Department
for Environment,
Food & Rural Affairs

Progress report on the storm overflows discharge reduction plan (SODRP)

December 2025

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for Environment,
Food & Rural Affairs

Progress report on the storm overflows discharge reduction plan

Presented to Parliament pursuant to section 141B(6) of the Water Industry Act 1991

December 2025

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Executive summary

This progress report provides a statutory update on the implementation of the storm overflows discharge reduction plan ('the Plan'), as required under section 141B of the Water Industry Act 1991 ('WIA 1991'). This report covers the period between August 2022 and August 2025. The Plan, first published in 2022 and extended in 2023, sets out a long-term strategy to reduce the frequency and impact of storm overflow discharges in England. It aims to protect public health and the environment through ambitious targets:

- that storm overflows discharging into or near 'high priority sites' (HPS), such as chalk streams, do not cause local adverse ecological impact by 2045
- to significantly improve discharges near designated bathing waters by 2035
- that no overflow should discharge above an average of 10 times, over a 10-year period, per year by 2050

The ecological target, which focuses on the reduction of local adverse ecological impact from storm overflow discharges, saw an improvement from 22.6% in 2022 to 2023 to 33.7% in 2024 to 2025 of storm overflows near HPS, meeting a proxy measure of no more than 10 spills a year.

There remains substantial progress to be made to be on track for the 2035 public health target, which focuses on reducing discharges of harmful pathogens near designated bathing waters. 44.8% of relevant overflows met the required spill standards in 2024, down from 55.3% in 2022.

Preliminary modelling data indicates good early progress against the 2050 rainfall target. 27.6% of storm overflows spilled 10 times a year or fewer in 2022 to 2023, increasing to 42.9% in 2024 to 25 across a 3-year dataset. Modelling indicates that, even after adjusting for rainfall and seasonality (which remain the strongest predictors of spill frequency), the average number of spills per overflow has declined since 2022.

Water companies invested over £3.1 billion during the 2020 to 2025 period (Price Review 19) to improve storm overflows. Most companies exceeded or achieved their individual commitments to reduce storm overflow discharges, although 2 companies failed to meet their targets. The Thames Tideway Tunnel was completed in May 2025, providing an estimated 95% reduction in sewage pollution entering the Thames.

The government introduced new powers under the Water (Special Measures) Act 2025, including for Ofwat to ban unfair bonuses for water company executives. This allowed the Environment Agency (EA) to impose financial penalties using a lower, civil standard of proof. This provided for new automatic penalties, and gave the EA the resources needed to:

- monitor storm overflows
- investigate incidents
- act where companies fail to meet standards

Full coverage of event duration monitoring (EDM) across all storm overflows was achieved in December 2023, enabling near real-time public reporting of storm overflow discharges. The Plan has been embedded into drainage and wastewater management plans (DWMPs), the Water Industry National Environment Programme (WINEP) and the Price Review process, ensuring alignment across planning and regulatory frameworks.

Government action has extended beyond regulation and investment. Updates to the National Planning Policy Framework now encourage the use of sustainable drainage systems (SuDS) in all new developments with drainage impacts or in flood risk areas. The government is considering further reforms to enable 'upstream' pre-pipe interventions, including on rainwater management, sewer misuse and SuDS.

Looking ahead, the government remains committed to supporting delivery of the targets set out in the Plan. More than £10 billion has been allocated in the 2025 to 2030 cycle (Price Review 24) to upgrade approximately 2,500 overflows in England. This investment is prioritised at the most sensitive locations, including designated bathing waters and ecologically sensitive sites. Price Review 24 (PR24) includes a target to reduce average spills per storm overflow by 45% by 2029 compared to 2021 levels.

The Secretary of State announced in July 2025 that the government will respond to the Independent Water Commission's final report through a white paper and a water reform bill, including a detailed transition plan. The transition plan will provide a clear roadmap for the government's expectations of regulators and the water industry throughout implementation of white paper reforms.

The next statutory progress report, due in 2030, will be able to provide a more comprehensive assessment of the Plan's impact, supported by enhanced data over a longer implementation period.

The 2025 progress report

Storm overflows are a legacy feature of Victorian sewerage infrastructure but have become a symbol of unacceptable environmental harm. This government has been unequivocal: the routine discharge of untreated sewage into our natural environment must end.

The storm overflows discharge reduction plan ('the Plan'), first published in 2022, responds to these challenges by setting clear targets for water companies, supported by regulatory reform, investment and improved monitoring.

This report evaluates the progress between the Plan's publication in August 2022 and August 2025 in accordance with section 141B of the Water Industry Act (WIA) 1991. Since its publication in 2022 (and subsequent revision in 2023), the Plan has been widely embedded into the regulatory and planning landscape for drainage and wastewater in England. This report also considers next steps in improving reporting on the implementation of the Plan and highlights opportunities for future refinement to policy and delivery to support the targets.

Progress against the Plan's targets

This report uses publicly accessible data, where available, to ensure transparency and reproducibility. Assessment of progress is primarily determined using monthly event duration monitoring (EDM) data provided by a combination of data directly from water companies and from the Environment Agency (EA), following quality assurance. Assessing companies' progress against the targets is one of the ways in which we are assessing progress made on implementing the Plan, as required by section 141B WIA 1991.

Approach to assessing progress

The storm overflows considered eligible for each of the Plan's targets were determined using geospatial mapping based on proximity to designated bathing waters and high priority sites (HPS), as defined in annex 1 of the Plan.

Criteria used to determine whether a storm overflow qualifies for the 2035 and 2045 'ecological target' milestones and the 'public health target' are outlined in annex 1 of the Plan, and in section 3.2 of the storm overflows policy and guidance document.

This report is based on complex datasets and informed analytical decisions. The modelling approach for the rainfall target was designed to capture broad national patterns, and this should be considered when interpreting the findings. For more information on the methodology and analytical approach please refer to the technical annex.

It is important to recognise that the benefits of improvement schemes already delivered under the Plan are not yet fully reflected in the EDM data presented in this report. This is due to the inherent lag between the completion of an intervention and the point at which its impact becomes evident in EDM data.

This first progress report covers a relatively short period (3 years' data), much of which predates full EDM coverage. This means that the assessment of progress towards the targets remains provisional and should be interpreted with caution.

Ecological target

The Plan set the following ecological milestones and targets for water companies:

By 2035, water companies will have ensured that:

- 75% of storm overflows discharging into, or near, HPS do not cause local adverse ecological impacts.

By 2045, water companies will have ensured that:

- all remaining storm overflows discharging into, or near, HPS do not cause local adverse ecological impacts.

By 2050, water companies will have ensured that:

- no storm overflow in England, whether discharging into HPS or elsewhere, causes local adverse ecological impacts.

Progress towards the ecological target

Currently, there is an absence of data to directly assess the ecological impact of storm overflow spills. Progress was therefore assessed using a threshold of 10 spills a year as a proxy for local adverse ecological impact. This is in line with the approach in the storm overflows policy and guidance document (section 3.2.1.1).

Overflows discharging into or near HPS are covered by the 2035 and 2045 milestones and are prioritised for improvement in water company business plans.

For the ecological target, this report assesses progress across an 'SODRP reporting year', spanning August to August. This aligns with the reporting period coverage specified by the

WIA 1991, determined by the Plan's publication in August 2022, and ensures this report contains the most up-to-date data through to August 2025.

Our mapping has shown that a total of 4,865 storm overflows met the criteria for priority improvement under the 2035 and 2045 ecological target milestones by the end of the reporting period (Table 1). The data in Table 1 outlines progress toward the ecological target using a 10-spill threshold as a proxy for adverse ecological impact. The number and percentage of storm overflows achieving the interim 10-spill threshold has progressively increased each year, from 1,114 (22.6%) in 2022 to 2023 to 1,641 (33.7%) in 2024 to 2025.

Table 1: National summary of progress toward the 2035 'ecological target' milestone (2022 to 2025) using a 10-spill threshold as a proxy. Figures in brackets represent the percentage of the total covered overflows for each year.

Data related to the ecological target	2022 to 2023	2023 to 2024	2024 to 2025
Total storm overflows covered by the ecological target	4,919	4,929	4,865
Number of storm overflows with 10 or fewer spills (surrogate threshold)	1,114 (22.6%)	1,242 (25.2%)	1,641 (33.7%)
Number of storm overflows still requiring improvement to meet 75% by 2035	2,576 (52.4%)	2,455 (49.8%)	2,008 (41.3%)
Number of storm overflows without complete EDM data	1,353 (27.5%)	654 (14.3%)	313 (6.4%)
Number of storm overflows with complete EDM data across the year	3,566 (72.5%)	4,275 (86.7%)	4,552 (93.6%)

Over the reporting period, 171 storm overflows covered by the 2035 and 2045 ecological target milestones were decommissioned. After accounting for newly commissioned sites, between 2022 to 2023 and 2024 to 2025 there were 54 fewer active overflows covered by the ecological target.

Improving measurement of progress toward reduction of adverse impact on the environment

This report is unable to make substantive findings on the reduction in adverse environmental impact attributable to progress in implementing the Plan proposals. The complex relationship between storm overflow discharges and environmental harm cannot be accurately quantified without reliable, site-specific data. The 10-spill target is a useful proxy, but better data are required to make substantive findings on the reduction in adverse environmental impact.

That is why government is working with regulators and water companies to roll out continuous water quality monitoring (CWQM) during this Price Review cycle (PR24, which runs from 2025 to 2030), with a target of 25% coverage by 2030. This programme will provide the high-quality data for water quality impacts from each storm overflow that is required to better understand and measure the environmental outcomes of interventions and storm overflow improvement schemes.

In addition, from 2025 all water companies are participating in a new research project to identify suitable monitoring approaches for estuarine environments.

Public health target

The Plan set the following target for water companies:

By 2035, water companies will have ensured that:

- all storm overflows discharging into, or near, designated bathing water sites meet the required spill standards.

Progress towards the public health target

The assessment of progress towards this target is based on spill data from the bathing season (May to September inclusive). Monthly EDM data for overflows affecting designated bathing waters were compared against the bathing water classifications and bathing water type (coastal or inland) spill standards for each designated bathing water site in each year within the reporting period. Data in 2022 extends back to May 2022 (in other words prior to publication of the Plan) to ensure full coverage of that bathing season. Overflows that did not have EDM data for every month of the bathing season have been deemed to not be meeting the spill standards for this target.

Since the publication of the Plan, the recent guidance on storm overflows has clarified that water companies should prioritise reduction in spills to meet this target. In addition, disinfection or other treatment methods can be applied to further enhance water quality near designated bathing water sites. However, spill reduction remains the key measure for achieving the public health target. The target in the Plan applied spill frequency targets to storm overflows which, while further upstream of a bathing waters sites, can impact on them. This approach provides greater benefits in protecting public health in designated bathing waters. Any new overflows covered by this target will form part of the first cycle of improvement work in the period April 2025 to March 2030.

Our mapping shows that a total of 1,382 storm overflows qualified for the public health target by the end of the reporting period (Table 2). Data in Table 2 outline water company progress the public health target. The EA regulates discharges from storm overflows through environmental permits. Permits ensure storm overflows are only used legally during times of rainfall and snowmelt. Permits also reflect design standards for overflows, including the volume of flow which must be being passed forward to treatment before an overflow can be used, or the volume of storage which must be provided. Permits will in future contain spill standards, to ensure these design standards are reflected in the performance of storm overflows and will limit how often storm overflows can discharge[1].

The number of storm overflows achieving the spill standards, relevant to the environmental and quality classification of each bathing site, across the reporting period has varied over the 3 years. In 2022, 55.3% met the target by meeting the applicable spill standards, but this proportion declined in the subsequent wetter years, to 41.4% in 2023 and 44.8% in 2024. This shows that there remains substantial progress to be made to be on track for the 2035 public health target. It should be noted that this is based on a small sample size, rather than the full 10 years required by the guidance on storm overflows for an accurate average.

[1] Bathing water spill standards, according to section 3.2.3.1 of the policy and guidance document on storm overflows:

For designated coastal bathing waters (including estuarine), storm overflows within kilometre (km) upstream and in hydraulic continuity must be designed to achieve on average, for each bathing season, no more than: 3 spills for ‘good’, sufficient’, and ‘poor’ status: 2 spills for ‘excellent’ status.

For designated inland bathing waters (river and lake), must be designed to achieve no more than an average of one spill per bathing water season.

Table 2: National summary of progress towards the 'public health target' (2022 to 2024). Figures in brackets represent percentage of the total covered overflows for each year.

Data related to the public health target	2022	2023	2024
Total storm overflows covered by the public health target	1,297	1,299	1,382
No. storm overflows achieving the public health target (% total)	717 (55.3%)	538 (41.4%)	619 (44.8%)
No. storm overflows requiring improvement (100% by 2035)	580 (44.7%)	761 (58.6%)	763 (55.2%)
No. of storm overflows without complete EDM data	171 (13.2%)	112 (8.6%)	59 (4.3%)
No. storm overflows with complete EDM data across the season	1,126 (85.9%)	1,187 (91.3%)	1,323 (95.7%)

The bathing water classification and the type of waterbody that they are located in help determine the spill standards applied to nearby storm overflows, ensuring that the level of protection for public health and the environment is appropriate to the sensitivity of each site[1]. The 2025 bathing water season was still underway by the end of the period covered by this report and so progress for 2025 was not assessed.

