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IS THERE HARM IN REDUCING SPILLS AT STORM OVERFLOWS BEYOND HARM?

1 INTRODUCTION

Storm overflows are relief points in the sewer network designed to spill flow to waterbodies when the capacity of the sewerage network is reached. The purpose of storm overflows is to prevent sewage flooding in homes, businesses and public spaces.

However, when sewage spills to rivers it can contain high levels of harmful pathogens which can pose health risks to people who use waterbodies for recreation. Sewage can also contain organic pollutants, microplastics, pharmaceuticals, nutrients, heavy metals and visible litter, all of which can negatively impact the ecology of the river.

Storm overflows have become a topic of national importance, and many articles have been published in the media recently which have put the spotlight on water companies and challenged them to reduce the frequency of sewage spills from storm overflows.

The Storm Overflow Discharge Reduction Plan (SODRP) was published in 2022 by the Department for Environment, Food & Rural Affairs as a follow up to the Environment Act and identifies actions water companies have to complete by 2050. One of the statutory requirements outlined in the SODRP is "Storm overflows will not be permitted to discharge above an average of 10 rainfall events per year by 2050".

The aim of this paper is to promote discussion surrounding reducing spill frequency at all overflows to an average of 10 rainfall events per year and highlight the challenges meeting these targets will present.

2 PRESENTING ARGUMENTS FOR AND AGAINST REDUCING SPILL FREQUENCY AT STORM OVERFLOWS TO AN AVERAGE OF 10 PER YEAR

Does reducing spills to 10 per year achieve water quality improvements?

Reducing spill frequency to 10 per year, as per the SODRP is a clear target which will likely improve the water quality of a river. This target also minimises the potential for misinterpretation of legislation. However, storm overflows can often achieve the optimum water quality benefit available in that river reach prior to 10 spills. Assessing harm is complex, and Figures 1 and 2 show water quality impact assessment results for a number of different storm overflows to demonstrate different water quality modelling scenarios. In Figures 1 and 2, spill frequencies of storm overflows are plotted against Biological Oxygen Demand (BOD) concentration (mg/l). The spill frequencies at a number of storm overflows were reduced to set spill targets (40, 30, 20, 10, 5 and 0 spills per year) and an updated storm overflow water quality impact assessment was run to assess the change in BOD concentration at each spill target.

Figure 1 shows that reducing spills to an average of 10 per year achieves the optimum water quality benefit at each overflow shown in the figure. This demonstrates that reducing spill frequency to an average of 10 per year will generally yield water quality improvements, and sometimes achieve the optimum water quality benefit available. On the other hand, Figure 1 shows overflows that achieve the optimum water quality benefit available, which in some cases is a WFD High classification, prior to 10 spills. Additionally, there are some overflows shown on this graph that already achieve WFD "Good" status even though they spill more than 10 times a year. Should we be reducing spill frequency at these assets?

Figure 2 shows that reducing spills at an individual overflow to an average of 10 per year does not always achieve a water quality improvement, as sometimes other assets draining to the reach affect the background water quality and therefore improvement can only be achieved when spill reductions are made at all assets draining to the reach. Additionally, there may be other sources of pollution contributing to the river reach which may mean that reducing spill frequency to 10 per year does not achieve the optimum water quality benefit within a river reach.

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The 10 spills target may reduce complexity, especially in water quality modelling as this target encourages improvements to be made at all overflows affecting a river reach. It is cheaper to analyse and more straightforward to monitor spill frequency. However, the optimum water quality classification can sometimes be achieved prior to 10 spills and this may allow for more affordable and feasible solutions to be designed. This raises the question, is reducing spill frequency to an average of 10 per year a target we should be aiming for at every asset to ensure consistency or is reducing spills to 10 per year not necessary when it can be demonstrated that an asset does not cause harm?

