meavy river (including Burrator reservoir);
- River Yealm.

The River Tamar is not included in this list as it does not have a Q95 deficit, but it should be noted that there is a significant deficit at Q70.

Further detail regarding those water body flow deficits linked to PWS abstraction is given in **Table** 3.1 below and a summary of their current ecological status catchment data has been presented in **Table 2.1**.

This provides the surpluses and deficits at different flow percentiles, and also compares with the same outputs for the '**Business as Usual'** (BAU) scenario which is less stringent at higher flows in the Lower Tamar and Lower Tavy river water bodies.

Table 3.1 Predicted Fully Licensed 2050 Environmental Flow Surplus or Deficit (Water body outflow, Ml/d), for water bodies where potential PWS abstraction reductions are highlighted by the Environment Agency

Flow Condition	Q30		Q50		Q70		Q95	
(Ml/d)	BAU	ENH	BAU	ENH	BAU	ENH	BAU	ENH
Lower River Tamar GB108047007860	239.07	-15.31	-5.43	-5.43	-48.93	-48.93	26.09	26.09
Withey Brook GB108047007680	6.87	6.87	-1.06	-1.06	-5.06	-5.06	-4.10	-4.10
Lower Tavy	-21.59	-121.19	-119.98	-119.98	-76.43	-76.43	0.5	0.5

Flow Condition (Ml/d)	Q30		Q50		Q70		Q95	
	BAU	ENH	BAU	ENH	BAU	ENH	BAU	ENH
GB108047007840								
Upper River Yealm GB108047004050	17.03	6.01	6.58	6.58	1.42	1.42	-0.49	-0.5
Burrator GB30846279**	-60.36	-72.39	-40.57	-40.57	-27.65	-27.65	-14.24	-14.24
Meavy GB108047003660	-41.53	-64.71	-32.74	-32.74	-24.59	-24.59	-13.23	-13.23

*BAU - Business as Usual; ENH – Enhanced Scenario
** Burrator Reservoir is Heavily Modified for Water Resources purposes, so closure of these environmental deficits is not required.

3.2 How do the Environment Agency's estimates of flow reductions due to climate change compare with updated UKCP18 for the Tamar?

The Environment Agency's National Framework predictions of natural flows for 2050 were based on one of the eleven UKCP09 Future Flows projections known as 'afixK', as available at the time. This projected relatively more marked falls in flow over time compared with the remaining 10 'equally likely' suite of UKCP09 models. At the end of 2021, CEH and a consortium of associates working with the Meteorological Office have delivered the UKCP18 successor to the Future Flows data which includes 12 possible projections of river flows and groundwater levels from 1982 to 2080 using a variety of alternative modelling approaches. These Enhanced future Flows and Groundwater (eFlaG) data are available online[4] and have been used to compare against the Environment Agency's assumptions for the Tamar and provide stakeholders with a clear picture of how flows are expected to change to 2050 and beyond.

Figures D3.2 and **D3.3** plot rolling 18-year flow percentile statistics in Ml/d derived from modelled daily flow projections for Gunnislake on the Tamar. Plots are included to show how high (Q1 'floods'), median (Q50), low (Q95) and very low (Q99 'droughts') flows are predicted to change through the 21st century. There are lines for each of the 12 possible UKCP18 regional climate models (RCM) provided from eFlaG compared with the projection for the same location from UKCP09 Future Flows, as included in the Environment Agency's calculations.

On the right of each percentile time series, an area plots indicates how many of the 12 UKCP218 eFlaG models show increases or decreases in flow, how big that projected change is relative to the start of the century (2000), and how the differences evolve past 2050 and on to 2080.

These plots indicate that highest flood event flows (Q1 and above) are expected to be steady or perhaps increase with time according to most of the projection models. These increases are

[4] https://eidc.ac.uk/

modest – perhaps over 10% by 2050, but this still represents a very large increase in highest flood flows. It indicates that flooding risks in the Tamar are expected to get worse, but also emphasises the value of surface storage options designed to capture high flows to support drier period supplies.

Figure D3.2 flow predictions are based on the most reliable of the eFlaG gauge-calibrated river flow models (the Probability Density Model PDM) and indicate how flows calibrated against the historical gauged record (i.e. including the influence of upstream abstractions, discharges and reservoir storage operation) may change due to climate shifts in rainfall and potential evaporation. Projected falls in median (Q50), low (Q95) and very low(Q99) flows are similar to or greater than the UKCP09 afixK dashed black line. i.e. the Future Flows scenario which was considered worst case now appears reasonable or perhaps even optimistic compared with the updated UKCP18 projections. By 2050, most of the eFlaG models are predicting more than 10% reductions in median flows, with falls of 30 or even 50% predicted by several models under drier conditions.

