Groundwater Impacted System Management Plan

Markyate, River Ver

September 2021

Version control

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Annual Update 2023	October 2023	Addition of Annual Update 2023	MB	DJ	DJ
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Introduction

This document sets out Thames Water's approach to the management of groundwater infiltration in sewerage systems where the influence of groundwater infiltration is viewed as being significant and likely to lead the sewerage network, on occasions, becoming overwhelmed.

All sewerage systems combined and separate will experience some groundwater infiltration[1] and a nominal allowance in design will be made for this. However, in some catchments the impact of groundwater infiltration can be considerable leading to impacts on service during periods of high groundwater, typically during the winter.

Groundwater can enter the sewerage system through the pipes and manholes, this may occur at a defect (crack, hole, displaced joint) or on a normal joint on the sewer or in the manhole. A key point to note is that where infiltration occurs it is not necessarily an indicator that the sewer is in poor structural state simply that jointing techniques used are not completely watertight.

Ingress of groundwater is not limited to the public system that Thames Water owns and maintains but potentially the private drains, manholes and sewers that connect to our system.

Preventing and reducing the impact of groundwater infiltration is predominately achieved through the lining of sewers and sealing of manholes. This entails the application of a synthetic liner within the pipe that creates a contiguous membrane for the length of the pipe or possibly section if the source of ingress can be narrowed down. For manholes it will typically entail sealing in a similar manner.

To line all sewers and manholes within most catchments would be prohibitively expensive to do so. Our approach to date has been centred on a 'find and fix' basis which has involved monitoring and investigating the networks in periods of high groundwater to identify sources of ingress and fix as we find them. This approach is constrained for the reason that investigations are typically limited to periods of high groundwater and when high groundwater occurs there are limited windows of time in which investigations can be successfully undertaken before flows either subside or the system is fully surcharged meaning CCTV surveys are not possible[2]. Once sections of sewers have been lined, it will be a case of waiting until high groundwater levels reoccur to assess the effectiveness of the work undertaken, which may not be the subsequent winter but several years later.

It is recognised that the 'find and fix' approach to date lacks a degree of certainty of resolution and for this reason Thames Water in 2020 undertook a different approach for the medium to long-term management of groundwater, which is covered within this

[1] Sewers for Adoption makes an allowance for 10% of peak wastewater flow to allow for unaccounted flows such as groundwater infiltration.

[2] On occasions it is possible to over-pump between manholes to isolate sections of sewer to survey, this is not always feasible when the flows involved are simply too great to over-pump or the location prohibits this approach.

document under the plan section. These plans require significant investment which Thames Water will seek to secure through the price review process as ser- vice enhancement. In the meantime, we will continue to investigate sources of in- filtration when it occurs and where feasible, undertake the work through our capital maintenance budgets. We refer to these as ‘quick win’ opportunities i.e. where we have high degree of certainty of reducing point sources of infiltration and can do so with reasonable costs and time.

The structure of this document has been created with input from the Environment Agency. Sections covered in this document include our ‘Outline Plan’ with timescales, Mitigation i.e. how we intend to manage the risk until our plan is fully implemented and when we will publish future updates on progress against this plan.