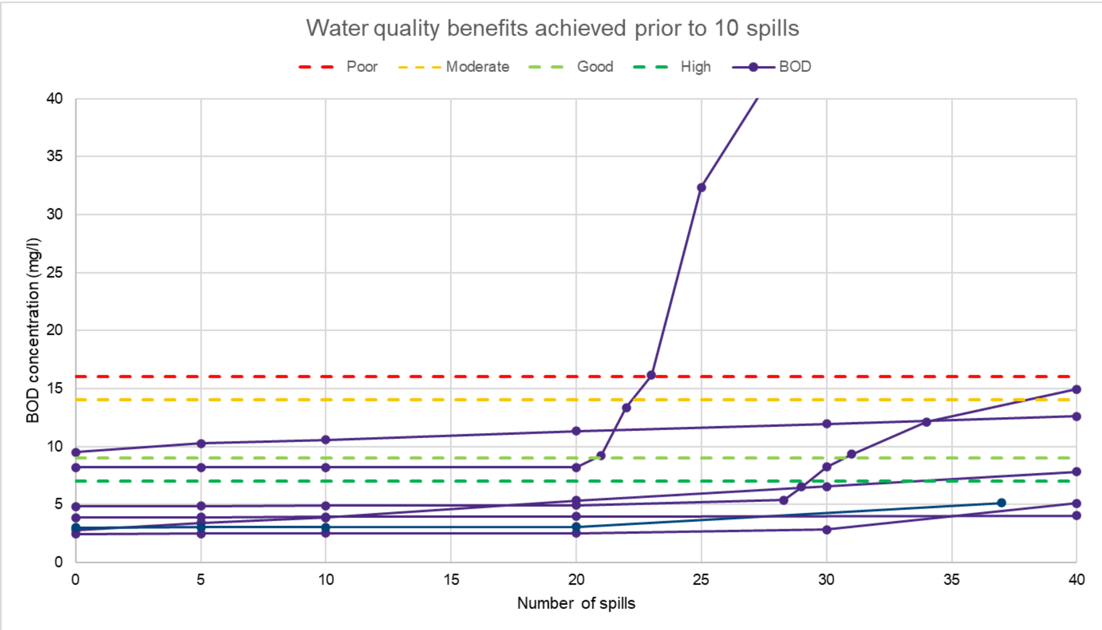

Figure 1- Impact of storm overflow spill frequency on BOD concentration (mg/l) at a number of different overflows discharging to different river reaches.

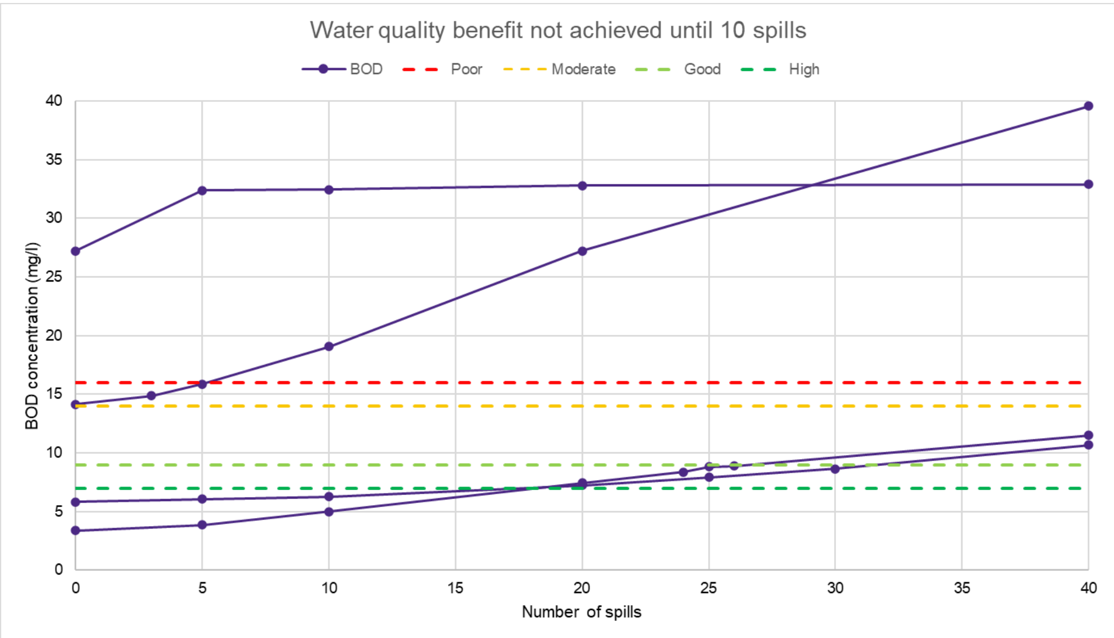

Figure 2- Impact of storm overflow spill frequency on BOD concentration (mg/l) at a number of different overflows discharging to different river reaches.

Should we be aiming to eliminate harm caused by overflows rather than achieve the 10 spills target?