The **Figure D3.3** plots are based on the natural flow projections of the national 'Grid to Grid' (G2G) model using the same RCM climate inputs, but no gauged record calibration. Although less well adapted to the gauged local flow responses and probably less reliable, these projections are included for comparative purposes because they ignore any abstraction or discharge influences on the gauged record. Highest flood flow projected changes are similar, but median and lower flow falls are much steeper.

In order to more confidently understand future flow shifts in all the water bodies across the Tamar catchment it is recommended that the UKCP18 climate projections are reviewed a considering the potential influence of reservoir storage, flow regulation and downstream abstraction management. However, **Figures D3.2 and D3.3** confirm that low flows are expected to fall significantly to 2050. Even though the Environment Agency will therefore need to allow EFI regulatory flow-based Hands-off-Flow thresholds to evolve downwards with time, and the proportion allowed for abstraction will be squeezed.

This forward look adds real urgency to the need to consider options which will boost storage and low flows support on the supply side, beyond the current demand-side and leakage focus of WRMP options. It also highlights the need for riverine and wetland habitat restoration and active management to enhance ecological refuge resilience to dry periods which are becoming and will continue to become more frequent and longer. Broader re-wilding, soil and environmentally sensitive farm land management initiatives are also vital to improve water quality but they will not change the projected decline in low flows. As the climate warms, the higher temperatures will result in more evapotranspiration and less water in our rivers regardless of any 'nature-based solutions' implemented upstream.

3.3 Licences highlighted by the Environment Agency for potential abstraction reductions (or other low flow support)

If the flow deficits identified in the Environment Agency's 2050 Environmental Ambition projections need to be fully addressed, having accounted for the water resources purpose of the 'heavily modified' reservoir-related operations, licence reductions may be required for four surface water licences owned by South West Water. Licence details for these abstractions which are 'at risk' are given in **Table 3.2.**

At this first draft report stage, no review of the implications of the Environmental Ambition challenge has been possible for the surface water abstractions associated with the current or potential future operation of the Roadford or Burrator reservoirs. Whilst annual and daily licence limits may not change, the imposition of tighter compensation release or hands-off-flow constraints may still affect drought period deployable output for public supply.

Additionally, for the Meavy catchment (which includes the Burrator reservoir) the EA has identified flow deficits, and this is partly due to a change in catchment sensitivity from ASB 3 to CSMG ASB 4, which has resulted in additional constriction of the available resource at the Q30. The CSMG designation appears to be connected to the presence of protected migratory fish although the tighter standard should only be applied for flows above Q10. South West Water have noted that there is a deficit at all flow percentiles and that this is greatest at higher flows due to the impact of the reservoir which is a Water Resources Heavily Modified Water Body. So it is currently unclear whether the ASB4 enhanced ambition target is appropriate. The Burrator licence has been included in **Table 3.2** for completeness although more work is required to determine how this reservoir resource could be optimised to realise environmental flow improvements as well as maintaining supply resilience. A leat intercepts water from the neighbouring Dart catchment to Burrator which is also under environmental flow impact scrutiny.

It is important to note that the Environment Agency's Water Resources GIS platform used for the Environmental Ambition projections includes a number of fixed 'Complex Impact' representations of the influence of reservoir and river abstractions on flows. These 'fixed impact' assumptions do not capture how reservoir storage and operation may buffer the effects of climate change by capturing higher winter flows to support low flows. They also do not increase the frequency and duration of low flow constraints applied river licences as the climate shifts. Time series modelling of the climate, reservoirs and abstractions is needed to build more confidence in the predicted size of the problem as well as to provide a platform for testing potential solution options.

Table 3.2 Details of PWS abstractions for which potential abstraction reductions have been flagged by the EA

Abstraction Information	River Tavy at Lopwell Dam	River Tamar - Gunnislake	Withey Brook at Bastreet	River Yealm Dendle Wood, Cornwood	Burrator Reservoir
Licence Number	15/47/041/S/039	15/47/013/S/020	15/47/141/S/026	15/47/001/S/025	15/47/002/S/031
Water company	South West Water	South West Water	South West Water	South West Water	South West Water
Fully Licensed Ml/d	91	148	7.745	0.165	70.286
Recent Actual Ml/d	1.596	0.039	6.663	1.809	71.191
Surface water/ Groundwater	Surface Water	Surface water	Surface water	Surface Water	Surface Water
WFD Waterbody	GB108047007840	GB108047007860	GB108047007680	GB108047004050	GB30846279
Investigations	AMP 4-5 Increased prescribed flow for 1 July - 30 September inclusive. DO reduction 3.2Ml/d. Currently in Operating Agreement but not changed on abstraction license yet.			AMP5-6 2016. RSA Habitats Directive sustainability reductions of 4.8Ml/d. Estimated total impact of sustainability reductions on several licences in Roadford WRZ (Erme, Yealm, Swincombe, R Dart at Littlehempston, Fernworthy)	

