Foreword by Richard Brazier

The following report represents the culmination of 5 years research to understand the impact of South West Water's ground-breaking Upstream Thinking project 2015-2020. The science and evidence makes an objective assessment of where water quality problems occur and where they might be tackled by using innovative methods of catchment management, to complement more traditional 'end-of-pipe' solutions to treat water and wastewater. A multidisciplinary approach is also taken, drawing on techniques from hydrology, aquatic ecology, water quality science, digital mapping and environmental modelling to provide an evaluation of the combined impact of interventions. Out of the 11 Upstream Thinking catchments, this report showcases results from 6 catchments across the South West, but results can also be used to inform future approaches elsewhere, especially where rainfall event driven pollution of surface waters in intensively farmed landscapes is a problem. The questions answered herein have been co-created by researchers and water industry staff, as well as informed via collaboration with a wide range of stakeholders, including landowners and managers, regulatory bodies such as the Environment Agency, catchment management delivery Partners (Devon and Cornwall Wildlife Trust, Westcountry Rivers Trust, Exmoor National Parks and FWAG-SW). The research portrays a well-rounded understanding of the potential for Upstream Thinking approaches to deliver real change to the way in which we manage our water resources. The approaches, when combined in a strategic and integrated manner, can deliver huge benefits to water quality but also to a wide range of other ecosystem benefits, representing a truly progressive way of working across the South West and indeed any region that seeks to enhance natural capital as well as safeguarding water resources.

Richard Brazier

Professor of Earth Surface Processes and Director of the Centre for Resilience in Environment, Water and Waste, The University of Exeter.

Foreword by David Smith

In 2015, when I was first appointed to the role of Upstream Thinking Programme Manager, one of the first things I did was to look at what had been achieved so far. It was clear that, although there were numerous descriptive case studies of the great work that was going on, along with projected modelled outcomes, there was a gap in the empirical evidence gathering required to make objective long-term observations and investment decisions.

Building on the relationship between South West Water and the University of Exeter, established through the upland peatland monitoring work we had collaborated on since 2011, we established with Dr. Emilie Grand-Clement from Prof. Richard Brazier's team a new programme of evidence gathering on the many Upstream Thinking catchments across the South West, with the aim of understanding the long-term impact of the programme, not just on the rivers but also at SWW's treatment works.

Over the last five years, while the research programme has been running, the Upstream Thinking Partners have engaged with farmers managing over 70,000 hectares, delivered over 850 farm plans and follow-up co-funded grants worth £3.5 million.

This report helps us to begin to understand the value of this investment and the future difference to the quality of water in the rivers that we abstract from, for the benefit of not just our water treatment works but for all river life and users.

David Smith

Upstream Thinking and Biodiversity Team Manager, South West Water Limited.

EXECUTIVE SUMMARY

- Following on from the first phase of the project (2010-2015), Upstream Thinking 2 (2015-2020) aimed to improve water quality through catchment interventions tackling a number of point source and diffuse pollution issues in 11 catchments across Devon and Cornwall. **Page 8.**
- The University of Exeter has been monitoring water quality to assess the impact of catchment interventions using a number of different methods. **Page 14.**
- In rivers, rainfall is a key driver in the mobilisation and movement of pollutants: although there is some inter-annual variability, on an annual scale, there is often a cyclical pattern, with worse water quality in winter and better water quality in summer. Because of their size, water quality issues in reservoirs tend not to be rainfall event driven; seasonal algal blooms are the biggest water quality concern in reservoir sources, primarily occurring in the summer; inter-annual variability in climatic conditions and diffuse pollution is likely to cause variability in the timing and extent of the algal blooms. **Page 20.**
- Across the region, the main interventions used are: establishing new hedges, minimising the volume of dirty water produced (i.e. sent to dirty water store) and fencing off rivers and streams from livestock. **Page 24.**
- Both the SPARROW and Simply-P models used to link interventions to water quality showed marginal improvements across all parameters and catchments: load improvements were estimated to be less than 0.01% for nitrate and Dissolved Organic Carbon, up to 1.8% and 0.5% for suspended sediments and total phosphorus respectively. Reasons for these minimal changes are discussed. **Page 28.**
- Monitoring results in the **Argal** catchment highlight a higher nutrient contribution to the reservoir from the Antron stream compared to the Argal Stream. Efforts should particularly focus on reducing P input, as peaks are concomitant with blue-green algal blooms. Metaldehyde detections were consistently below 100 ng L^{-1} in the catchment and at the Water Treatment Works, and decreased between autumn deployment periods. **Page 36.**
- In **Drift** reservoir, detrending analysis (2012 to 2018) shows that most of the high turbidity peaks were driven by climatic conditions (particularly high rainfall); no statistically significant change in water quality can be observed throughout the duration of the project. Nutrient input of both Total Oxidised Nitrogen and Soluble Reactive Phosphorus into the reservoir during storm events are consistently above targets set by the Environment Agency and SWW. Levels of individual pesticide detections in the reservoir were below 0.1 µg L^{-1} throughout the monitoring periods. **Page 42.**
- In **Upper Tamar Lake** we observed a decrease in turbidity in the feeder stream to the reservoir at high flow between 2016-2017 and 2018-2019; this reduction is not yet detectable in the raw water at the WTW. Two different sources seem to be contributing to Soluble Reactive Phosphorus pollution in the feeder streams during storm events: either a deep zone within the soil, or a more distant, agricultural source further up catchment. Algal blooms are not concomitant with nutrient input to the reservoir, and are therefore likely to be driven, to some extent, by climate combined with existing nutrient loads in reservoir. Three high detections (i.e. > 100 ng L^{-1}) of 2,4D, Fluroxypyr and Trichlopyr were recorded in the catchment and reservoir over the study period. **Page 50.**
- In the **Cober** catchment, the critical threshold of 2 mg L^{-1} of ammonium level was exceeded 0.85% of the time. The reduced frequency of ammonium detections since 2015 is likely to be a result of Upstream Thinking interventions in the catchment. Pesticide monitoring has shown high numbers of detections throughout the monitoring period, with the regulatory limit of 100 ng L^{-1} per compound and per detection exceeded on four occasions in the River Cober. **Page 56.**
- In the River **Fowey**, continuous turbidity measurements in all flow conditions show a slight decrease throughout the 2012-2013 to 2017-2018 hydrological years, and a slight decrease in turbidity and colour at low flow, which may be attributable to Upstream Thinking interventions. Change is however not yet visible at high flows. It is hoped that it will be noticeable after continued engagement and further interventions are implemented in the catchment. Although pesticides are frequently detected in the catchment, the level of concentrations measured in river water are consistently below 100 ng L^{-1}, thereby fulfilling the Upstream Thinking objectives. **Page 60.**
- In the **Exe** catchment, turbidity is driven by rainfall events and increased river flow; high turbidity events occur more frequently in winter, reducing across the study period in line with the overall reductions in flow observed. Although no pesticide detection reached the regulatory limit of 100 ng L^{-1} in treated water, the number of detections in raw water from both SWW drinking water treatment works was high. All compounds of concern for the EA are still detected in the catchment apart from Chlorotoluron, highlighting the need for continued work on the pesticide amnesty. **Page 64.**
- In the sub catchment of the **Headwaters of the Exe (HotE)**, nutrient levels tend to be low. Significantly higher levels in the River Exe compared to the River Barle, potentially indicate more extensive diffuse pollution and a greater need for interventions. Pesticide detections were recorded are more prevalent in the River Barle; the number of pesticide detections in spring makes this the more "at-risk" period. **Page 70.**