Over the reporting period, several storm overflows covered by the public health target were decommissioned, while a number of new overflows were commissioned and previously unreported overflows were added. There were also 27 new bathing water site designations in 2024. As a result, the total overflows in scope for this target changed from 1,297 in 2022 to 1,382 in 2024.

Improving measurement of progress toward reduction of adverse impact on public health

While it is possible to report against the Plan's targets, we cannot accurately and reliably quantify any reduction in impacts of storm overflow discharges on human health attributable to progress on the Plan. This is due to the complex relationship between the two and the lack of a targeted monitoring programme. We want to better understand the reduction in adverse impacts on public health resulting from progress in implementing the Plan's proposals. Work is underway to improve understanding of these impacts through a cross-government collaboration between the Department for Environment, Food and Rural Affairs (Defra) and the Department of Health and Social Care (DHSC). This research will inform future reporting and policy development, including the 2030 progress report, ensuring that health considerations are more robustly integrated into the long-term strategy for managing storm overflows.

Rainfall target

The Plan sets a 'backstop' target for water companies:

By 2050, water companies will have ensured that:

- no storm overflow in England spills over an average of 10 times a year (across a 10-year dataset)

Progress towards the 'rainfall' target

Progress was assessed against the Plan's target which states, "storm overflows will not be permitted to discharge above an average of 10 rainfall events a year by 2050". This was clarified in the recent Defra storm overflow policy and guidance document, which stated that the target "translates to water and sewerage companies designing, operating and maintaining their storm overflows and associated sewerage systems to ensure there are no more than 10 spills a year on average over a 10-year period. This is not limited to spills caused by rainfall".

Table 3: National summary of progress toward the 'rainfall target' (2022 to 2025). Figures in brackets represent percentage of the total covered overflows for each year.

Data related to the rainfall target	2022 to 2023	2023 to 2024	2024 to 2025
Total number of storm overflows	14,751	14, 536	14,128
Number of storm overflows with complete EDM data	10,297 (69.8%)	12,284 (84.5%)	13,221 (93.6%)
Number of storm overflows with spills equal to, or below, 10	4,068 (27.6%)	4,428 (30.5%)	6,062 (42.9%)

A total of 14,128 storm overflows were in scope for the 'rainfall' target during the 2024 to 2025 reporting period (Table 3). The number and percentage of storm overflows spilling fewer than or equal to 10 times in a year has progressively increased each year, from 4,068 (27.6%) in 2022 to 23 to 6,062 (42.9%) in 2024 to 2025.

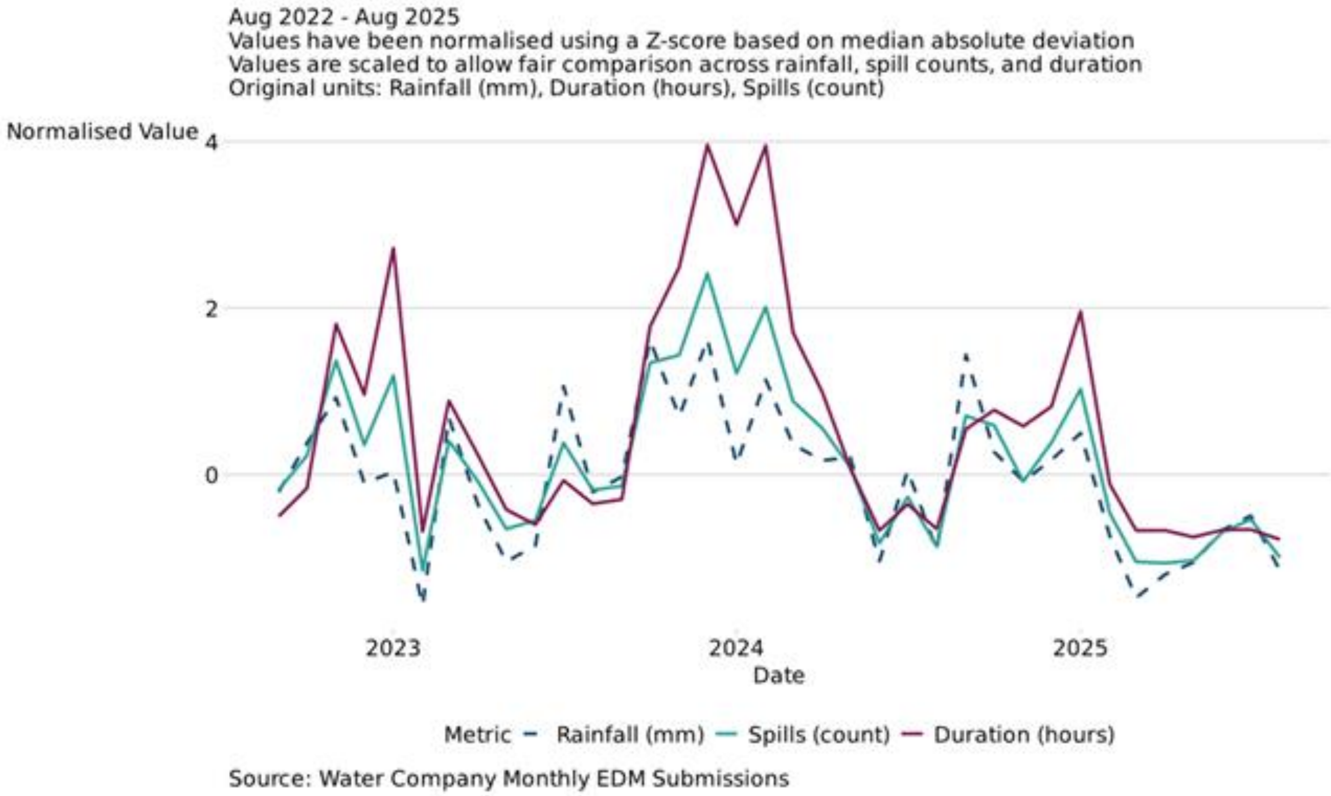
Given the short dataset, and rainfall variability, the following section explores the robustness of these data in indicating a trend. It concludes that there has been a statistically significant reduction in the average spills per overflow over the reporting period, after accounting for rainfall and seasonality. However, a longer data set will be needed to establish a direct causal relationship between the Plan and spill frequency reductions.

Understanding storm overflow discharge frequency and duration

Storm overflow discharge activity in England is strongly influenced by rainfall patterns. Infrastructure and operational improvements aim to reduce this dependency over time. Periods of above-average rainfall typically led to increased spill counts, while drier conditions yielded fewer discharges.

Figure 1 shows strong correlation between rainfall and both spill frequency and discharge duration, with peaks occurring during wetter periods in late 2022, and late 2023 and 2024. A marked decline in all 3 variables is observed by mid-2025. Given this close correlation, we have focussed our analysis on one indicator, spill frequency.

Figure 1: Normalised trends in rainfall, storm overflow spill frequency, and discharge duration (2022 to 2025). Values for rainfall (millimetres), spill count, and discharge duration (hours) have been normalised using a Z-score based on median absolute deviation to allow direct comparison.



To understand the data better, this report uses monthly EDM spill data with corresponding rainfall data based on storm overflow national grid locations. This has been used to develop a statistical model for a 'mean' value of annual spills for each active overflow between 2022 to 2025.

Defra's storm overflows policy and guidance document recommends a 10-year dataset to estimate this true mean. 100% EDM coverage was achieved at the end of 2023, therefore the analysis in this report applies a mixed effects regression model for monthly spills across overflows at a regional level between 2022 to 2025, with rainfall and seasonality as predictors. Overflows were evaluated on the rainfall target if they had at least 2 years of consistent EDM data across the 3 years. This combination of analytical approaches provides an early indication of progress toward the rainfall target, while acknowledging the inherent uncertainty associated with a shorter monitoring period.

The mixed-effects model estimates the average number of spills per overflow across all sites, with rainfall and seasonality emerging as the strongest predictors. A model using only these 2 factors explains 87% of the variation in spillage[2]. Even after controlling for rainfall, January consistently shows the highest spill rates, while July has the lowest, confirming a clear seasonal pattern.

The model indicates a statistically significant reduction in the average number of spills per overflow across the reporting period when controlling for rainfall. This suggests that, after accounting for rainfall effects, average spill counts in 2024 to 2025 were lower than in 2021 to 2022. The average number of spills per overflow in 2021 to 2022 was 20. For this average across all overflows, the model predicts about an 8% reduction by 2024 to 2025 would be expected after accounting for rainfall and seasonality. Overflows with higher or lower spill counts would see different percentage changes. While this suggests a potential improvement, year-to-year changes are inconsistent, and with only 4 years of data (using 2021 data as the baseline for the 3-year reporting period), it is unclear whether this reflects a sustained trend.

While rainfall predicts overall average spill rates, individual overflows vary widely. Some sites consistently spill more or less than expected, indicating that local factors such as infrastructure, operations, or geography also play a role.

We expect to be able to provide a more conclusive assessment of the relationship between progress on the Plan and reductions in spill frequency and duration within the next progress report in 2030, at which point there will be an additional 5 years' data. At this stage, we are unable to establish a conclusive causal link between the Plan and spill frequency, despite some promising early indications. Due to its close correlation with spill frequency, we have not sought to model spill duration, therefore conclusions cannot be made as to the effect of the Plan on spill duration specifically.

Reduction of storm overflow discharge volume

At the time of this report is not possible to make substantive findings on reductions in the volume of storm overflow discharges caused by progress on implementing the Plan proposals during the reporting period. The monitoring scheme currently in place measures discharge frequency and duration from storm overflows, rather than volume.

The government is committed to working with water companies and regulators to develop availability of volume estimates to inform future progress reports. This will include considering the use of sewer hydraulic modelling.

[2] ($R^2 = 0.87$, p-value = 0.03).

Progress towards the 2025 public commitments

Table 4 summarises the additional commitments made by companies, in addition to the 3 Plan targets analysed above (see annex 4 of the 2023 revised Plan). This section explores whether water companies are making progress on implementing their proposals in the Plan, against the 2025 deadline.

In the 2024 to 2025 reporting year, most companies were making progress to achieve or exceed their additional commitments to reduce storm overflow discharges (Table 4). Anglian Water, Northumbrian Water and Severn Trent Water reduced their discharges to an average of 20 a year, achieving 16, 15, and 16 average discharges respectively. Southern Water committed to a slightly more stringent reduction to an average 18 discharges, which they averaged during this period.

Thames Water committed to reducing the number of average discharges to 24 and achieved an average of 23 during the reporting period. United Utilities committed to a 33% reduction in the number of discharges (against a 2022 baseline), achieving a reduction of 56%. Yorkshire Water committed to a 20% reduction (against a 2021 baseline), achieving a reduction of 44%.

South West Water and Wessex Water are not on track to achieve their respective commitments. South West Water aimed to reduce their average discharges to 20 a year but averaged 29 in the 2024 to 2025 reporting period. Wessex Water aimed to reduce its duration of discharges by 20% but only achieved a 0.2% reduction against a 2020 baseline.

These provisional results show that almost all companies are making progress to successfully implement their proposals, apart from two companies which are currently far from achieving their targets.

A final assessment against the commitments will only be available once the EA publishes the full 2025 annual EDM data set in March 2026.

Table 4: Breakdown summary of individual water company 2025 additional commitments to reduce storm overflow discharges, alongside observed EDM activity in 2024-2025.

Water company	2025 annex 4 commitment	Observed Sept 2024 to Aug 2025 EDM activity
Anglian Water	Reducing discharges to an average of 20 a year	Average of 16 discharges
Northumbrian Water	Reducing discharges to an average of 20 a year	Average of 15 discharges
Severn Trent Water	Reducing discharges to an average of 20 a year	Average of 16 discharges
South West Water	Reducing discharges to an average of 20 a year	Average of 29 discharges
Southern Water	Reducing discharges to an average of 18 a year	Average of 18 discharges
Thames Water	Reducing discharges to an average of 24 per overflow a year	Average of 23 discharges
United Utilities	33% reduction in discharges against a 2020 baseline	56% reduction in discharges against a 2020 baseline
Wessex Water	25% reduction in duration of discharges against a 2020 baseline	0.2% reduction in duration of discharges against a 2020 baseline
Yorkshire Water	20% reduction in average number of discharges against a 2021 baseline	44% reduction in average number of discharges against a 2021 baseline

Progress on wider actions to tackle storm overflow discharges

This chapter outlines the steps taken to strengthen regulation, improve monitoring, and accelerate investment, as well as the measures planned for the next reporting period, to support delivery of the Plan's initiatives.

Actions to improve transparency

The government has taken action to ensure that the public, regulators, and water companies have a complete picture of their storm overflow activity in near real-time. By the end of the 2023 reporting year, full coverage of discharge events from storm overflows in England had been achieved through the installation of EDM. As a result, 2024 was the first year of full EDM coverage of storm overflow discharge activity.

Although all storm overflows were equipped with EDM monitors by this point, some sites did not yet have a complete year of EDM data coverage for the 2024 to 2025 reporting period (for example, where monitors were newly installed or undergoing calibration and verification). This explains the small remaining gaps in EDM data shown in the tables.

This complete EDM coverage of storm overflow discharge activity marks an important step towards accurately identifying and addressing company storm overflows which discharge too regularly. Furthermore, it ensures that regulators and the public can increasingly hold water companies to account.

There remain some differences in data held on storm overflows between Defra or regulators and the water companies. The government will continue to work with water companies and regulators to establish a single, agreed baseline list of storm overflows eligible for each target under the Plan for the next Price Review cycle (PR29) and ahead of the 2030 progress report. The government will take the following actions.