Harm is a subjective term and modelling is required to determine the impact of storm overflow discharges. If the 10 spills target was removed from legislation and spill reductions at overflows were based on demonstrating that overflows have no local adverse ecological impact, then this opens up a grey area regarding which parameters determine harm and introduces modelling uncertainties. Currently the Urban Pollution Management (UPM) manual has identified standards for BOD, Total Ammonia, Unionised Ammonia, Dissolved Oxygen (DO). However, there are other pollutants that could be defined as causing local adverse ecological impact and therefore using a harm-based approach would mean that these additional parameters should be considered.

Setting an arbitrary target of 10 spills per year means that solutions will need to be implemented for all storm overflows, even when a storm overflow doesn't cause an adverse ecological impact. Figure 3 shows an overflow that spills 12 times a year, with a total yearly spill volume of 393m^3. Under current legislation, a solution would need to be designed for this overflow to reduce average annual spill frequency to 10. An overflow that spills to a river 12 times a year may cause harm, however, there are many cases where an additional two spills a year may not cause harm to the environment, especially if an overflow discharges to a large river. It would likely be straightforward to reduce spills at this particular overflow but a significant investment would be required to do so. Would there be greater benefit in prioritising assets that are causing serious harm to the environment?

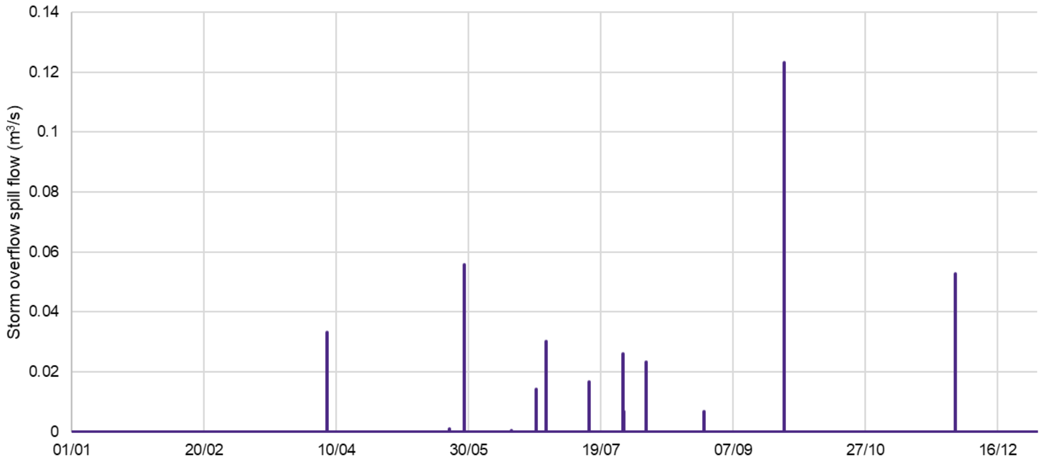

Figure 3- Storm overflow spill flow in a typical year.

Do we have the resources and can we afford to reduce spill frequency to 10 per year?

It could be argued that reducing spills at all storm overflows to 10 per year is necessary due to public pressures. The public want to use waterbodies for recreational purposes without being concerned about their health. The public also don't want to harm the environment. Reducing spills to 10 spills per year at all storm overflows could mean that everyone has access to rivers of improved water quality and priority is not given to communities that shout the loudest. This would allow access to rivers of improved water quality regardless of the local population's involvement in environmental activism. At this moment in time, it is a statutory requirement to reduce spills at all storm overflows to 10 per year, and therefore we should focus our attentions on implementing these schemes.

On the contrary, there are approximately 15,000 overflows in England and many of these overflows will need schemes designing to reduce the spill frequency to 10 spills per year. The Storm Overflow Evidence Project, Gill et al (2021) estimated that reducing spill count at all overflows to 10 and eliminating harm when still present will cost approximately £73 billion by 2050. This cost calculation assumes that retrofitted SuDS accounts for 10% of the upstream impermeable area. Ofwat have approved an accelerated infrastructure programme with £1.7 billion investment in 10 schemes across seven water companies, providing interventions at over 250 overflows. This is 2.3% of the estimated costs and only improves 1.7% of overflows in England. This is not the entire programme of ongoing overflow improvement work but is an example which demonstrates the cost and the scale of the improvements required. Consideration should also be given to the annual costs of maintaining any schemes as it is expected that the maintenance and energy costs of the network will increase significantly to achieve this target. This will be exacerbated by increased costs at treatment works due to increased flow to full treatment and treatment of a wider range of pollutants.