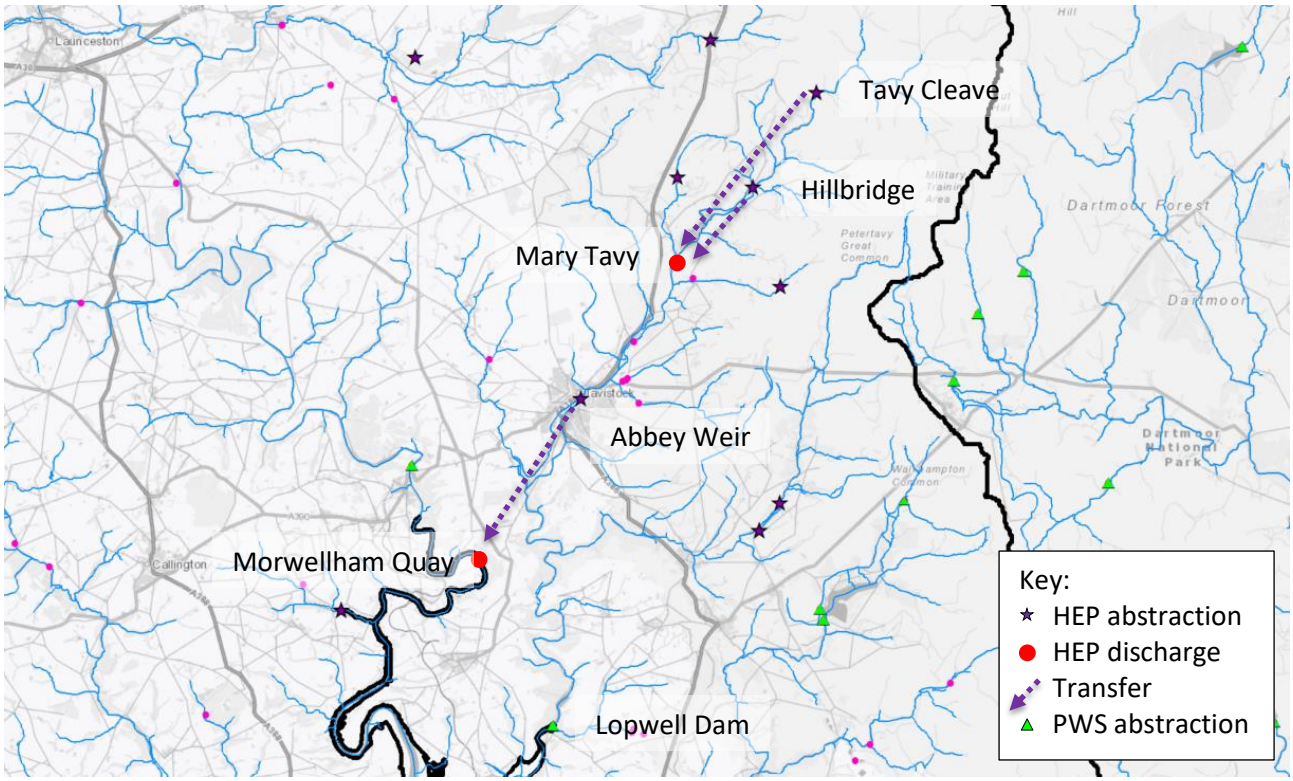
The total licence reductions across the catchment flagged by the Environment Agency are potentially very large (over 130Ml/d), but there are a number of assumptions and uncertainties which remain to be ironed out through the use of more appropriate time series modelling.

A large proportion of the total reduction required across the Tamar catchment results from the River Tavy abstractions. The following licences have large abstractions from the River Tavy (*pers. comm*. Jackie Turner):

- Tavy Cleave: *non-consumptive* Hydro-electic Power (HEP) licence which abstracts at Tavy Cleave (west Dartmoor), transfer to Mary Tavy power station for HEP generation, discharge to River Tavy at Mary Tavy.
- Hillbridge: *non-consumptive* HEP licence which abstracts at Hillbridge (west Dartmoor), transfer to Mary Tavy power station for HEP generation, discharge to the River Tavy at Mary Tavy.
- Abbey Weir (Tavistock): *consumptive* HEP licence which abstracts from River Tavy at Abbey Weir (Tavistock) and is then transferred along Morwellham Canal to Morwellham power station for HEP generation and discharged to River Tamar at Morwellham Quay (downstream of tidal limit). This is owned and operated by SWW.
- Lopwell: consumptive public water supply abstraction to supply Plymouth.