Bring forward secondary legislation to implement section 81 of the Environment Act (2021) in 2023

The commitment to achieve full coverage of EDM on storm overflows across the sewerage network has now been delivered. Section 141DA of the WIA 1991 (as inserted by section 81 of the Environment Act 2021) was brought into force on 1 January 2025. This provision introduces a statutory duty on water companies to publish near real-time information on storm overflow discharges, within one hour of them starting and stopping.

Water companies are now publishing data through regional maps on their individual websites and on Water UK's National Storm Overflow Hub, which consolidates live data from all 9 English water companies into a single, publicly accessible platform. This ensures that the public, regulators and stakeholders have timely and transparent access to information on the frequency and duration of storm overflow discharges.

Compliance with this duty is monitored and enforced by Ofwat, which uses near real-time data from the National Storm Overflow Hub to assess performance. Ofwat has issued guidance to water companies outlining expectations for monitoring and publishing requirements, with further updates to be provided where useful lessons are learnt from early monitoring of companies' performance following full implementation. These measures represent a significant step forward in delivering world-leading transparency, strengthening regulatory oversight, and supporting the government's broader objectives to reduce harm from storm overflows and protect the water environment.

Bring forward secondary legislation to implement section 82 of the Environment Act (2021) in 2023

Section 82 of the Environment Act 2021 places a duty on water companies to monitor the water quality impact of assets that discharge sewage, including storm overflows. The government will bring forward secondary legislation to bring this provision into force in due course. Meanwhile, Defra has issued technical guidance to water companies on programme design for CWQM, and in 2024 provided an interim technical standard ahead of the PR24 determination. This standard sets out how the programme will be assured to ensure that data collected is consistent, representative and reliable.

Over 2025 to 2029 (the period covered by PR24), water companies will install CWQM on 25% of assets in scope for the programme. This phased approach allows for innovation in future price review cycles, as technology for water quality monitoring continues to evolve and new methods are trialled. This approach was supported by the Independent Water Commission's final report.

The government will review progress on the rollout of CWQM before determining the pace and scale of installation for the next Price Review cycle (PR29). These steps represent an important foundation for delivering comprehensive water quality monitoring, which will improve understanding of waterbody health and support progress towards the Plan targets.

Encourage innovation to continuously monitor complex sites

As part of the 25% CWQM rollout in PR24, half of the monitors will be installed at HPS. These monitors will provide regulators with reliable water quality data upstream and downstream of these sites, to more accurately assess pollution from storm overflows. At complex locations, such as estuarine and transitional waters, data from investigations and pilot studies will also support the development of ecological standards, which are currently lacking for these environments.

The government will continue to work with the EA and water companies to fully develop ecological standards for complex environments before CWQM is fully rolled out across the sewerage network.

As part of PR24, regulators have asked water companies to investigate priority sites to identify the best ways to reduce the impact of storm overflows. This includes work in estuaries, coastal areas, and inland waters such as lakes and canals. The results will help improve monitoring and management of storm overflows and wastewater discharges, guiding future improvements in water services. Starting in 2025, all water companies are participating in a research project to identify suitable monitoring approaches for estuarine environments. The findings from this initiative will contribute to the development of technical guidance for PR29. These monitoring and investigation efforts are complemented by innovative treatment approaches, which are described in the 'storm overflow treatment trials' section below, including nature-based solutions (NbS) trials at sites with high infiltration, helping to reduce environmental and public health impacts and providing evidence to inform future strategies and regulation.

Manage our rainwater better

The government is pursuing a long-term, integrated approach to drainage and wastewater management that tackles the root causes of issues like storm overflow discharges while building resilience for development, climate change and population growth. Central to this strategy is reducing rainwater entering combined sewers through sustainable drainage systems (SuDS), rainwater reuse, and better surface water management. Measures such as permeable surfaces, green roofs, and rainwater harvesting help ease pressure on infrastructure and together with addressing sewer misuse improves sewer capacity.

The scale of this rainwater management challenge is significant. For example, it is estimated that the average household roof collects approximately 85,000 litres of rainwater each year[3]. In 2025, there were 47 million roofs (commercial, retail, and residential) across Great Britain[4], which, if all runoff entered the combined sewer network, would contribute an estimated 4 trillion litres of rainwater annually. This is the equivalent amount of water as that needed to fill 1.6 million Olympic-sized swimming pools. Therefore, reducing this

[3] WaterUK, 'Vast majority of Brits have no idea how much water they are using', 2023

[4] Ordinance Survey, 'Ordinance Survey releases new roof data for over 40 million buildings', 2025

inflow through rainwater management including separation, sustainable drainage and water reuse measures can make a substantial contribution to achieving the storm overflow targets set out in the Plan[5].

Improve Sustainable drainage systems (SuDS)

The government remains strongly committed to ensuring the use of standardised SuDS in new developments. It wants to see an increase in quantity, better design quality and effective adoption and maintenance of SuDS.

The government is considering the most effective approach to achieve this objective, which may involve either enhancing the existing planning-led framework using powers now available, in parallel with legislation related to the adoption of public amenities, or commencing Schedule 3 of The Flood and Water Management Act 2010. A final decision on the preferred approach will be made in due course.

The government has updated the National Planning Policy Framework to encourage a more integrated approach to drainage. Developments of all sizes are now expected to incorporate SuDS where they could have drainage impacts, in a manner proportionate to the nature and scale of the scheme. In June 2025, the Government released national standards for SuDS, which have been positively received by stakeholders as a constructive development.

Further changes to SuDS provision will be considered as part of upcoming consultations on wider planning reforms, including national policy related to decision-making and legislation related to the adoption of public amenities. These steps reflect the Government's commitment to reducing surface water pressures on the sewer network and improving resilience to flooding.

Implement the Storm Overflows Taskforce findings to better manage our rainwater

The government is considering legislative changes to enable better management of our rainwater, including the findings of the Storm Overflows Taskforce and the Independent Water Commission.

Policies regarding motorways and major A-roads are the responsibility of National Highways, and investments are through 5-year cycles through the Road Investment Strategy. Defra has been working closely in partnership with the Department for Transport

[5] Defra, 'Storm overflows discharge reduction plan: Impact assessment', 2023

and arm's-length bodies to ensure highway drainage aligns with Defra's priorities for water.

Deliver the surface water management action plan

The management of surface water to mitigate flood risk and the maintenance of a functional drainage network to reduce sewage discharges remain closely linked priorities, as measures to alleviate storm overflows also contribute to reducing surface water flooding.

Significant progress has been made in delivering the surface water management action plan (the 'Action Plan'), which set out actions for government, the EA, and other partners to mitigate surface water flood risk. The target set out in the Plan to deliver over 60% of the Action Plan by the end of 2022 has been achieved. The Action Plan is now complete, with all remaining actions either closed or embedded within future policy development.

Government continues to work with local authorities through the Flood and Coastal Resilience Innovation Programme, led by the EA, to trial and demonstrate how practical innovative actions can work to improve resilience to surface water flooding. These 'resilience actions' include the use of sustainable drainage systems to control surface runoff and natural flood management interventions which use natural processes to help slow the flow and store flood waters. The learning from this programme, alongside the findings of the National Infrastructure Commission's study on surface water management, will inform future policy, to strengthen resilience and reduce the risk of harm from surface water flooding.

The government has also made drainage and wastewater management plans (DWMPs) statutory for water and sewerage undertakers in England and Wales. Statutory DWMPs will ensure that wastewater infrastructure planning is consistent, transparent, and accountable, helping to safeguard communities from flooding and environmental harm. The plans also identify options to manage surface water more sustainably, reducing runoff into combined sewers while delivering multiple benefits in collaboration with other risk management authorities and stakeholders, such as local and highways authorities.

Ban wet wipes

Defra has worked with the devolved governments to legislate to ban wet wipes containing plastic across the UK. The ban in England will come into force in spring 2027 and will reduce plastic and microplastic pollution, particularly in our waterways. The government are supportive of industry efforts to encourage the correct disposal of wet wipes, including Water UK's 'Bin the wipe' campaign.

Further protect our bathing waters

Government has taken several steps to protect bathing waters in England, beyond the public health target in the Plan.

Review the Bathing Water Regulations (2013)

The government remains committed to ensuring that bathing water regulations reflect current patterns of recreational water use and continue to protect public health. On 12 November 2024, Defra, in partnership with the Welsh Government, launched a 6-week consultation on potential reforms to the Bathing Water Regulations 2013.

The consultation closed on 23 December 2024, and a formal government response was published on 12 March 2025. On 28 October 2025, Defra, alongside the Welsh Government, laid a statutory instrument to amend the Bathing Water Regulations 2013, with certain provisions in England having come into force on 21 November 2025. The SI included changes to deliver 3 core reforms and several technical amendments to respond directly to calls from stakeholders to modernise the framework governing bathing waters.

These measures aim to ensure that the regulatory framework remains fit for purpose, supports the designation of additional bathing waters, and delivers further improvements in water quality.

Review bathing water guidance on applying for new bathing water designations

To ensure the application process for bathing water designation is clear and accessible, the government has taken steps to improve guidance for both designations and de-designations. Updates were made to provide additional clarification for how planned reforms to the Bathing Water Regulations 2013 may affect new applications.

This approach ensures that the guidance remains aligned with planned regulatory changes and continues to support the government's objective of increasing the number of designated bathing waters while maintaining high standards of water quality. We will continually review guidance to ensure its accuracy once planned reforms are in place.

Improve transparency of bathing water quality

Improving the timeliness and accessibility of information on bathing water quality remains a priority, to help the public make informed choices. From May to September, the EA issues daily pollution risk forecasts (PRFs) on its Swimfo platform, where users can search for details of designated bathing waters by name or location. Work is underway to upgrade Swimfo to make it more user-friendly and improve the overall experience for the public.

One of the wider reforms explored in our 2024 consultation was the introduction of multiple monitoring points at each bathing water site to provide more detailed spatial information. This approach could enable water users to better assess individual risk in future when swimming. We are also considering changes, including clarifying and expanding the definition of ‘bathers’, by exploring potential immersion and epidemiological studies. Both reforms received strong support in the 2024 consultation and could enhance public health protection and information provision, but further evidence and consideration are needed before progressing to implementation. Further updates will be published in due course.

Prioritise measures to improve the water quality of the largest shellfish waters in England by 2030

The EA requires water companies to explore the need for action (improvement, prevention of deterioration or investigation) at 63 shellfish waters between 2025 and 2030. This will lead to reductions in sewage discharges from storm overflows and increased disinfection of treated sewage.

Defra has asked the EA to undertake a review of shellfish water protected areas before 22 December 2027, in line with the obligations under the Water Framework Directive Regulations. More details will be provided as part of a future update.

Act on antimicrobial resistance

The government continues to prioritise understanding and mitigating the role of wastewater and sewage discharges in the spread of antimicrobial resistance (AMR). Under the UK’s second 5-year national action plan for AMR (2024 to 2029), significant progress has been made in strengthening surveillance and research to address environmental pathways of resistance. The PATH-SAFE programme, a £19.2 million cross-government initiative, has piloted advanced genomic surveillance across multiple environmental sources, including wastewater, surface water, and sludge, to identify AMR prevalence and transmission routes. This work has provided critical evidence on the contribution of water industry discharges to AMR and informed future policy development.

Building on these findings, the government is implementing measures to improve waste minimisation and wastewater treatment processes to reduce the dissemination of AMR-driving chemicals and resistant organisms into the environment. This includes research under the UK Chemical Investigations Programme and commitment to implement effective waste management, wastewater treatment methods and agrochemical stewardship to minimise dissemination of AMR and AMR-driving chemicals into the environment. Regulators and water companies will play a key role in delivering these improvements, supported by enhanced monitoring and reporting requirements.

The government is also investing in innovation and surveillance to ensure that interventions are evidence-based and proportionate. This includes exploring new wastewater treatment technologies, supporting antimicrobial stewardship across sectors, and integrating environmental AMR monitoring into the UK's One Health surveillance framework. These actions will inform future regulatory and investment decisions, helping to:

- reduce the risk of AMR transmission through sewage discharges
- protect public health, ecosystems and food safety

Progress on actions to regulate the water industry: actions from the EA to support the delivery of the Plan

The EA continues to strengthen its regulatory and enforcement approach to address impacts on the environment and public health from the water industry. This includes risks associated with storm overflows and wastewater discharges. These are the key areas of change.

Introducing spill frequency threshold permitting (SFTP)

The EA is introducing spill frequency thresholds into storm overflow permits. These thresholds, aligned with the targets in the Plan, will ensure that improved storm overflows maintain their performance and enable the EA to act swiftly if performance deteriorates. Each storm overflow will be permitted at the most stringent spill frequency under the Plan or other legislation such as the Urban Wastewater Treatment Regulations (UWWTR) 1994.