Another consideration is whether we have enough resources in the industry to deliver these programmes of work. We will need urban drainage and water quality modellers, scheme design engineers, surveyors, water

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quality sampling lab technicians and many more. We are facing a significant increase in recruitment needs across the industry but there are not currently enough resources in the industry to meet the future demand.

Will reducing spill frequency to 10 spills per year encourage the implementation of catchment wide solutions?

Reducing spill frequency to an average of 10 spills per year at all storm overflows might encourage us to think smarter and encourage the implementation of catchment wide solutions. These solutions would allow us to use catchment wide SuDS, solve existing flooding and use preferred approaches like surface water separation. In an ideal world, solutions would optimise and improve the operation of the existing catchment in addition to achieving spill targets.

However, a spill targets-based approach can lead to solutions being designed purely for individual poorly performing assets within a catchment. As the 10 spill target isn't flexible, the success of overflow improvements depends on how assets are prioritised. Poor prioritisation may mean that solutions are designed within the same catchment years apart, which limits the scope of the work that can be completed and the value delivered. The implementation and prioritisation of solutions will be key to determining success.

Does improving river health cause other negative environmental impacts?

Clearly, the pollution of waterbodies needs to be addressed as storm overflows are causing harm to the environment. The National Water Environmental Benefits Survey (NWEBS) allows us to quantify the benefits of improving river health, however there will also be a negative environmental impact associated with building these solutions.

Effective implementation of SuDS schemes could minimise the environmental and carbon impacts caused by construction and operation of assets (through reduced surface water pumping and treatment). Nevertheless, we need to recognise that there is a significant carbon impact of building schemes to reduce spills to 10 per year. It is estimated that approximately 19 million tonnes of CO_2 equivalent will be emitted initially when building schemes for overflow improvements in England (Gill et al, 2021). To quantify this, 19 million tonnes of CO_2 equivalent is approximately 1.9 million peoples' yearly CO_2 emissions based on a calculation that the UK average carbon footprint is 10 tonnes per person per year (Carbon Independent, 2023). CO_2 will also be emitted throughout an asset's entire life cycle once these schemes are built and this should be accounted for at the design phase. We need to consider the prospect that while improving river health we may be causing harm to the environment in another form.

3 SHOULD WE APPROACH THIS DIFFERENTLY?

Whilst designing and building schemes to satisfy the legislation, there are approaches we can take to ensure we are implementing effective schemes while understanding and minimising harm on the environment. The seven key ideas we should be considering are outlined below:

Identify sources of pollution

Firstly, we should be assessing the water quality impact of individual storm overflows whilst also identifying the key sources of pollution in that river reach, prior to designing solutions. To gain genuine benefits we need to hold all stakeholders accountable and consider all sources of pollution. The House of Commons Environmental Audit Committee (2022) reports that, on average, 40% of pollution in England's rivers is agricultural pollution; 36% is from sewage and wastewater; 18% is urban diffuse pollution and the remaining proportion is attributed to other sources of pollution. This highlights that investment in wastewater systems alone will not improve water quality if other sources of pollution are ignored.

Assess spill volume and duration as well as spill frequency

The 10 spills per year target is focused on spill frequency, however, spill volume and duration are arguably more useful measures to determine harm caused by an overflow. Figure 4 shows spill flows of two assets that have a very similar spill frequency (43 versus 40); spill durations differ and spill volumes differ from 30,000m^3 to 6,700m^3. Assuming the concentrations of pollutants in the discharges are the same, if these assets were to discharge to the same river reach then the impact of one is likely to be greater than the other. It is also important to consider that fish are particularly affected by the duration of a pollution event, which is why the Fundamental Intermittent Standards are also used to assess harm. Spill frequency is not necessarily the most appropriate metric to use for setting targets if other contextual information such as spill volume and duration is available.