Brief description of Markyate catchment

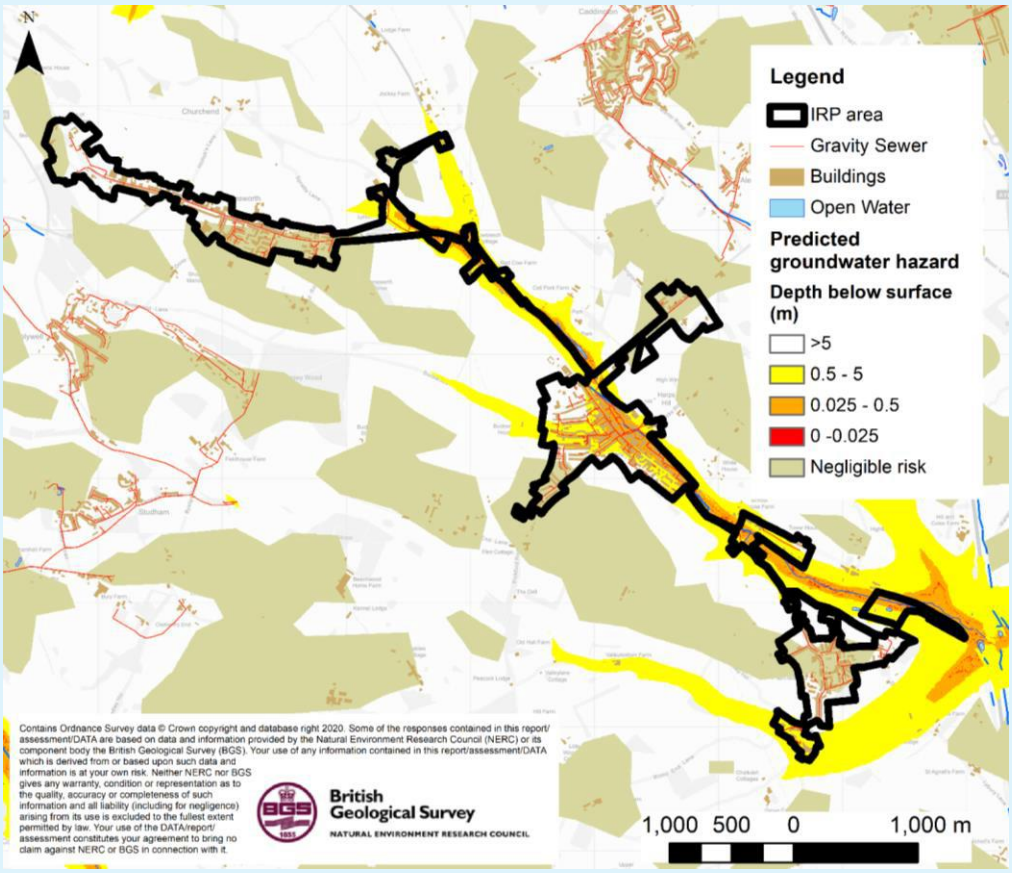

Figure 1.0 – Markyate catchment

Markyate is located in north-west Hertfordshire, England, approximately 3 miles south- west of Luton. Markyate serves a population equivalent[3] of 6,548 with a partially separate sewerage network totaling some 46 km in length excluding private drains and sewers. The extent of the catchment is shown in Figure 1.0 above.

Problem Characterisation

Groundwater has the potential to enter our sewers when levels are high and a positive head above the soffit of the sewer is created. Significant groundwater ingress can im- pact sewer capacity and increase the risk of the sewerage system becoming overwhelmed. There's a strong link between the rising river levels related to rising ground- water levels and the increased flows seen within the sewerage network and at the Sewage Treatment Works.

[3] Population equivalent based one unit per capita loading, (PE), in waste-water treatment is the number expressing the ratio of the sum of the pollution load produced during 24 hours by industrial facilities and services to the individual pollution load in household sewage produced by one person in the same time.

The sewerage system is identified on the public sewer records as being a partially separate foul system, rather than a combined system. We believe that significant volumes of surface water runoff from surrounding saturated fields and built-up land have entered the foul sewerage network during recent wet winters, causing the network to become overloaded and surcharged (mainly through submerge manholes).

It is believed that unwanted flow into the foul sewer network is occurring when groundwater levels are high, and surface water inundation from highways, public spaces and properties and fluvial flooding from local watercourses. Surface water misconnections (i.e. down pipes from roofs into the sewer network) are also suspected to be a contributing factor, hence further analysis is required to determine the extent to which this has contributed to sewer flooding.

A number of our sewerage systems include for overflows, these structures are there to protect against sewer flooding as a result of rainfall or equipment failure where appropriate. Discharges from these structures should not be impacted by excessive infiltration. The use of storm sewage overflows is accepted by our regulators, subject to conditions.

We believe it is likely that unwanted flow in the Markyate catchment is the most probable cause of incidents of surchar- ging and where the sewage treatment works has not been able to cope with all incoming flows, triggering problems to homes and at the STW. The root causes of sewer surcharges require all stake-holders responsible for drainage in the catchment to resolve them together.