Updated storm overflows assessment framework (SOAF)

The EA has also engaged on updates to the SOAF, which prioritises the investigation and improvement of sewerage assets and which supports companies in how they prioritise the investigation and improvement of sewerage assets to ensure their compliance with the UWWTR 1994. The revised framework incorporates improvements to the first version, enhances national consistency, and aligns with the targets set out in the Plan. Changes include:

- updated spill frequency triggers for investigation
- strengthened environmental and ecological impact assessments

Coinciding with the update of the SOAF, the EA also revised its best technical knowledge not entailing excessive cost (BTKNEEC) assessment guidance. This has significantly strengthened the approach and framework for assessing whether SOAF-identified improvements meet the BTKNEEC test for implementation. These changes should ensure that more emphasis is placed on:

- the quality of storm overflow improvements
- the spill reduction they achieve
- the detail of the assessment that is undertaken

Developing storm overflow treatment trials

Defra, the EA, and Ofwat have jointly developed guidance for pilots of NbS treatment of storm overflows which are subject to significant levels of infiltration with highly dilute effluent, where spill reduction is difficult to achieve. Success of these trials will be determined by whether these treatment processes applied to storm overflows can achieve the ecological target of the Plan by treatment in place of spill reduction, while also improving understanding of the real-world challenges of infiltration reduction. These trials build on the innovation and monitoring work described in the previous section, using evidence to test practical treatment solutions and inform future strategies and regulation.

Strengthened enforcement

The Water (Special Measures) Act 2025 (WSMA) provides a significant increase in enforcement powers to the EA, enhancing its ability to hold water companies to account, including to effectively manage storm overflows.

Key measures include:

- allowing the EA to impose financial penalties using a lower civil standard of proof, instead of criminal, for minor to moderate environmental offences
- introducing new automatic penalties, like a speeding ticket, for specific and obvious breaches without the need for lengthy investigations
- funding enforcement

In terms of funding enforcement, the Act introduces a water industry enforcement levy, ensuring the EA can recover the costs of investigating and enforcing compliance. This provides the EA with the resources needed to monitor storm overflows, investigate incidents, and act where companies fail to meet standards.

Together, these powers would enable the EA to take quicker, more proportionate enforcement action, driving improvements in how storm overflows are managed, reducing environmental harm and protecting public health. Some measures are subject to consultation.

Progress on actions to regulate the water industry: actions from Ofwat to support the delivery of the Plan

Ofwat continues to play a central role in driving delivery of the Plan through its regulation of water companies, including through investment oversight, and price review performance incentives. Its wider regulatory activities, such as its enforcement activities, also support improved environmental outcomes in relation to storm overflows.

Price Review 2024 (PR24)

PR24 has allocated over £10 billion of investment to improve around 2,500 storm overflows in England by 2030. This investment is underpinned by price control deliverables (PCDs), which set clear expectations for delivery. Where companies fail to meet these deliverables, they must reimburse customers, ensuring accountability for the use of customers' money.

Ofwat has also introduced ambitious performance commitments for storm overflows as part of PR24. These include targets to reduce average spills per overflow by 45% by 2029 compared to 2021 levels across the industry, assisting water companies with meeting their Plan targets. To ensure flexibility and maintain affordability, Ofwat has provided mechanisms for companies to reprioritise statutory improvements and adopt NbS where these offer best value. An uncertainty mechanism is also in place to allow additional funding for further improvements within the PR24 period if required.

Continuing outcome delivery incentives (ODIs)

Ofwat's ODIs continue to incentivise companies to deliver improvements against defined performance commitment targets where this is supported by customers and provides best value. These incentives are designed to reward strong performance and penalise underperformance, ensuring that companies remain focused on achieving environmental outcomes.

Regulating near real-time EDM data

Ofwat is responsible for enforcing the duty introduced by section 81 of the Environment Act 2021, requiring water companies to publish near real-time information on storm overflow discharges. Companies must publish details of when a discharge begins and ends, and the location of the overflow, within one hour of the event. This information must be readily accessible and understandable to the public.

PR24 includes common performance commitments that incentivise companies to maintain EDM coverage and accurate reporting. These commitments consider both monitored and unmonitored storm overflows, reinforcing the requirement for comprehensive monitoring and transparency.

Enforcement investigations into water and sewerage companies

Since November 2021, Ofwat has been investigating all the large water and sewerage companies' compliance with obligations relating to the operation of their wastewater treatment works and networks, including storm overflows. This was after several water companies explained that they might not be treating as much sewage at their wastewater treatment works as they should be, and that this could be resulting in sewage discharges to the environment at times when this should not be happening.

To date, Ofwat has concluded its enforcement action in relation to 6 companies, and its remaining enforcement investigations are ongoing[6]. In those cases, Ofwat found that the companies had breached their obligations under Regulation 4 and Schedule 2 of the UWWTR 1994, section 94 of the WIA 1991 and Condition P12 of the companies' licences. The companies had failed to operate and maintain their wastewater assets adequately, and to upgrade them where necessary, to provide sufficient performance. Companies had also failed to put in place adequate processes and systems to ensure they were meeting their legal requirements in this regard. The companies are now required to develop and deliver remediation plans to bring their assets into compliance, such that discharges from storm overflows only happen in exceptional circumstances, subject to BTKNEEC.

As part of its final decision for its concluded cases, Ofwat has set out a series of factors that should prompt a company to investigate and ensure compliance with section 94 of the WIA 1991, as supplemented by Regulation 4 and Schedule 2 of the UWWTR 1994. This includes when an asset has spilled more than 20 times a year (or any tighter legal requirement established by the EA or the government), and when an emergency overflow has discharged more than once a year.

Ofwat drives water company achievement of the Plan's targets through these regulatory activities.

[6] Ofwat: Investigation into sewage treatment works and sewage networks

Actions to invest in water companies

Government remains committed to ensuring that water company investment drives real improvements for our rivers, lakes, and coastal waters. Here, we outline the scale of funding, the types of projects being delivered, and how this investment supports both immediate reductions in spills and the transition to a more resilient wastewater network for the future, while delivering the long-term targets set out in the Plan.

Investment allowances for each water company are set during Ofwat's price review cycles, which provide the funding framework for the industry. These allowances are allocated to specific schemes within the Water Industry National Environment Programme (WINEP). Another source of investment outside of WINEP is through base allowances to maintain storm overflow assets. WINEP schemes are developed by water companies in response to drivers developed by the EA and Natural England (NE), who translate legislation and government priorities into actionable drivers for the industry, providing official strategic steers.

The WINEP methodology and driver guidance explains what water companies should do to establish the need for action for a specific driver. You can see the dataset for PR19.

2019 Price Review cycle investment (PR19)

In PR19, between 2020 to 2025, the industry invested a total of £3.1 billion towards improvement schemes relating to storm overflows. It is important to note that Ofwat's PR19 final determinations were published in December 2019, before the publication of the Plan (August 2022). As such, there were no SODRP-specific WINEP drivers included in PR19, making assessment of levels of investment linked to each specific target difficult.

Several improvement schemes in PR19 targeted storm overflow reduction, either directly or indirectly. Of the total £3.1 billion investment, £115.2 million funded flow monitoring at wastewater treatment works. A further £448.0 million and £460.1 million were invested to increase flow to full treatment and expand storm tank capacity respectively. Additionally, £237.5 million was invested to directly reduce spill frequency through projects such as new storm tanks. These schemes aimed to increase hydraulic capacity, either by expanding storm storage or enabling more combined rainwater and wastewater to be treated, rather than discharged into the environment.

A further £1.74 billion was invested on the Thames Tideway Tunnel, a major sewer project aimed at reducing sewage discharges to the Thames. This project was completed in May 2025, with the new sewer system providing an estimated 95% reduction in sewage pollution entering the Thames[7]. This is expected to translate to a reduction of spills from storm overflows into the Thames from 60 previously to approximately 4 a year on average.

In addition, £43.5 million was invested in PR19 for the installation of EDM at storm overflows. This investment saw a direct benefit at the end of 2023, with full coverage of EDM at all storm overflows on the sewer network in England.

2024 Price Review cycle investment (PR24)

Final determinations setting out expenditure allowances for water companies in PR24 (2025 to 2030) were published by Ofwat in December 2024. Based on the published storm overflow model allowances, £10 billion has been allocated to improving storm overflows. In addition, over £900 million has been allocated to monitoring (principally CWQM), giving a total of £11 billion. This is over a 4-fold increase from PR19 investment totals.

For PR24, new WINEP drivers and related investment have been introduced, which directly relate to each of the targets set out within the Plan:

- over £4 billion will be invested towards improvements to reduce storm overflow spills to protect the environment so that they have no local adverse ecological impact
- an estimated £1.1 billion will be invested to make improvements to reduce storm overflows that spill to designated bathing waters to protect public health
- £2.9 billion will be invested towards improvements to reduce storm overflows spills so that they do not discharge above an average of 10 times a year by 2050.

Through these drivers, water companies are investing approximately £8 billion in total (2022 to 2023 prices) in 2025 to 2030 to deliver over 2,300 spill frequency reduction schemes, aimed directly at each of the Plan’s targets. During this period there are approximately 6,000 environmental investigations by water companies to better understand the impact of the storm overflows to inform the next cycle of storm overflow improvements from 2030.

This is a significant scale of investment from the sector towards achieving the targets in the Plan, showcasing noteworthy delivery ambitions, with significant progress against the targets expected within the next reporting period. The 2030 progress report (which will take place at the end of PR24) will assess the effect of this Plan-related investment.

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[7] Sika’s Thames Tideway Tunnel, London.

Technical annex

Methods used to assess progress on the storm overflow discharge reduction plan (SODRP)

Introduction

This technical annex sets out the methodology and statistical processes undertaken by the Department for Environment, Food and Rural Affairs (Defra) to assess progress towards the targets in the storm overflow discharge reduction plan ('the Plan'). These processes guided the development of the progress report ('the Report') on the implementation of the Plan, which assessed storm overflow discharge frequency, duration and volume, along with their adverse impacts on public health and the environment.

The Report assesses progress against 3 core targets:

- ecological
- public health
- rainfall

The public health target assesses progress on storm overflows discharging into or near designated bathing water sites and whether they are on track to meet the required spill standards (no more than 1 to 3 spills per bathing season on average), depending on the site. Descriptive statistics were used to assess storm overflows spilling into designated bathing water sites annually from 2022 to 2024.

The ecological target assesses progress on storm overflows which have the potential to cause adverse ecological impacts. Descriptive statistics were used to identify the number and percentage of overflows spilling into a high priority site (HPS) annually from 2022 to 2025.

The rainfall target states that storm overflows will not be permitted to discharge above an average of 10 rainfall events per year by 2050. A combination of descriptive statistics and a mixed-effects linear model was used to assess progress toward this target. Descriptive statistics looked at historic spill and rainfall patterns, whilst the modelling accounted for rainfall and seasonal trends to enable a more robust evaluation of spill behaviour.

What the Report covers

The report evaluates progress against the storm overflow discharge reduction plan's targets, rather than introducing new guidance or regulatory changes.

Spill data in the Report follows the 12/24-hour counting methodology defined by the Environment Agency (EA). A spill begins with the first discharge, and any subsequent discharges within the next 12 hours are counted as part of the same spill. Discharges occurring within the following 24 hours also count as one spill, continuing until a full 24-hour period passes without discharge, at which point the 12-hour count resets.

The data presented reflects storm overflow activity from August 2022 to August 2025.The monthly event duration monitoring (EDM) data used in the Report may be further refined by companies when producing an annual summary for the EA. As such, there may be some differences between monthly data and annual data, as published by the EA.

Individual companies may hold more accurate or updated data for their region since the time of publication of the Report, in particular as part of their preparations for their annual EDM return to the EA. Changes to storm overflow permits, reclassifications, national grid references, and updates to environmental datasets since the publication of the Report may result in discrepances compared to the analysis produced in the Report.

The Report uses bathing water designations from 2022, 2023 and 2024. Notably, the bathing water designations for 2025 were not available during the preparation of the Report.

As storm overflow discharge volumes are not currently measured and reported, the Report does not consider any data relating to storm overflow volumes in its assessment. Water companies do not routinely measure discharge volume as there is no formal volume monitoring requirement currently in place. The government is committed to working with water companies and regulators to ensure that future progress reports can incorporate estimates on discharge volume reduction from water company sewer models.

Defra acknowledges limitations in estimating which storm overflows should be considered for improvement near designated ecological HPSs and bathing water sites, as defined within the Plan. Companies have used their own methodologies to identify overflows for improvement under the 2024 Price Review (PR24), which may differ from the Report’s approach. These mainly relate to companies using distances along water courses, rather than radial distances, and the report using the most up to date designations associated with HPS. Companies should continue with agreed works as outlined by Ofwat in PR24 final determinations and agreed with the EA in the WINEP programme.

The methodology for identification of HPS and bathing water overflows will be reviewed ahead of the PR29 final determinations. Defra has undertaken its own geospatial mapping to identify which storm overflows are within the defined distance of a designated HPS. It should be noted that this will be constrained by data limitations around HPS boundaries (geospatial files) and future work will seek to refine the analysis. Under the Urban Wastewater Treatment Regulations 1994 (UWWTR), bathing water sites are not defined as their own type. Bathing water sites are assumed to be covered under the bathing water mapping analysis.

Data sources

These are the data sources used throughout the analysis of the Report.

Monthly EDM

Storm overflows are fitted with Event Duration Monitors (EDMs) which record when, and for how long, the overflow spills. Roll out of the devices began at scale in 2015 and was completed by the end of 2023. The dataset includes the proportion of time for which the EDM was active and the total number of spill events (as defined by the 12/24 count method) for each overflow and month from January 2021 to August 2025.

Throughout this annex, 'EDM data' is used to refer to the percentage of time an EDM monitor returned data.

Sites included in the ecological and public health targets

Geospatial mapping to identify whether an overflow falls under the ecological and/or public health target was carried out internally by Defra. The Ordnance Survey Water Network data, EA HPS datasets and the Water Framework Directive (WFD) data were used to support this mapping exercise.