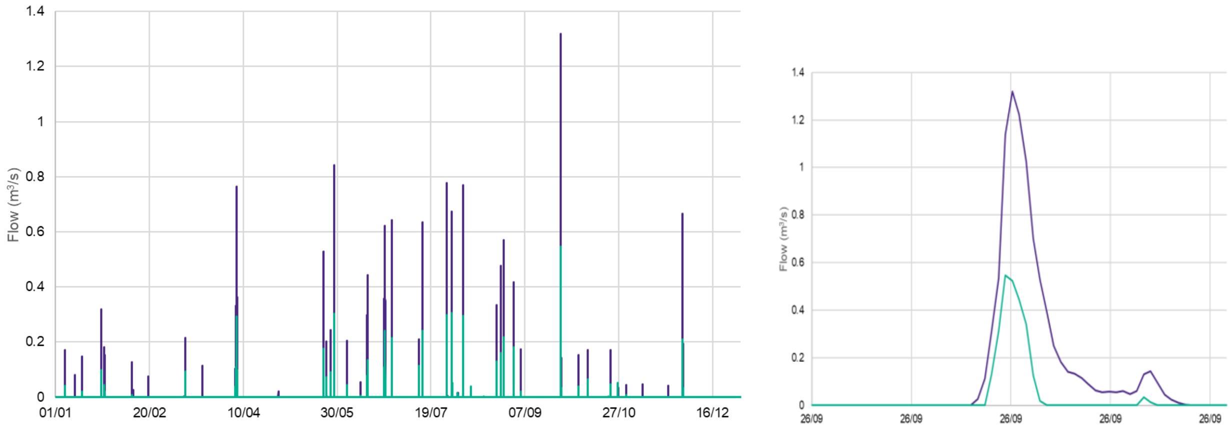

Figure 4- Comparison of spill flow at two storm overflows with similar spill frequencies.

Ensure effective prioritisation

We need to be aware of the impact overflow prioritisation has on the effectiveness of solutions. We should also consider how we are prioritising waterbodies that overflows discharge to. Water companies are already having to prioritise the overflows that will be improved first so this process is already underway. We should prioritise watercourses based on amenity value and ensure we improve water quality everywhere people use the rivers. We need to ensure everyone has access to a river they are able to use for recreation if they wish and we shouldn't just target areas that are highlighted by activism or the media.

Adopt a catchment-based approach

We should adopt a catchment-based approach and create solutions appropriate for each catchment based on slope, infiltration and many other catchment-specific parameters. We need to create bespoke solutions and consider things like treatment for catchments with high infiltration because reducing to 10 spills per year would likely mean storing large volumes of very dilute flow. Clarification of the legislation to make clear how treating flow could be used as an option to reduce impact, or perhaps even be used in place of reducing spill frequency, would be beneficial.

As part of our solutions we should identify areas within catchments that are currently separate but connect into combined systems and disconnect these systems as part of our solution design. We should disconnect systems wherever possible as this is a way to mitigate the impact of future development, creep and climate change.

Invest in monitoring technologies

As is outlined in the Environment Act, water companies need to monitor DO, temperature, pH, turbidity and Ammonia as a minimum upstream and downstream of every overflow and sewage treatment works. Currently this would provide us with an enormous dataset which is difficult to interpret as the parameters we need to measure are complex and do not always have a linear relationship with discharges of sewage. Additionally, the tolerance of monitoring equipment is often just as large as the variation in the parameters being observed during a pollution event. The investment in these monitors is going to be so significant that we need to make sure we get useful information out of them. Therefore, we should complete monitoring trials with the monitor manufacturers to ensure that we make the most out of what could be a useful dataset.

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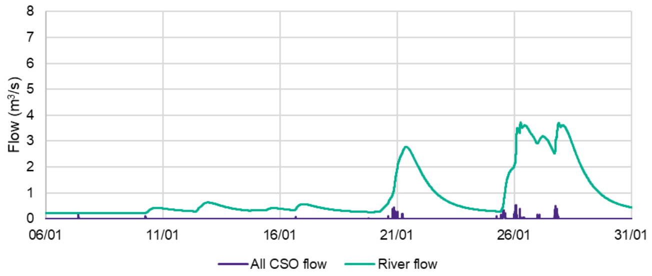
Consider the impact of river dilution

Figures 5 and 6 show the inputs and results of two water quality impact assessments RPS have completed using SOCRATES (a simplistic water quality modelling software designed to complete Level 1 and 2 water quality impact assessments). Figures 5a and 5b show CSO and river flows for two impact assessments. The river flow is the same for both assessments, however the CSO flow contributions are much smaller in Figure 5a, and therefore the resultant increase in BOD concentration is smaller.