The locations and transfers can be seen below in **Graphic 3.1**. The Tavy HEP abstraction licences do not have prescribed flows, but there is a documented operating agreement providing low flow protection. Whilst the Environment Agency has captured the associated 'complex impact' patterns in the historical climate context, this has remained fixed in the Water Resources GIS climate change projections. It is probable that the projected environmental flow deficits are overestimated.

Graphic 3.1: HEP licences on River Tavy



3.4 Potential 2050 supply loss compared to published WRMP options

Options explored in the water company WRMPs include demand reductions and leakage savings to reduce the future supply required (see **Section 2.3**). In this catchment, plans are being implemented to increase the refill pumping options for Roadford Reservoir, as well as improving treatment capacity for water abstracted from it to supply North Devon.

Table 3.3 puts into context the scale and magnitude of the potential 2050 abstraction reductions against the current licensed and recent actual abstraction from the catchment, and WRMP options. If the EA's 2050 abstraction reductions were implemented, then **the abstraction reductions would be higher than recent actual abstraction in the catchment**.

It is clear that these are huge Environmental Ambition challenges which demand measures well beyond the options published in existing WRMPs. Potential solutions will be associated with large financial and carbon costs and will take around 25 years to complete. The Environmental Destination plan needs to be phased so that incremental benefits can be realised along the way – as set out in **Section 4**.

Table 3.3 Tamar catchment: context of potential 2050 supply losses

Tamar	South West Water*	Unit
Annual PWS licensed abstraction (catchment total) *SWABS and GWABS combined*	344.4	Ml/d
Annual PWS RA abstraction (catchment total) *SWABS and GWABS combined*	123.9	Ml/d
Water company total water into supply (WAFU) *Base year 2017/2018*	415.1	Ml/d
WRMP baseline WAFU 2045	399.1	Ml/d
Catchment PWS RA as % of water company WAFU (Base Year 2017-18)	29.8%	%
Total WRMP projected 2045 demand-side and leakage savings	22.4	Ml/d
2045 demand reductions and leakage savings as % of current total water into supply	5.4%	%
WRMP preferred additional supply-side options (catchment total)	0.0	Ml/d
EA 2050 potential abstraction reductions (catchment total)	-138.1	Ml/d
Potential 2050 catchment supply loss, reduced by the effect of proportional 2045 demand reductions and leakage savings	**-131.4**	**Ml/d**
Potential 2050 catchment supply loss (% of abstraction)	**-106.1**	**%**
Potential 2050 catchment water impact (2045 WAFU impact, abstraction impact plus effect of demand and supply options)	**-131.7**	**Ml/d**
Potential 2050 catchment supply loss (% of recent actual PWS Abs)	**-106.3**	**%**

*catchment summarised in this table as the Roadford and Colliford WRZs combined

Data sources:
Wessex Water (2019). Final Water Resources Management Plan
South West Water Bournemouth Water (2019). Final Water Resources Management Plan.

4. Environmental Destination catchment plan to increase future water supply and low flow environmental resilience

The Environmental Ambition challenge has highlighted the potential constraints to water resource availability in the 2050s. Adapting to the ongoing pressure of climate change, population growth and enhanced environmental ambition will require holistic approaches to deliver sustainable resilience for both public supplies and low flow habitats.

This section sets the context of the relevant projects already underway or soon to be implemented in the Tamar catchment, that include measures which will improve the resilience of the water resource for both public supplies and the environment. It also summarises wider catchment soil, land management, drainage restoration and nature-based initiatives which are important for the real biodiversity and water quality benefits they can deliver but are not expected to significantly change the decline in river low flows as temperatures warm.

A catchment plan then sets out and prioritises the water company measures best suited to achieve future flow and supply resilience as part of improving biodiversity outcomes in the catchment.

4.1 Current projects in the catchment

There are a number of projects currently being undertaken across the Tamar catchment that may improve the water availability and the resilience of the Tamar catchment. In addition, there are a number of Tamar catchment partnerships set up to promote the catchment-based approach (CaBA) examples of which include the **Upstream Thinking**[5], a South West Water initiative looking at catchment improvements, the **Mires on the Moors**[6] project which is focussed on scientific enhancement and the **Tamar Catchment Partnership**[7] led by the Westcountry Rivers Trust.

A summary of current projects within the Tamar catchment is provided below.