Monthly rainfall

Daily totals from all EA intensity rain gauges are combined into one dataset, which also includes daily totals from intensity rain gauges near Scottish and Welsh borders.

All data is quality assured, with values outside plausible ranges flagged for further inspection. These flagged sites are visually compared against near neighbours and rainfall radar totals to determine whether the value is likely to be genuine. If it is, the value will be retained, but if it is not, it will be omitted from the next stage of processing.

This quality assured dataset of point rain gauge totals is then used to produce a 1-kilometre (km) grid of daily rainfall values, using a geostatistical interpolation technique called ordinary kriging. Monthly long-term average 1 km rainfall data grids are used to normalise the dataset and aid the interpolation process. This gridded dataset is then combined with previous gridded rainfall datasets, with data prior to October 2023 coming from the Met Office Had-UK 1 km quality-assured dataset.

National grid reference (NGR) points from overflows were then be used to extract daily rainfall data for required locations of overflows around England.

Bathing water geographical classifications

The EA classifies bathing water sites by water body type:

- lake or river for inland sites
- coastal or transitional for coastal sites

Bathing waters data

The EA classifies bathing water sites annually as:

- excellent
- good
- satisfactory
- poor

See the EA's bathing waters data

Date preparation and preprocessing

Data validation and exploratory analysis checks

Summary statistics (mean, median, mode) and interquartile ranges (IQR) were calculated for key variables (rainfall, EDM data, spill counts) to identify implausible values and assess distributional properties.

Data cleaning

Records with negative spill values were deemed invalid and set to NA. These were excluded from all summary statistics and modelling, and associated EDM uptime and duration data were set to 0%.

To address implausibly high spill counts, values were capped based on the maximum number of days possible in each month of the year:

- months with 31 days (January, March, May, July, August, October and December) months were capped at 31
- months with 30 days (April, June, September and November) were capped at 30
- February was capped at 29 to account for leap years

For any month where EDM data return was less than 1% or greater than 100%, associated spill and duration values were set to NA and EDM data is set to 0%.A small proportion of overflows have been decommissioned since the start of the roll-out of EDM monitors in 2021. However, the indication of such is not always clear or accurate. Overflows were inactive if they are marked as such in the data and do not have any further EDM activity or time when they are marked as active. This means if an overflow was marked as inactive but later has EDM activity or an active status in the data, we assume that this overflow was also active for the intervening period.

Limitations of the analysis

Currently, the model only utilises 4 years of EDM data are available which means we are unable to calculate averages over 10-year periods to account for rainfall and seasonal variability. This limits our ability to assess long-term trends and progress towards the 3 targets. For this reason, ecological and public health targets were evaluated annually, and rainfall was addressed through annual performance and statistical modelling. This could make progress appear better or worse throughout the Report, depending on whether the years assessed were unusually wet or dry, something the use of averaging over the course of 10 years aims to address.

The analysis is constrained by incomplete and ambiguous EDM data, particularly for the years 2021 to 2023, which has the potential to introduce bias into the analysis. EDM installation on all storm overflows was completed at the end of 2023, and data collection methods have evolved since then, affecting comparability over time. Not all storm overflows had EDM monitors installed in 2021 and 2022, therefore care should be taken when considering historic comparisons.

The geospatial mapping is subject to constraints arising from:

- incomplete or inconsistent waterbody naming
- absence of waterbody IDs in coastal catchments
- gaps and generalisation in WFD transitional and coastal waterbody geometries
- some bathing water locations were points instead of polygons
- the overall reliance on a line-based dataset

These constraints collectively introduce potential misclassification of storm overflow proximity to high priority and bathing water sites.

Not all storm overflows have National Grid references (NGR), reducing accuracy in the geospatial mapping and matching to rainfall data.

Public health target

For the public health target, assessment of progress solely used EDM data from the bathing season (May to September, inclusive). Monthly EDM data for overflows affecting designated bathing waters were compared against the bathing water classifications and bathing water type (coastal or inland) spill standards for each bathing water site in each year within the reporting period. Data in 2022 extends to May 2022 (prior to the publication of the Plan) to ensure full coverage of that bathing season.

Overflows eligible for the public health target were selected by using internal geospatial mapping.

Overflows that spill into bathing water sites were assessed on the following standards depending on the type and classification of the site:

- inland sites: 1 or fewer spills per season
- coastal sites classified ‘excellent’: 2 or fewer spills per season
- coastal sites classified as ‘good’ or lower: 3 or fewer spills per season

Please note, performance was not averaged over a 10-year period due to lack of data at the time of the Report.

Some overflows discharge into multiple bathing waters and were only considered compliant if they met the standards for all associated sites.

Overflows were required to have EDM return greater than or equal to 1% for every month of the bathing water season and meet the bathing water standards (site type and classification) to be on track to meet target for that season.

Overflows that were decommissioned before September of the relevant year were removed from the analysis.

Ecological target

For the ecological target, there is an absence of data to directly assess the ecological impact of storm overflow spills. Progress was therefore assessed using a threshold of 10 spills per year as a proxy for local adverse ecological impact. This is in line with the approach in the storm overflows policy and guidance document (section 7.2.2).

Overflows eligible for the ecological target were selected by using internal geospatial mapping.

Any overflows which were decommissioned throughout a reporting year are excluded from the analysis for that year.

Overflows were required to have EDM data greater than or equal to 1% for every month and less than or equal to ten spills in a given reporting year to be on track to meet target.

Rainfall target

This analysis is based on EDM monthly data which was provided from water companies and rainfall data provided from the EA.

Additional data cleaning

Rainfall data from the EA was matched to the EDM data by NGR value and month. Therefore, the rainfall data for each overflow and month comes from the closest 1-km grid point in the rainfall data.

Where rainfall data was missing for a given overflow at any given month, the value was imputed using the rainfall measurement from the geographically nearest overflow (based on NGR coordinates) that had valid data for that month.

Mixed effects model

EDM roll-out since 2021 means a 10-year average cannot be calculated, at the time of the Report. Therefore, a model was used to assess whether there is an underlying trend over time in spill counts. Specifically, the analysis seeks to determine how spill counts would have changed if rainfall had remained constant across the 3-year period assessed. This approach isolates changes in performance that are independent of rainfall and seasonality, providing insight into progress toward the long-term target of reducing spills to 10 per overflow over a 10-year period.

Model data preparation

Data between September 2021 and August 2025 was assessed and all overflows with at least 36 months of data with EDM data greater than or equal to 1% were included in the regression modelling. Overflows that didn't meet this requirement were excluded.

Averaging rainfall and spills per overflow by region

Spill counts are measured for each overflow and rainfall (in millimetres) is taken from the nearest 1km grid point in the rainfall data. Monthly regional average rainfall was calculated by dividing the total amount of rainfall at each overflow by the number of storm overflows for each of the regions and months. Monthly regional average spill count was calculated by dividing the total number of spills by the number of unique storm overflows for each of the regions and months.

The regions correspond to the operating areas of the sewage companies. Aggregating at the region level allowed the analysis to focus on broader trends in how rainfall influences spill behaviour, whereas modelling at the individual overflow level would have introduced substantial complexity.

Data transformation

The key variables include average number of spills per overflow and average rainfall per overflow, for a given region and month. Both metrics have strong positive skews, therefore, the square root transformation was applied to achieve a more symmetric distribution suitable for linear modelling.

Figure 1: histogram of monthly regional average rainfall (mm)

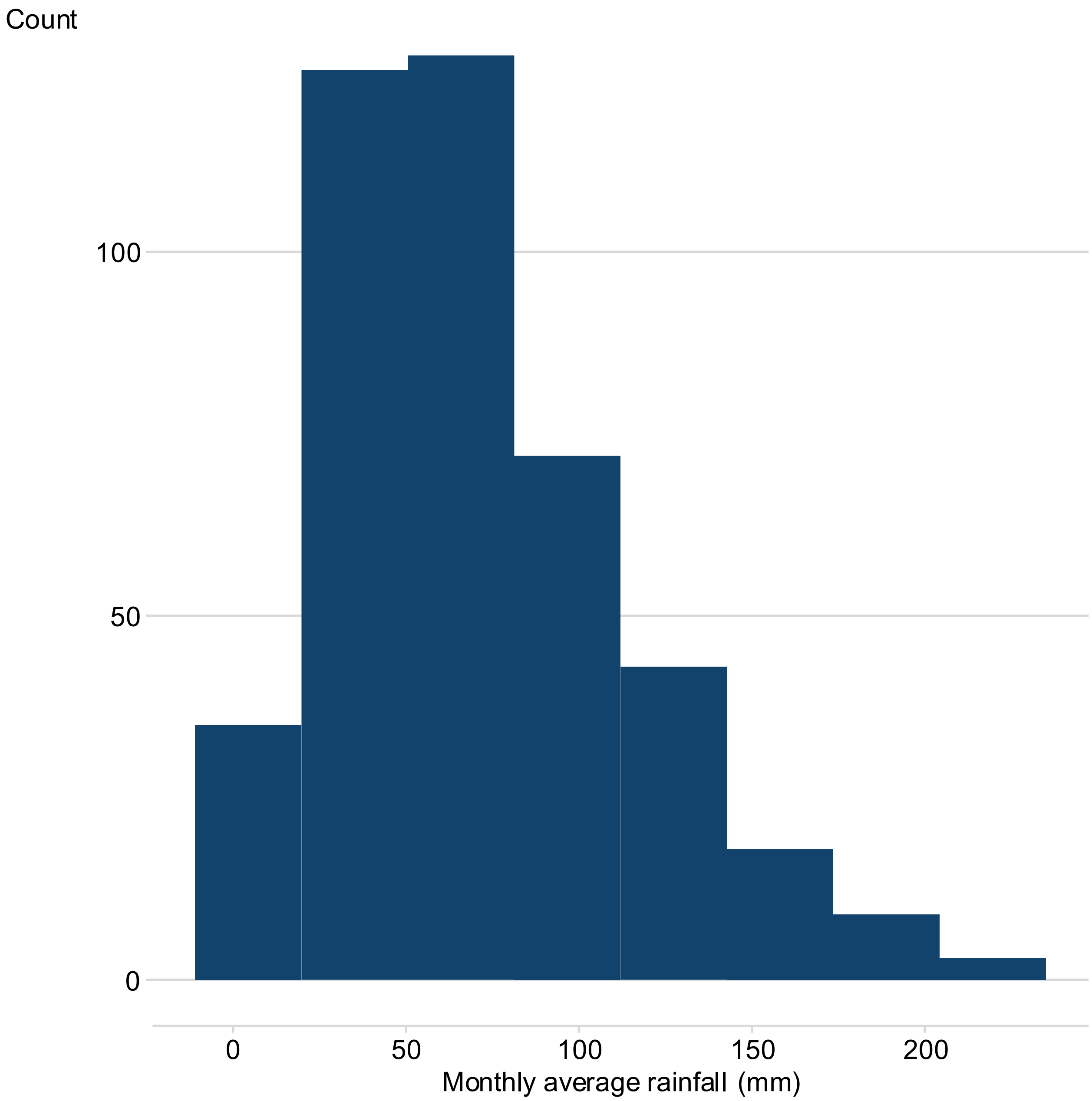


Figure 1 shows a histogram of monthly average rainfall in millimetres (mm), each bar represents how many regions had monthly average rainfall within a certain range for the given reporting period. The distribution has a positive skew.