When the sewers respond to rainfall, so does the river they discharge to. If the river is large enough then the sewage discharges will be diluted by river flow, and the impact of the sewage may be mitigated. It is important to highlight that if an overflow discharges a small spill volume to a large river, it is unlikely to cause harm to that river. We should be assessing the harm caused by a storm overflow discharge and taking the river dilution into account before designing solutions to meet arbitrary spill targets.



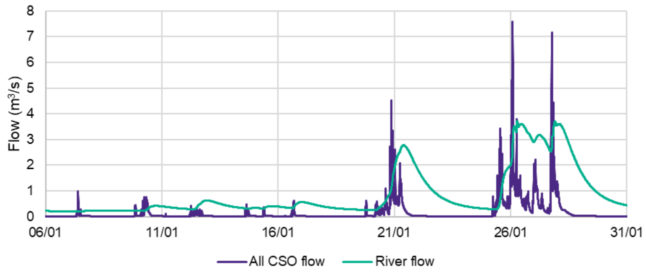
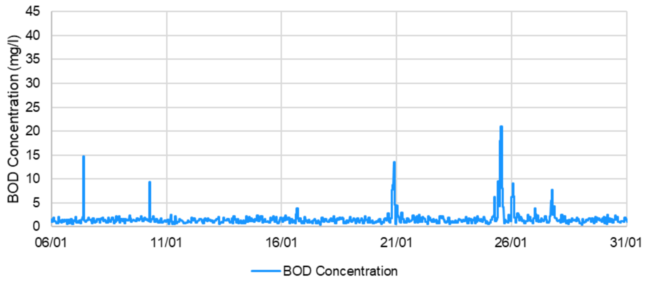


Figure 5a **Figure 5b**

Storm overflow spill flow and river flow inputs for two water quality impact assessments.



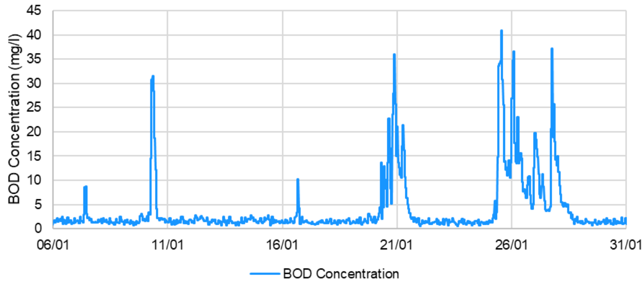


Figure 6a **Figure 6b**

BOD concentrations of two water quality impact assessments.

Invest in treatment technologies

We need to invest and research treatment technologies further. 19% of pollution comes from urban diffuse pollution House of Commons Environmental Audit Committee (2022). The main way we can address this pollution source is through increased treatment of surface water that is discharged directly to waterbodies. In some cases, final effluent at sewage treatment works is a source of pollution. In these examples, further treatment of the sewage needs to be implemented, however this is not always straightforward due to a number of limiting factors such as land availability. In some catchment scenarios, treatment of storm overflow discharges may be the most appropriate solution. All of these examples would benefit from investment in treatment technologies and the scale of treatment that is likely to be required creates a market for innovation in treatment technology to increase efficiency.

4 SUMMARY

The target outlined in the storm overflow discharge reduction plan "Storm overflows will not be permitted to discharge above an average of 10 rainfall events per year by 2050." is a clear target that will reduce harm caused by storm overflow discharges to waterbodies. This is also a statutory requirement and water companies have to achieve this target. It is acknowledged that, politically, it would be very difficult for the legislation to be changed, however achieving this target is not going to be straight forward and we will struggle to deliver the amount of work that is required with the resources and investment currently available in the industry. We should also consider the climate and wider environmental impact of the work we are completing.

The success of reducing spills at storm overflow to 10 spills per year can be measured in the reduction of harm caused by these overflows and whilst the current approach is likely to reduce harm, we need to consider the cost of these improvements. We should employ pragmatism in the approaches we take to deliver these solutions and this will be key in determining our success. This programme of work can feel like an overwhelming challenge, and we need to take a step back from the pressures of programme delivery and meeting targets to ensure we are doing the right thing. This requires stakeholders, such as water companies, the government, consultancies, researchers, the media and the general public, to engage in the honest conversations required to give us as an industry the flexibility and trust to implement best practices, effective prioritisation methodologies, conduct research and implement catchment-specific schemes to produce solutions that deliver value for money and benefit our environment.

5 REFERENCES

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