Upstream Thinking

The Upstream Thinking (UST) project is a South West Water initiative which is large scale catchment management programme undertaken in strategic partnership between South West Water, Westcountry Rivers Trust, Devon Wildlife Trust, Cornwall Wildlife Trust, SW Lakes Trust, Natural England, FWAG, Exmoor National Park Authority, South West Peatland Partnership and the University of Exeter. There have been two phases conducted to date; phase 1 UST (UST1) and phase 2 (UST2), with phase 3 (UST) currently underway.

[5] https://www.southwestwater.co.uk/environment/working-in-the-environment/upstream-thinking/
[6] https://www.southwestwater.co.uk/environment/working-in-the-environment/exmoor-mires-partnership/
[7] http://my-tamar.org/

The UST 1 project worked with farmers to undertake various interventions to improve water quality. These interventions included works to establish new hedges and in-field and riparian buffer strips, minimise the volume of "dirty" water produced, farm track management, construct troughs with concrete bases, ensure manure heaps were stored on impermeable bases and collect effluent, and soil aeration.

The UST2 project works across the Fowey, Tamar, Exe, Dart and Otter catchments. The project continued the work from the UST1 project with the primary aim of improving the water quality across the South West Water area through consideration of land and water quality at a catchment scale, engaging with farmers to explain the issues and working with those farmers to plan appropriate water quality management strategies and explore funding opportunities. The Westcountry Rivers Trust note that the first round of UST aimed to improve water quality through nutrient and sediment reduction. The second round had a particular focus on reducing pesticide pollution. It has successful project for vastly improving the water quality in the Upper Tamar Lakes catchment (UST1), and the wider Tamar catchment (UST2).

The next phase of the project, Upstream Thinking 3, is currently underway with ongoing schemes in the Stour, Otter, Exe, Fowey, Tamar and Dart catchments. Works in the Tamar are undertaken by a working partnership with the Devon Wildlife Trust and West Country Rivers Trust. The scheme remains multi-faceted, and the partnership continues supporting farmers to release money from grants to support projects which improve water quality and habitat enhancements, undertake soil and is currently working with farmers to build new ponds, cover farmyard manure stores, reinstate or add fencing to stop cattle destroying the river banks, install troughs and rainwater harvesting.

Whilst the UST thinking programme is primarily aimed at improving water quality, it is hoped that there will be some small-scale secondary benefits for water supply resilience, for example:

- by slowing water to the watercourse during high flows (e.g., buffer strips, hedgerow planting, soil aeration), there is a slower release of water to the river reducing the amount of time the river experiences low flows. However, this is not expected to make much difference to flow during dry summers and droughts;
- providing additional sources of water (e.g., rainwater harvesting) reduces the need for pumping from the river and or groundwater supplies during times of low flow.
- ensuring that the rivers are functioning well by improving water quality and in-stream geomorphology (e.g., stopping cattle access to river banks) so that during low flow events the aquatic habitat and rivers themselves may be more resilient.

The scheme is highly successful, and South West Water have commented that they anticipate the scheme will continue into the future.

Mires on the Moors Projects

This project has been funded by South West Water and is a partnership between the Environment Agency, Natural England, Historic England, Dartmoor National Park and Exmoor National Park. The project is focussed on scientific enhancement and peatland restoration. Whilst there are some areas of very little change post-restoration, the most notable changes are in the deeper peats where restoration increased the permanent deep-water storage in the soil by 7.3 cm and increased average water table by 2.45 cm. In shallow peat, the water table responses to restoration were characterised as complex with the results showing that in the driest area, where drainage had the

greatest effect pre-restoration, water tables rose by up to 4cm. The reporting (Brazier et al., 2020) notes that restoration can significantly alter rainfall run-off regimes in restored catchments reducing gully flow by up 66%.

In terms of water resource resilience, the University of Exeter (Brazier et al., 2020) highlight that peatland restoration has the potential to drive changes in water storage and base flow regimes, reducing flood risk and improving water security, although the scale of these changes is currently unknown. In addition, the restoration will drive water quality changes, carbon stocks and fluxes, reducing in DOC loading, water colour and carbon cycling as well as alter habitat structure and function, enhancing priority habitats and delivering biodiversity and carbon sequestration benefits.

South West Peatland Partnership

The South West Peatland Partnership was a three-year partnership programme which started in 2018 to restore damaged peatland on Bodmin Moor, Dartmoor and Exmoor. The programme impacted the Tamar catchment through works to improve the Dartmoor national park. South West Water (SWW, 2021) note that the partnership in the Dartmoor area included the Dartmoor National Park Authority, Duchy of Cornwall, Forest of Dartmoor Commoners Association South West Water Dartmoor, Dartmoor Preservation Association, Dartmoor Society, Devon Wildlife Trust, Environment Agency, Historic England, Ministry of Defence, Natural England, National Trust, RSPB, University of Exeter, University of Plymouth and Westcountry Rivers Trust.