Figure 2: histogram of the square root transformed monthly regional average rainfall (mm)

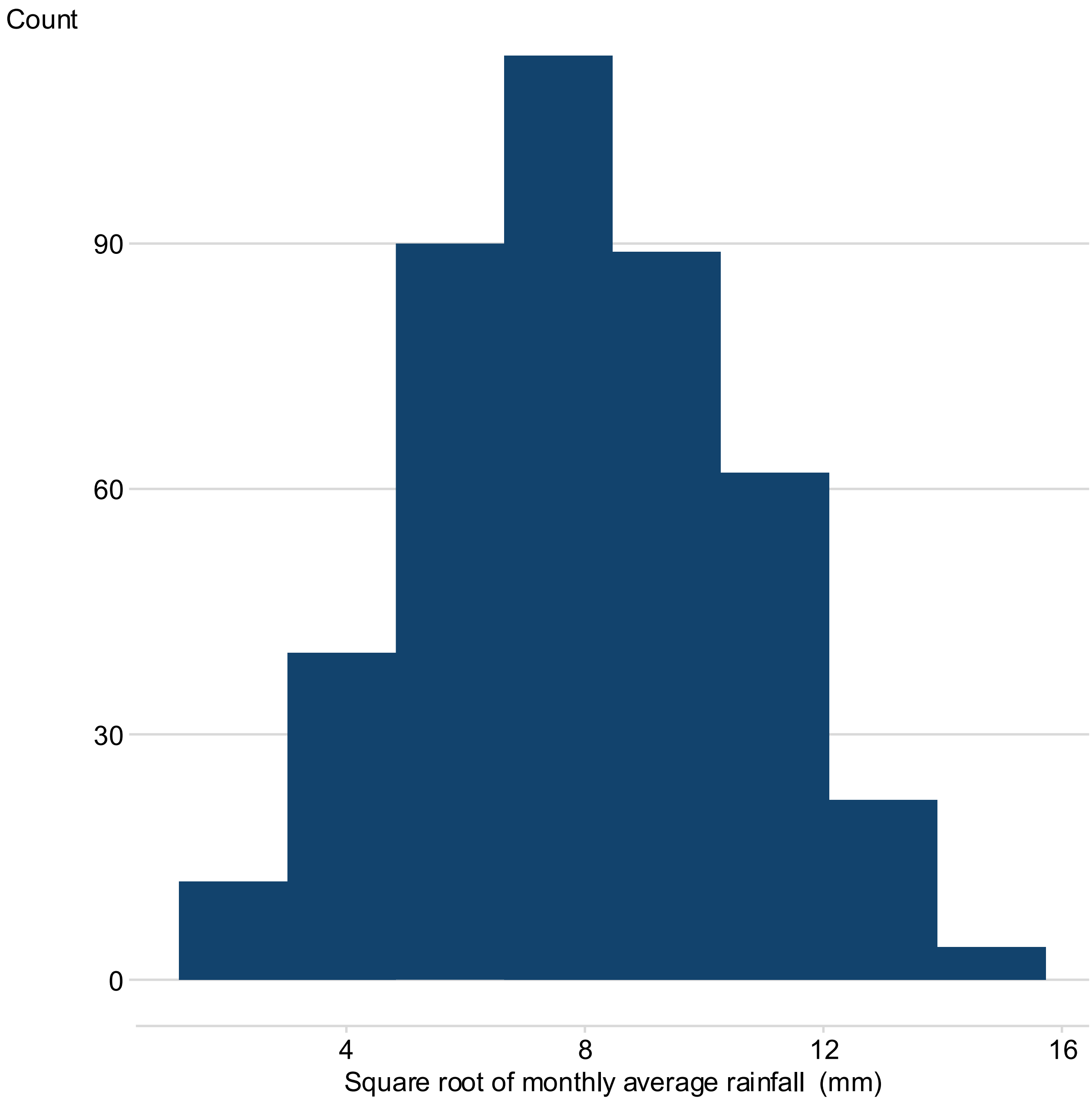


Figure 2 shows a histogram of monthly average rainfall (mm) with the square root transformation applied. The distribution is now closer to a normal distribution and is less skewed. The transformation reduces the skewness coefficient from 0.82 to 0.08.

Figure 3: histogram of monthly regional average spill count

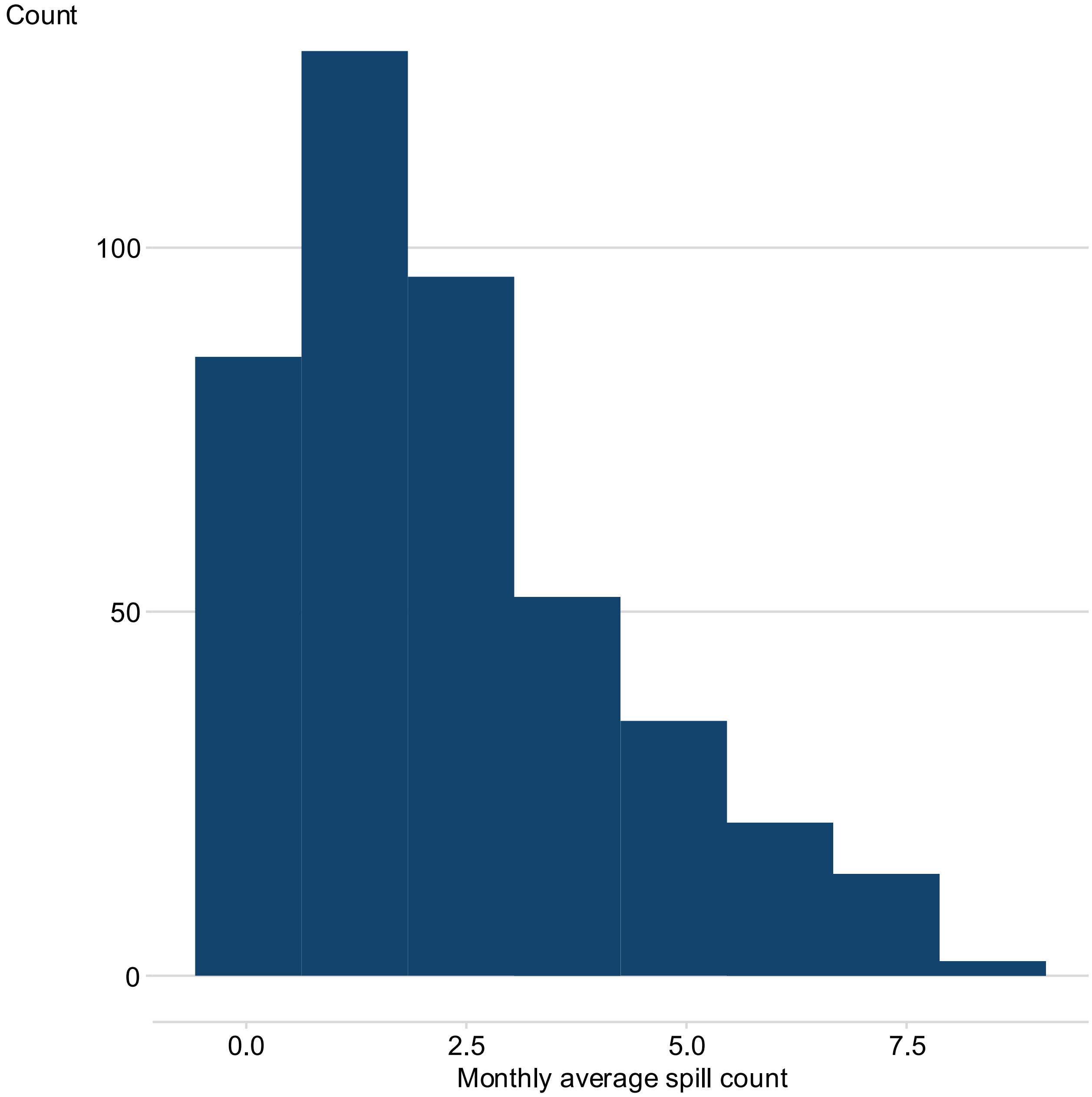


Figure 3 shows a histogram of the square root transformed monthly average spill count. The distribution has a strong positive skew.

Figure 4: histogram of monthly regional average spill count

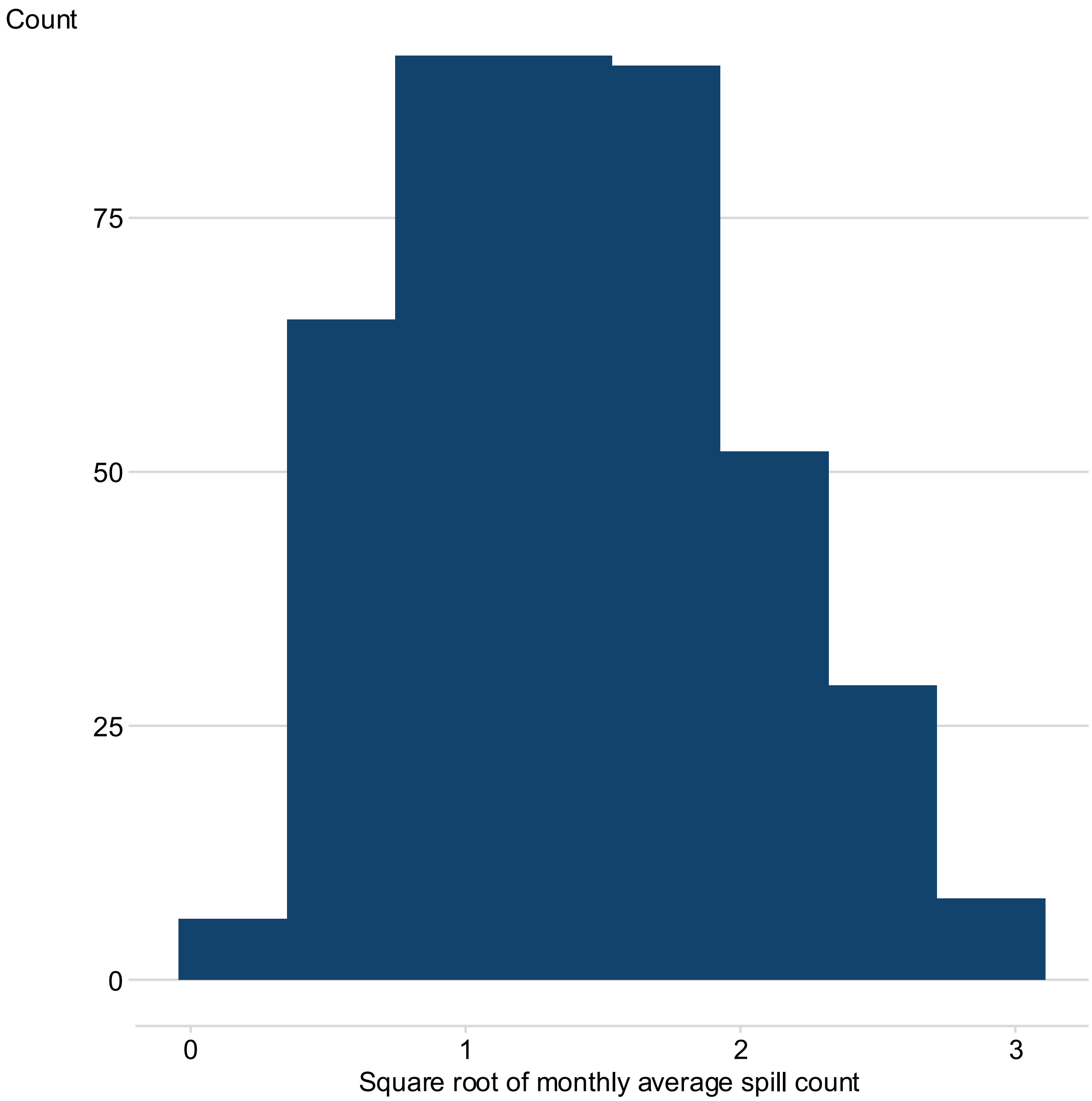


Figure 4 shows the histogram of the monthly average spills after the square root transformation. The distribution is closer to a normal distribution, but there is still a slight positive skew. The transformation significantly reduces the skewness coefficient from 1.01 to 0.27.

Figure 5: scatter plot showing the relationship between average monthly spill count against average monthly rainfall. Each point represents a region in a specific month.