Our permit conditions for Markyate STW state: *"The discharge shall only occur when and only for as long as the flow passed forward is equal to or greater than the overflow setting indicated due to rainfall and/or snow melt."* and *"Off-line storm storage must be fully utilised before a discharge occurs. It shall only fill when the flow passed forward is equal to or greater than the overflow setting indicated due to rainfall and/or snow melt and shall be emptied and its con- tents returned to the continuation flow as soon as reasonably practicable."*

The Flood and Water Management Act 2010 places a responsibility on Lead Local Flood Authorities (LLFAs), to manage flood risk from surface and groundwater, plus a duty on all Risk Management Authorities (RMAs), to cooperate regarding flood risk. In our role as an RMA, Thames Water will work with Dacorum Borough Council as Lower Tier 1, and both Hertfordshire County Council and Central Bedfordshire Council as Lead Local Flood Authorities, Council and Planning Authorities, and the Environment Agency to ensure that a collaborative approach can be developed to address the problems.

Thames Water also has a statutory obligation to comply with environmental legislation. The Water Framework Directive establishes a strategic approach to managing the water environment, which the Environment Agency achieves through River Basin Management Plans and setting environmental objectives for groundwater and surface water. The environment is also protected from adverse effects of discharges of urban wastewater through the Urban Wastewater Treatment Directive, which

requires us to improve and extend the sewerage system according to section 94 of the Water Industry Act (1991).

Anticipated unavoidable discharges

Within recent years there have been unavoidable sewage escapes in the network as a result of surcharging manholes causing pollution.

We anticipate that this situation may continue until such time we are able to implement a long-term solution.

No mitigation in the form of temporary overflows has been undertaken in this system.

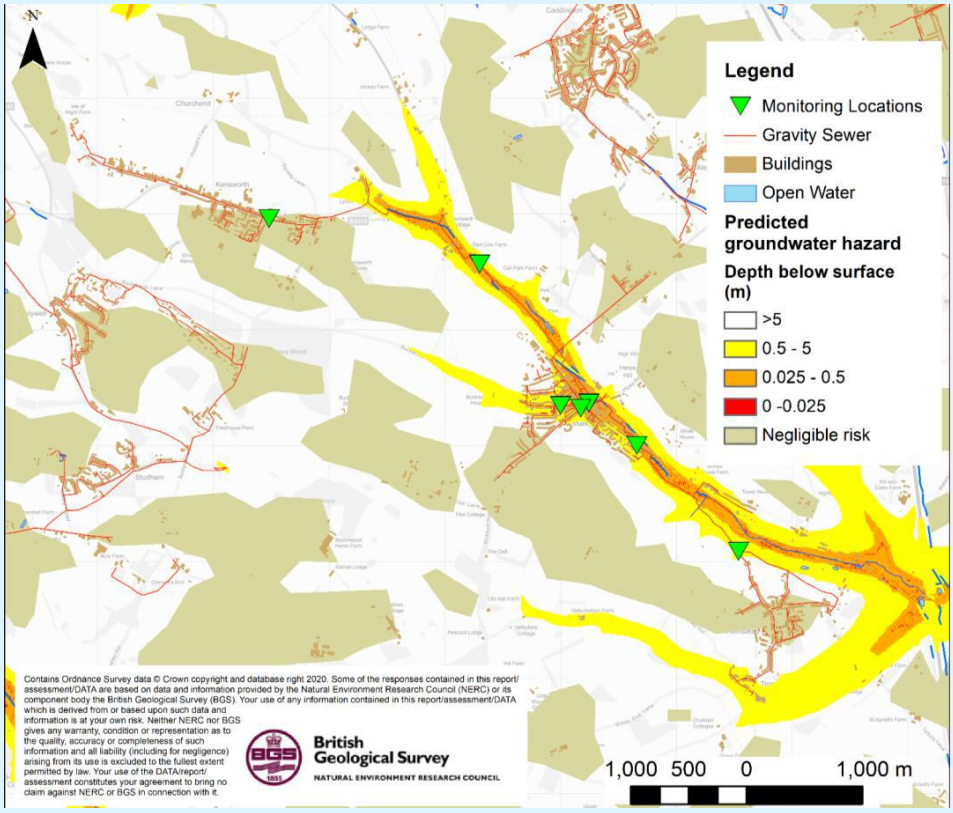

Figure 2.0 – Markyate monitoring area and infiltration zones

Key to bringing the impact of groundwater infiltration under control is an enhanced monitoring regime. Figure 2.0 presents the current monitoring installation locations.

Complimenting the flow [at the treatment works] and depth measurement [in the sewer network] we will use pumping station run time data, rainfall data, river level data, and groundwater level data to create a full picture of movement and source of flows around the catchment.