The project sought to block ditches in order to enable re-wetting of extensive areas of damaged peatlands. The various ditch blocking techniques using sustainable materials (wood, peat, grass and heather) are being used on historic peat cuttings, drainage networks and eroding gullies to enable the re-wetting. The benefits of this programme for water supply resilience are the increase in water storage in the upper reaches and the reduction of run-off and poor water quality.

Dartmoor Headwaters Natural Flood Management Project

A partnership project between the Dartmoor National Park Authority and the Environment Agency working with landowners to promote natural flood management measures including floodplain reconnection, leaky dams, wetland creation, addressing poor soil condition, peat restoration and tree planting to reduce the risk of flooding. This work has been ongoing in pilot since 2018 and will be upscaled across Dartmoor between 2021 to 2027[8].

Catchment Based Approach and the Tamar Catchment Plan

The Tamar Catchment Partnership was formed in 2011, under the "Catchment Based Approach" (CaBA) programme which is a multi-stakeholder model that promotes engagement, discussion and decision-making amongst community representatives, landowners and managers to ensure a catchment approach to ecosystem services and water management. The partnership is led by the Westcountry Rivers Trust.

The Tamar catchment partnership is a highly successful partnership designed to facilitate communication between everyone working within the catchment landscape to protect and improve

[8] https://www.dartmoor.gov.uk/wildlife-and-heritage/our-conservation-work/dartmoor-headwaters-project

the health of the river, at a local community and citizen level[9], engaging with the food and drink sector, farmers and milk processors to improve supply chain sustainability both in terms of water quality and quantity[10], farm soil health advisory projects[11], and as part of wider initiatives. The partnership has its own website http://my-tamar.org/action-plan/ where more details can be obtained. The partnership is composed of a 'Steering Group', 'Technical Members' and the 'Wider Partnership'. The Tamar catchment partnership website[12] highlights the plans going forwards to resolve low flow issues which includes:

- Increase wetland management, restoration and creation; and
- Increase management advice on high-risk soils. Give best practice (win-win) advice through bespoke plans and promote soil management measures to reduce compaction and improve infiltration; and
- Promote development of sustainable drainage solutions on farms/ land including on-farm rainwater harvesting and water storage solutions for irrigation.

CaBA opportunity mapping: a resource for future projects

CaBA's opportunity maps from the '**Working with Natural Processes - Evidence Base'** project[13] identify the types of measure that may be effective in flood and coastal risk management (FCRM) and wider ecosystem service benefits (Environment Agency, 2018). These maps can be used to inform and prioritise future catchment measures.

Figure D4.1 shows the opportunity mapping across the Tamar catchment for:

- Floodplain reconnection (for example, in the headwaters of the River Carey and the River Ottery where there is connection to the underlying superficial deposits).
- Tree planting in riparian areas (identified everywhere along the river network).
- Countryside stewardship options (for example, buffer strips, wildlife strips, regeneration of habitats, livestock fencing, coppicing of bankside trees, hedgerows).
- Priority habitat creation projects (at individual locations to create or restore habitats, e.g., Culm Grassland projects in the headwaters of the upper Tamar or Tamar valley Invasives project).

Wider scale implementation of these CaBA opportunities will help to deliver biodiversity and water quality benefits. Local channel, drainage and floodplain habitat restoration projects will also provide a vital role in improving the ecological resilience to droughts and dry periods. However, neither catchment-wide nor local habitat initiatives are expected to make much difference to river low flows, or to change the projected environmental flow deficits in the water bodies with abstraction pressures highlighted by the Environmental Ambition challenge.

[9] For example, the Plymouth River Keepers initiative https://wrt.org.uk/project/plymouth-river-keepers/ and the CaSTCo Catchment Systems Thinking Cooperative project https://wrt.org.uk/7-1m-win-to-bolster-citizen-science/
[10] For example, the collaborative work between the Tamar Water Stewardship Business Board with Westcountry Rivers Trust https://wrt.org.uk/tamar-water-stewardship-business-board/
[11] For example, soils management advice through the Devon & Cornwall Soils Alliance https://wrt.org.uk/project/dcsa/
[12] http://my-tamar.org/action-plan/
[13] https://catchmentbasedapproach.org/learn/working-with-natural-processes-evidence-base/

Natural Environment Investment Readiness Fund

DEFRA have announced a £10 million Natural Environment Investment Readiness Fund (DEFRA, 2021b) which is being used to develop the projects to the point they can provide a return on investment by capturing the value of carbon, water quality, biodiversity and other benefits provided by natural assets such as woodlands, peatlands, catchments and landscapes. Funding has been awarded to environmental groups, businesses and local authorities to develop projects that protect and enhance nature while also demonstrating innovative approaches to generating revenues from the wide range of benefits that nature provides.