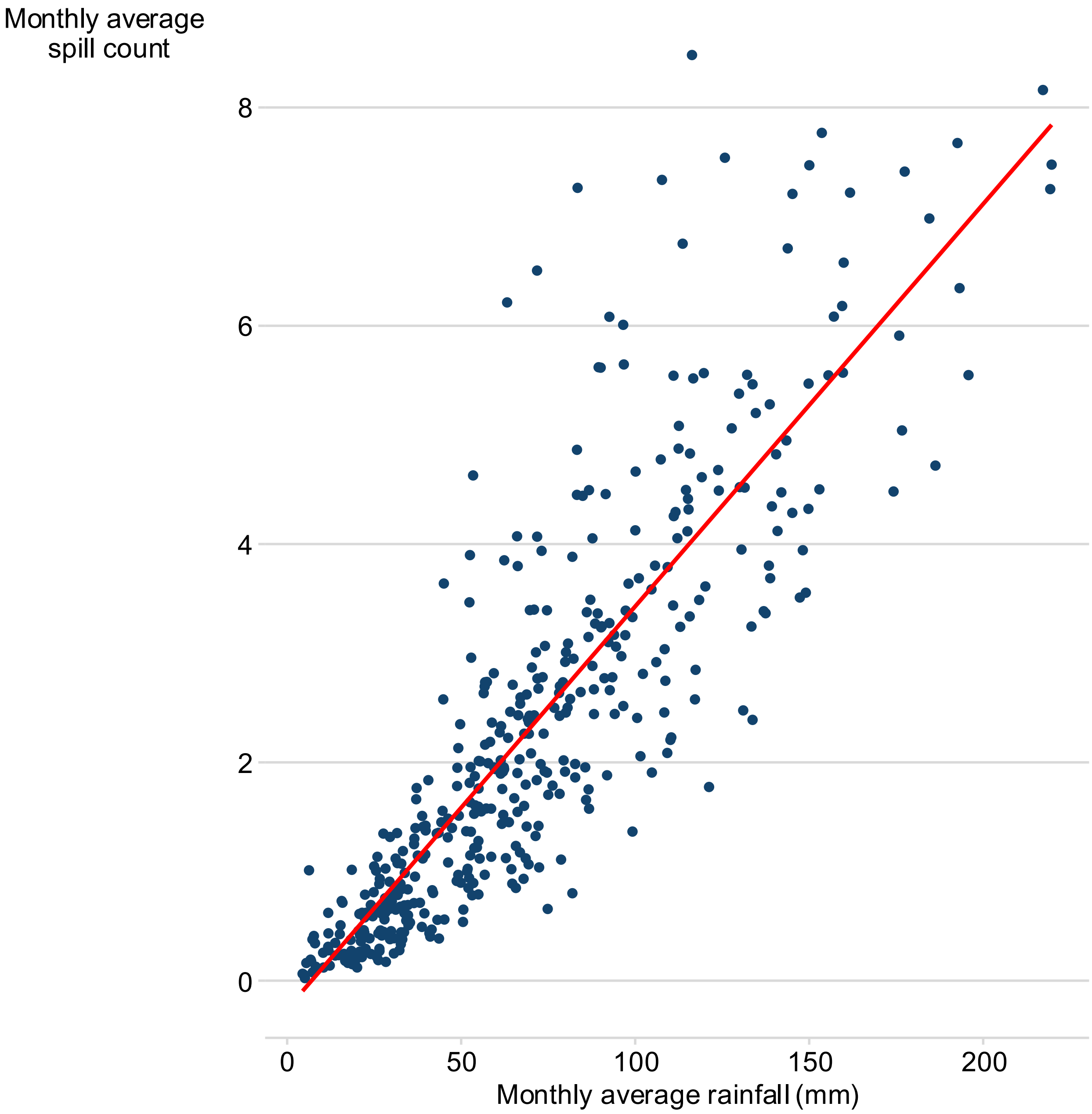
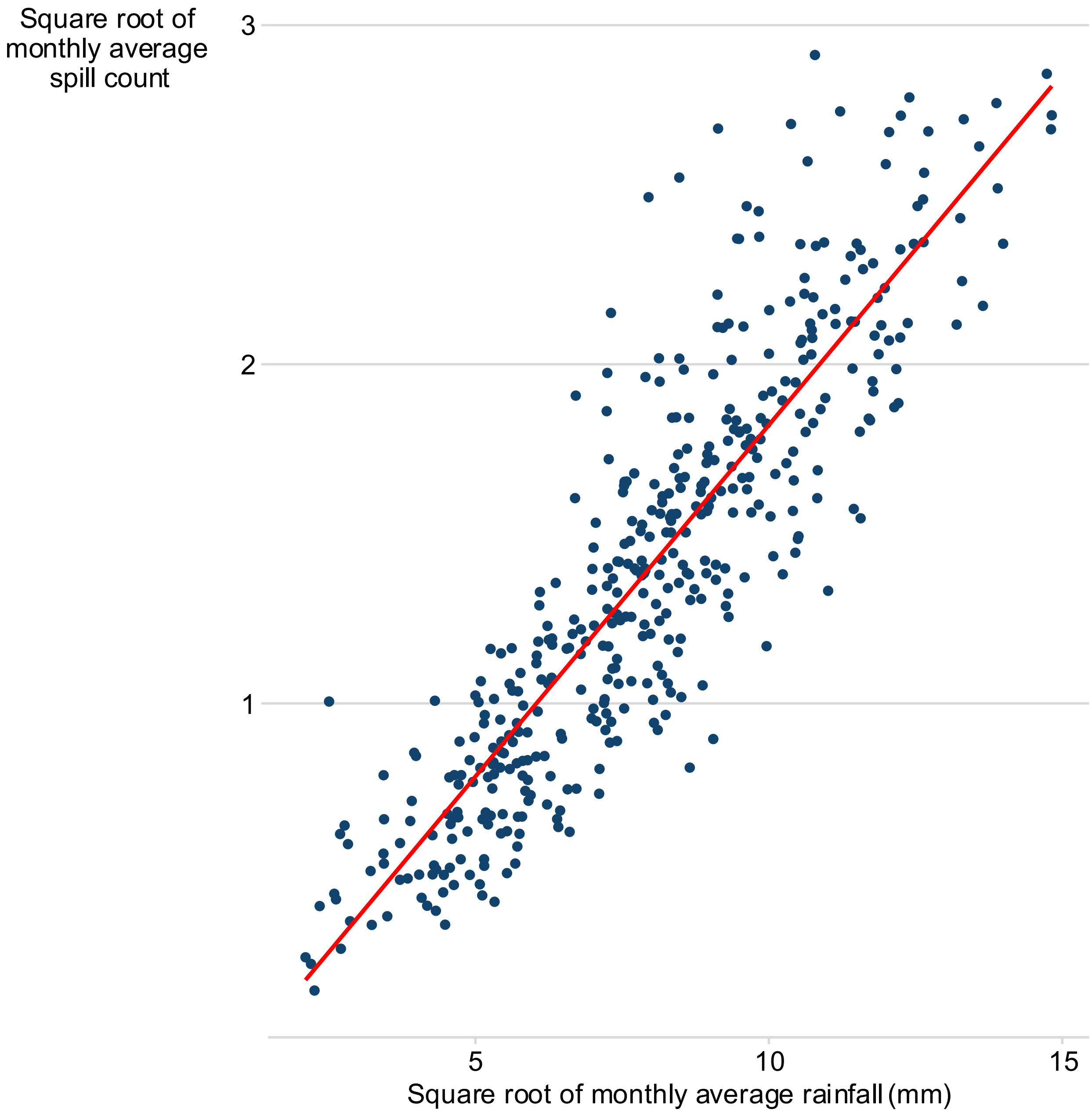


Figure 6: scatter plot showing the relationship between the square root of average monthly spill count against the square root of average monthly rainfall (mm). Each point represents a region in a specific month.



Figures 5 and 6 compare the relationship between average monthly rainfall and spills, before and after applying a square root transformation. Figure 5 shows that without the transformation there is a linear relationship between average monthly rainfall and spill count. However, the data points form a 'cone shape' suggesting there is a much larger variance in spill count for higher values than for lower ones. Figure 6 shows that after the square root transformation has been applied the variance in spill count is more constant across the range of values of rainfall.

Model specification

Rationale

A linear mixed-effects model was selected for the following reasons:

- there is a linear relationship between average monthly spill counts and rainfall after the square root transformation as shown in figure 6, making a linear model appropriate
- standard linear regression assumes independence of observations, but repeated measurements within the same water company create correlation, violating this assumption
- the data has a hierarchical structure with observations nested within regions; therefore, a model that accounts for clustering is needed
- random intercepts allow for region-specific baseline differences in the average number of spills per overflow

Variable selection process

Variables were initially selected based on prior evidence of factors known to influence spills, complemented by exploratory analysis. Variables were refined further by iterating the model to improve predictive power and model-fit indicator scores.

Including both current and lagged rainfall, annual trends, and month effects helps capture short-term variability, seasonal patterns, and long-term trends.

The variable ‘year’ was treated as continuous to model annual change as a linear trend. A model with ‘year’ as a categorical variable was considered to assess the rainfall-spill relationship for each reporting year, but this gave higher Akaike and Bayesian information criterion (AIC and BIC) scores indicating worse model fit.

Allowing for a difference in baseline spill count by region was found to improve predictions, and so random intercepts for regional groupings were included in the model. Models that allowed for differences in the response to rainfall by region did not sufficiently improve prediction, suggesting that there is no significant regional difference in how much rainfall effects spills.

Model formula

The model is expressed as:

Square root of average spills = a + b[regional] + c[month] +
d x square root of average rainfall from current month +
e x square root of average rainfall from the previous month +
f x year

Where a to f are coefficients of the model

The model includes:

- current month rainfall
- previous month rainfall
- month as a categorical factor
- a year-centred term as fixed effects

All of these were statistically significant at the 5% level. Water company regions were included as a random effect to capture baseline heterogeneity.

Variables

Variable	Description	Transformation
Spill count	Spill count averaged across overflows in a region	Square root
Rainfall	Rainfall in millimetre (mm) of the relevant month averaged across the region	Square root
Lagged rainfall	Rainfall of the previous month averaged across the region	Square root
Month	Month of the year	Categorical variable
Year	12-month periods between September 2021 and August 2025	Year – mean (Year)
Regional baseline	Adjusts the intercept for the different regions	

Table 1: coefficients of the model

Variable	Coefficient	Standard error	z score	P value	Confidence interval	
Intercept	-0.212	0.077	-2.752	0.006	-0.362	-0.061
February	-0.202	0.047	-4.333	0	-0.293	-0.111
March	-0.223	0.047	-4.747	0	-0.316	-0.131
April	-0.301	0.048	-6.317	0	-0.394	-0.207
May	-0.385	0.048	-7.957	0	-0.479	-0.29
June	-0.381	0.049	-7.839	0	-0.477	-0.286
July	-0.458	0.049	-9.380	0	-0.553	-0.362
August	-0.453	0.048	-9.497	0	-0.546	-0.359
September	-0.435	0.048	-9.028	0	-0.529	-0.34
October	-0.409	0.047	-8.648	0	-0.502	-0.316
November	-0.280	0.046	-6.042	0	-0.371	-0.189
December	-0.164	0.047	-3.516	0	-0.255	-0.073
Rainfall	0.202	0.005	44.705	0	0.193	0.211
Lagged rainfall	0.039	0.005	8.563	0	0.03	0.048
Year	-0.018	0.009	-2.139	0.032	-0.035	-0.002
Regional variance	0.015	0.041				

Model interpretation

Interpretation of variables included in the modelling:

- intercept: baseline square root of average spills for January when rainfall = 0 and year = mean
- rainfall: the current month's square root of monthly average rainfall strongly predicts the square root of average monthly spill count. Each unit increase in the square root of average monthly rainfall increases the square root of average monthly spills by 0.202 units, holding other variables constant
- lagged rainfall: square root of average rainfall for the current month has a stronger influence on the square root of average spill count in comparison to the square root

of the previous month's rainfall, with the coefficient being roughly 5 times larger on the transformed scale

- year: the year coefficient is negative, showing that there has been a decrease in expected spill count for given rainfall and seasonal conditions
- month factors: the coefficients for all months are negative, showing that they have lower spills for the same amount of rainfall compared to January, with the summer months having the lowest
- regional variance: there is variation in baseline spill levels across regions

Coefficients are estimated on the square root scale. The model estimates the relationship between spill counts and rainfall after the square root transformation.

The model shows the magnitude of the effect on average spill counts depend on the baseline average monthly regional rainfall and spill levels. For example, a region averaging 30 spills per overflow in the baseline year (2021 to 2022) is expected to have about 2 fewer spills (approximately equal to a 7% reduction) by the final reporting year (2024 to 2025), while a region averaging 5 spills per overflow would see a decrease of about 0.8 spills (approximately equal to a 16% reduction) over the same period.

Model assumptions

Mixed-effects linear models assume:

- linearity
- normality of residuals and random effects
- independence
- homoscedasticity
- correct random structure
- appropriate handling of missing data

Diagnostic tests in the following section cover these in more detail.

It is assumed that the overflows missing from the analysis due to poor EDM data would not materially change the estimated average spills per overflow or the rainfall–spill relationship.

Overflows within the region are assumed to respond similarly to rainfall, due to the fact we are using the average spills per overflow at the regional level.

Modelling year as one continuous variable assumes the reduction in spills is linear across all 3 years of the reporting period.

Model diagnostic tests

In the section, multiple diagnostic tests were undertaken to assess model assumptions, model fit and robustness of the results. The analysis in this section refers to the following values.

Actual values: observed measurements of the response variable, monthly average spills per overflow at the region level (square root transformed).

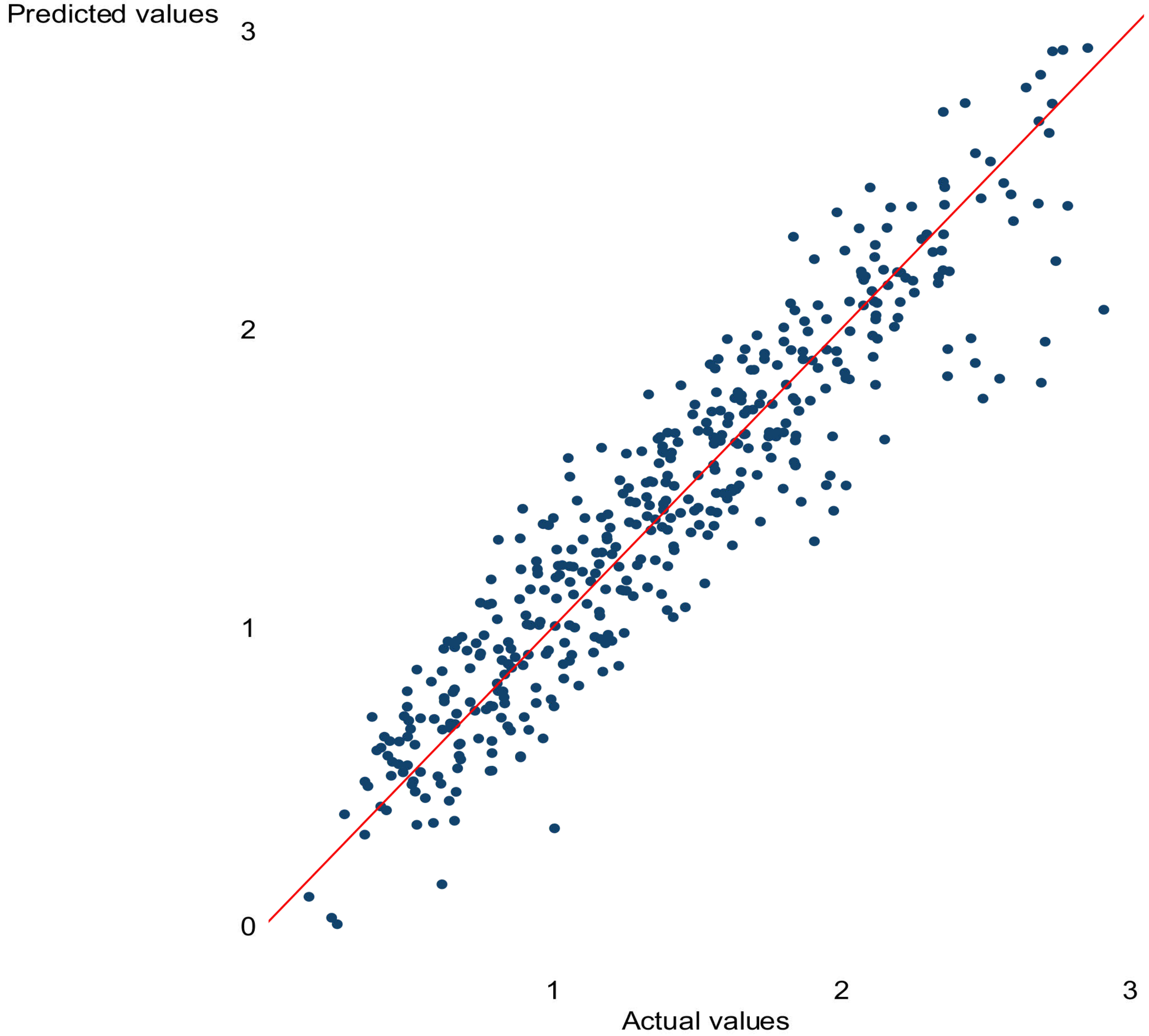
Predicted values: the models estimated outcomes, based on actual average rainfall, year, month and region.

Residual values: the actual value minus the predicted value. The residual shows how different the predictions from the model are from the actual exhibited values. Small residuals indicate good model fit.

Convergence and fit summary: R squared is a statistic of a linear regression model that measures the proportion of variation in the data that can be explained by the model. In the mixed effects model, 86.4% of the variation can be explained by the model only using the fixed effects (rainfall and seasonality) increasing to 90.1% when considering the different baselines for the regional groupings.

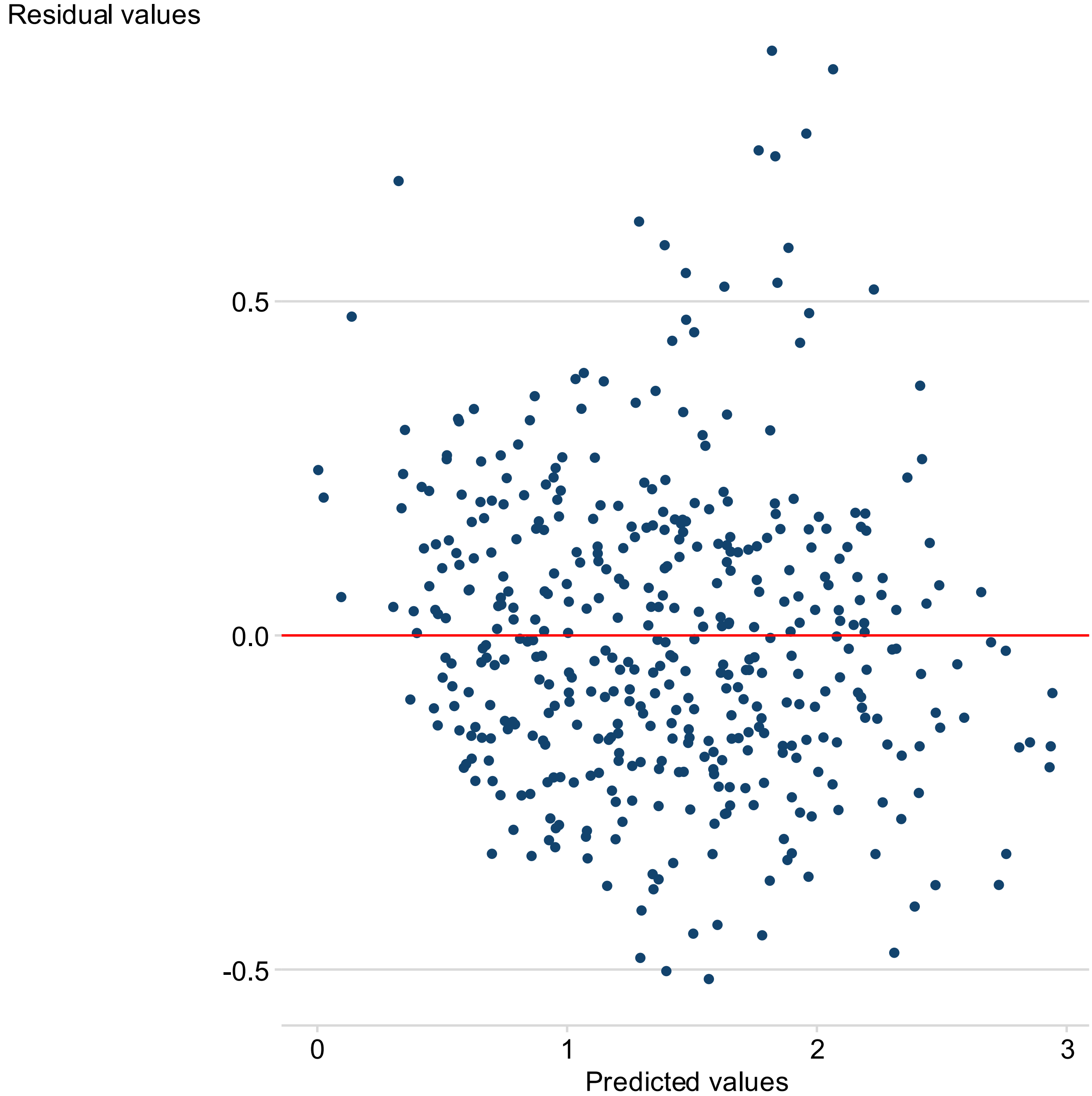
Predicted compared to actual values of monthly regional average spill counts: figure 7 compares predicted values against actual values, with the red diagonal representing perfect agreement. Points are closely clustered around the line, indicating that the model provides a good fit and accurately predicts the response variable. Minor deviations from the line suggest some residual error, but no strong systematic bias is evident.

Figure 7: scatter plot of predicted against actual values of monthly regional average spill count (square root transformed)



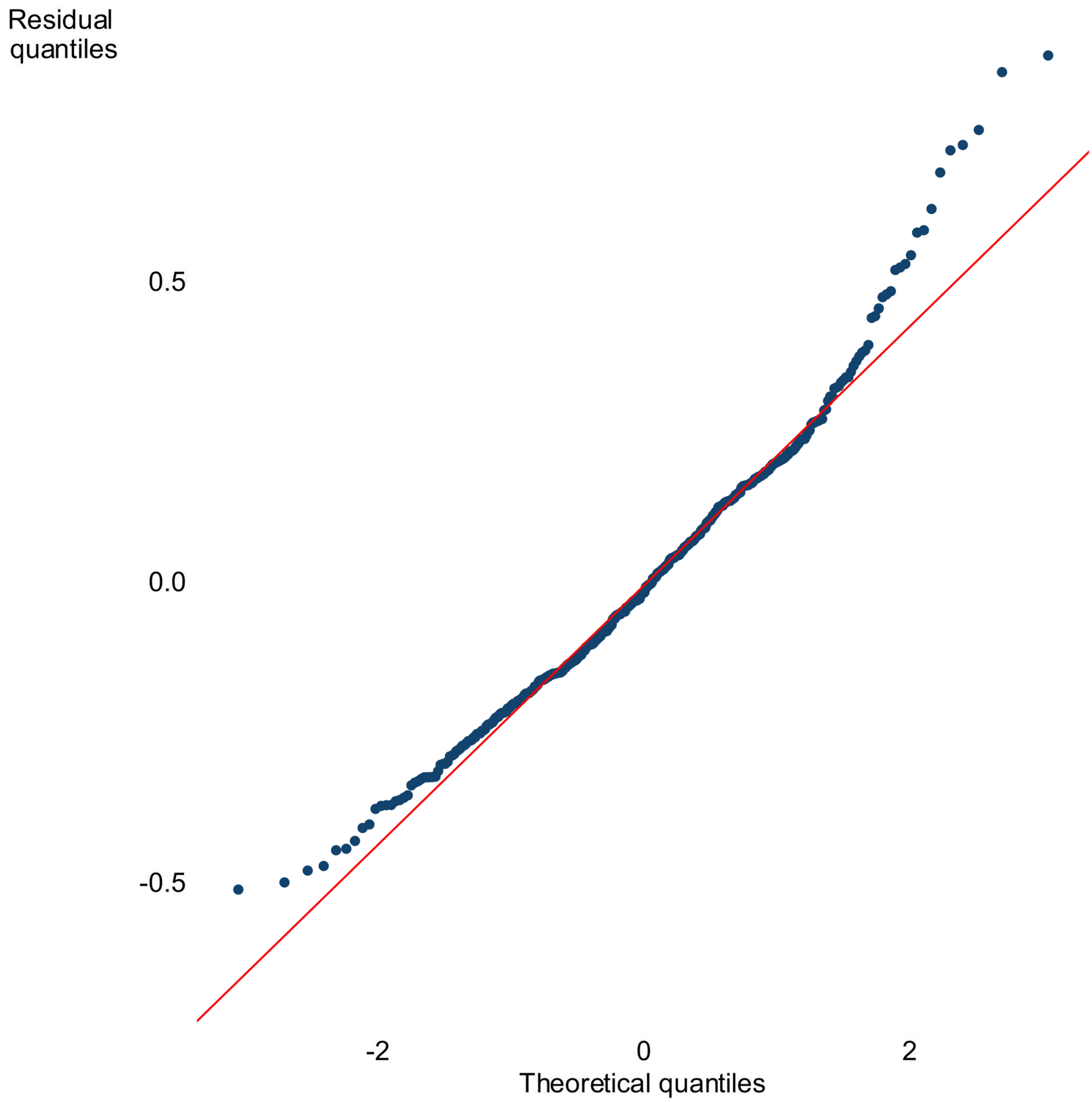
Independence of residuals: figure 8 shows the plot of the residual values against predicted values. The residuals are randomly scattered around the horizontal line at zero and the spread of residuals appears constant. This indicates that the model does not suffer from obvious non-linearity or heteroscedasticity, and that the residuals are approximately independent of the fitted values. However, the increasing spread at higher predicted values suggests mild heteroscedasticity and the presence of potential outliers. Overall, the model appears adequate for identifying general trends and estimating effects, but caution should be exercised when interpreting predictions for extreme values.

Figure 8: scatter plot of residual values against predicted values of spill count (square root transformed)



Normality of residuals: the Q-Q plot in figure 9 compares the distribution of model residuals to a theoretical normal distribution. Most points lie close to the diagonal reference line, indicating that the residuals are approximately normally distributed. Deviations at the tails suggest minor departures from normality, but overall, the assumption of normality appears reasonable for the model.

Figure: 9: QQ plot showing that the residuals are close to the normal distribution, with deviation at the tails



The skew of the residuals is 0.49 and the kurtosis is 1.31, showing that the distribution deviates from the normal distribution at the tails.

ACF of residuals: an autocorrelation function (ACF) plot of model residuals indicated some correlation. This suggested that there was a seasonality effect which was not fully captured by the model. However, this effect decreases in later months.

Multicollinearity: a variance inflation factor (VIF) measures the overlap between two or more variables. Predictor variables used in the model had VIFs ranging from 1.01 to 2.02 which indicates they are relatively independent of each other. This implies that the predictors are not highly correlated and that variance in the regression coefficients would not be significantly inflated due to multicollinearity. As well as this, changes in the model did not produce large or erratic changes in the coefficients of the predictor variables. These tests suggest that the regression coefficients can be interpreted reliably.

Sensitivity analysis: a sensitivity analysis showed that data points from one region were having a larger influence on the model. The model was rerun with datapoints from that region excluded. This model produced broadly similar results and had an R squared score of 89.1%, or 92.6% with regional grouping. In this model with the influential region removed, the coefficient for year was 0.03 with a p-value of less than 0.001. meaning that the annual improvement was both larger and more statistically significant, showing that our overall result is robust to outliers in the data.

Model limitations

Aggregating spill data to the company level offers a useful summary but makes the analysis susceptible to ecological fallacy, as it assumes all overflows respond similarly to rainfall. This assumption can mask important differences in sensitivity, particularly given that some overflows consistently exhibit very high or very low spill counts.

There are only 4 years of data available which limits insight into annual trends.

In a previous model iteration, the September to August year was treated as a categorical variable. While the reduction in spill count given rainfall and seasonality generally showed a downward trend, the fluctuations suggest that some of the observed improvement may reflect random variation rather than a consistent underlying effect. Although the results from our final model are encouraging, the uncertainty from this iteration of the model should be acknowledged. Greater confidence in the trend will be possible as more data becomes available.

There are seasonal factors which influence the average spill count per overflow at a regional level which are not fully captured in the model but are currently captured in the ‘month’ variable. These include, but are not limited to:

- the amount of impermeable area (for example roads or roofs) which is not drained separately and so rainwater enters the combined sewer in the network
- the extent to which the ground is waterlogged and so rainfall will not percolate into the ground
- the amount of water that is already held in the network, in other words storage capacity already being utilised and the network’s hydraulic capacity not draining entirely

There are also other factors (non-seasonal) which are not included in the modelling which may influence the average spill count per overflow. These include, but are not limited to sewerage network capacity, and sewer blockages.

Diagnostic testing shows that some extreme values are not predicted well by the model, possibly due to a breakdown in the linear relationship or due to not all factors not being fully captured.

Some influential observations were identified in the model, primarily associated with a specific region. Sensitivity analyses were conducted by excluding these observations, and the year coefficient remained statistically significant. This suggests that the overall trend is robust, despite the presence of influential values.

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