The Tamar AONB has received £99,163 to develop a local ecosystem service market through testing trading mechanisms which will market benefits from environmental enhancement of five sites in the Tamar Valley. The project will identify and monetise a range of benefits in the form of carbon, biodiversity credits, natural flood risk management, and water quantity improvement (DEFRA, 2021b).

Tree-planting for Channel Payments for Ecosystem Services (CPES) and Riparian Planting Programme

Channel Payments for Ecosystem Services project lead a pilot study through the "Channel area" (Southern England and Northern France). The primary aim of the project is to improve water quality in catchments by implementing sustainable Payments for Ecosystem Service. One of the six CES catchments is the Roadford Lake catchment and as part of this scheme the WRT have received over 7,000 trees to plant. The WRT had a further 9,000 trees that have been planted though the Riparian Planting Programme on the Tamar/Lyd. Tree planting is often used to improve water quality but can also benefit water resources availability through reducing run-off and slowing peak flows in the river which can mitigate against flood. Tree planting also reduces pollutants and sediment reaching the river and can be used for enhancing a rivers in-channel ecosystem to enhance resilience during low flows by improving biodiversity and habitat (e.g., for fish) through the provision of shade moderating river water temperatures and reducing the growth of weeds and algae.

4.2 Future planned projects

Future planned work of particular relevance in the Tamar catchment includes:

- Plans to change the compensation scheme at Burrator Reservoir to improve flows in the Meavy catchment. See **Section 4.3** for more details.
- Devon County Council's 'Devon Resilience Innovation Project'[14] (DRIP) funded by the Department for Food & Rural Affairs' Flood and Coastal Resilience Innovation Programme (FCRIP), which will identify low cost flood resilience measures including nature-based interventions in flashy rural catchments.
- Continuation of the majority of current multi-year catchment projects such as the South West Water led Upstream Thinking programme into the future to provide resilience and improve habitats in the upper catchments.

[14] https://www.devon.gov.uk/floodriskmanagement/flood-and-coastal-resilience-innovation-programme-fcrip/

4.3 WCWR Tamar catchment action plan

Good work is clearly already underway or planned by catchment stakeholders in the wider Tamar catchment. These interventions may deliver small-scale improvements to low flow availability as well as providing water quality and biodiversity resilience, but they are unlikely to significantly improve low flow resilience in the face of climate change.

Consultation with WCWR during this project has contributed to the development of a **strategic action plan of water company measures that could be implemented in a phased approach,** tabulated in Error! Reference source not found.**.** This plan has been sketched out to add further supply-side options to the existing preferred demand management and leakage reduction measures in order to support the environmental ambition challenge. However, these water resources measures would also work in synergy and holistically with the wider catchment projects, all building resilience for the Tamar itself. A phased implementation should deliver incremental benefits along the way and would require step-wise changes in abstraction regulation.

South West Water are currently looking to deliver abstraction reductions through demand management and are considering a range of options for their Colliford WRZ and Roadford WRZ that will impact the Tamar. Due to the scale of the apparent Environmental Ambition challenge in the Tamar flagged by the Environment Agency's projections, these options may need to be reconsidered in the medium and long term.

The options which could be considered by SWW to address this additional challenge are combined and summarised in **Table 4.1**. This includes considering possibilities to review aggregate conditions for the licences in the Roadford WRZ at the Lyd, proposed Gatherley, and Gunnislake intakes to improve supply resilience and reduce combined licensed risks, as well as changes to the way the HEP licences are operated. In particular, the large HEP abstraction from Abbey Weir in Tavistock which is discharged to the transitional water at Morwellham Quay might be aggregated with the Lopwell Weir PWS licence, so that total licensed risks are reduced and public supply abstraction is prioritised during low flow periods. Wood are also aware that there are additional WINEP schemes ongoing (e.g. Burrator) which are not included in the WRMP, but will further improve water resilience.

In addition, Wood has included a number of potential options that should be considered in response to the environmental ambition challenge in the Tamar catchment as seen in **Table 4.2**. This includes investigations into effluent reuse – perhaps through relocating discharges upstream of new surface water intakes (e.g. Plympton 12 Ml/d, on the lower River Plym). There could also be potential to identify non-potable users of water located near other Wastewater Treatment works which may be able to use grey water in order to further reduce drinking water demands.

Schematic maps in **Figures D4.2** to **D4.4** show how the large-scale water company measures may be implemented over the short, medium, and long term.

Table 4.1 Water company phased water resources resilience action plan to 2050 for the Tamar

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
Changes to existing operations	Burrator changes	Alterations to Burrator compensation release to improve flows along Meavy and adaptive management trials. WINEP scheme currently in place to address issues here.	Meavy catchment	Improved flow regime			
Catchment Management	Catchment Schemes WINEP studies (Burrator and Roadford)	Continuation of Upstream Thinking initiative Continuation of Catchment Management Programme	Tamar WFD	Water Quality			
AMP7 investments	Customer side management options Leakage reduction	Metering, incentive, water efficiency campaigns, leakage innovations and continued investment.	Tamar WFD	Demand reduction			
Resource Scheme	Roadford / Northcombe pumped storage from Gatherley (River Tamar)	This option would involve a pumped storage scheme for Roadford Reservoir based on an intake on the River Tamar at Gatherley. A pipeline would connect the new intake to the existing Lyd/Thrushel pipework and transfer water to Roadford Reservoir and/or directly to Northcombe WTW. Although the main abstraction would be from the River Tamar, there would also probably be a small abstraction from the River Thrushel / Lyd mainly for water quality reasons. This scheme makes more effective use of reservoir storage.	Tamar catchment	Increased input and storage at Roadford			

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
		This is a scheme that could take account of the potentially slightly higher winter flows that could result from climate change. Likely that the Lyd abstraction which is currently in application could be delivered in the short term. The green recovery deal should also have an additional licence at Gatherley, and to aggregate the Gatherley, Gunnislake and Lyd refill abstractions. The move to an aggregate licence might be a medium-term objective.					
Enhancing existing supplies	Northcombe WTW capacity increase to 60 Ml/d	This scheme will enable more Roadford water to be treated at Northcombe WTW. This scheme should be considered in conjunction with the Rivers Taw and Torridge study and Roadford pumped storage resource management option.	Tamar catchment	Increased output from Northcombe could allow for reduced abstraction from elsewhere in catchment.			

Table 4.2 Additional solutions that could be considered as part of a phased catchment action plan: Tamar catchment

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
Catchment Management	Catchment Schemes	Continuation of catchment management schemes including, but not limited, to woodland management and planting, oversight of riparian and in-river practices, farm management e.g., livestock and nutrient management), continuation of advice on soil management. Develop closer ties with the Devon Local Nature Partnership to release mutual benefits under Devon LNPs nature recovery network and the resilient rivers and coasts initiative.	Tamar WFD	Water Quality			
Natural Flood Management	Slow and store water during higher flows to improve flow regime at low flows	Due to the lack of groundwater storage capabilities, to improve water availability NFM techniques should be utilised within the catchment. Natural attenuation features and further storage options in the wider catchment such as SUDS, natural attenuation features, leaky dams and increased use of rainwater harvesting across catchment. Liaison with stakeholder to identify “easy wins”. Expect small gains.	Tamar WFD	Low flow improvements			
Strategic review of HEP licences	HEP licence review	Strategic review of the HEP licences and their operation. Could there be improvements to the current management pattern? Consider changes to the HEP discharge	Tamar and Tavy catchments	Low flow improvements			

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
		locations, especially at Morwellham Quay (Tidal). SWW have discussed this as a potential option and could also consider an aggregated licence between HEP licence at Abbey Weir and the Lopwell Dam PWS intake. Review in the short term but the implementation is likely a medium term project.					
Nature Partnership		Consider a nature partnership to increase resilience in catchment. EA/NE					
Extension of existing resources	Enhance existing storage in catchment	Consider raising Roadford Reservoir, Upper Tamar Lakes and/ or Gunnislake by 1m to improve storage here. Not feasible to raise Burrator. Also unlikely at Lopwell Dam.	Tamar WFD	Increased storage			
Effluent Re-use	Review of potential for effluent reuse schemes	Review of the potential of effluent re-use within the catchment, potentially through the relocation of existing STW discharges (e.g. Plympton 12 Ml/d) further upstream for abstraction downstream.	Tamar WFD	Water Availability			
Grey Water Reuse	Review potential for grey water reuse schemes	Identification of non-public users (industrial?) of water that may be located near the Wastewater Treatment works which may be able	Tamar WFD	Water availability			

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
		to use grey water, rather than potable water to reduce demand.					
Regional solutions	New water resource	Consider locations for new reservoirs	Tamar WFD	Increased storage			
	Water Trading	Import from other water companies and other WRZ. Current economically unviable, but this may change in future if significant deficit remains.		Water availability			
	Desalination	Removal of salt from seawater for use in catchment. Likely to be very expensive.		Water availability			

5. References

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Figures