Zones of Groundwater Risk

We engaged with JBA Consulting to develop plans for Markyate that identify zones of groundwater risk, see Figure 2.0. These zones are modelled areas where the groundwater has been determined to be above the sewer and hence pose a potential risk for groundwater ingress.

The sewer depth monitors referred to earlier have been sited in and around these zones to verify and calibrate the risk in each of the zones.

If following the proposal to the sealing in part or wholly[4] of the high risk zones, should it be required, the system is found to be still experiencing excessive infiltration we would then look to potentially seal 'private' laterals and/or drains along with starting to seal the medium to low risk zones.

This document sets out an unconstrained approach to resolving the impact of groundwater infiltration within the system.

Investment to address infiltration will be assessed and prioritised against other drivers e.g., STW upgrades, both in the catchment and across the region at each price review.

With this plan we remain committed to minimising the impact of groundwater on the sewerage system in Markyate.

Our general medium to long term plan is therefore to apply a hierarchy to sealing the sewer as follows:

Activity	When	Description
Model Zones	2020/21	JBA have been engaged to undertake modelling activities to identify the areas (zones) to be targeted for sealing in the 56 systems identified as being impacted by infiltration in the Thames Water region.
Monitoring	2021-2023 (complete)	Monitoring has been installed. Each year completeness / coverage monitors will be reviewed and added to / or modified as necessary.
Calibrate zones	Refined each year	Following each winter, we intend to review the data from the monitors and if necessary, redefine the zones.
Look & Lift	Each winter	The look & lift surveys have two purposes, firstly to compliment the monitoring and secondly to identify 'quick fixes' that we would address through our normal capital maintenance.
CCTV	2020-2023 (ongoing)	Required to confirm sewer condition and provide information to assist with costing any sewer lining.

[4] Decision of extent of sealing will be based on outcomes of works undertaken, results of monitoring and successful submission of our plans for future investment

Activity	When	Description
Minor works	2020-2023	As mentioned, if we detect minor works being required, we will look to resolve these as and when we find them.
PR24	2023/24	Ideally through monitoring and on-going investigations work towards managing the infiltration risk, in AMP7, will be successful. However, in the absence of evidence justifying the need not to undertake sealing of the high-risk zone this is to be included as part of PR24 investment plan. This work will be subject to Cost Benefit Analysis and Best Technical Knowledge Not Entailing Excessive Cost (BTKNEEC assessments).
High risk zone sealing	2025-30	Sealing of high-risk zone undertaken subject to need being demonstrated.

Markyate Infiltration Management Plan

As detailed above the impact of infiltration is experienced in the network and at the STW.

Our approach to the resolution of

infiltration impacting the Markyate sewerage system is outlined below.

High level approach statement

For Markyate our approach to tackling infiltration will be undertaken as follows:

1. We will investigate the network with a view to identifying sources of ingress of infiltration that are cost effective[5] to address. To investigate the network, we have:

- Undertaken a desktop analysis to determine infiltration high to low risk zones (October 2020);
- Use installed monitoring to back up the analysis and to aide focusing of locations for identification of infiltration (2020 to 2023). Each year we will assess the completeness of monitoring and if required add to or modify the current locations.

To investigate the network, we will:

- Undertaken sample CCTV in the high to low risk zones to assess the general asset health of the sewers and manholes (ongoing).

We will also review results of Winter 2019/20 and 2020/21 with historic data to build up evidence to support interventions in the network (Autumn).

2. Where interventions can be undertaken as part of normal sewer maintenance activities these will be communicated and progressed.

3. If significant investment is identified as being required, then this will need to be considered in terms of relative

need compared to other systems being investigated for infiltration reduction. However, where viable opportunities are identified these will be included in our AMP9 (2030-35) programme of investment. Significant investment needs may need to be included in future investment cycles.

[5] Assessment of cost effectiveness is based on assessment of the ratio of the cost of a solution to the monetised benefit gained from implementing the solution i.e. reduction in flood/pollution risk and/or reduced operating costs.

Investigations

As mentioned above JBA Consulting have been supporting by undertaking an exercise involving assessing groundwater elevation data to determine which areas of the network are potentially below the groundwater table during high groundwater periods.

Site investigations, undertaken by Dene- Tech and our Customer Field Services (Thames Water Operations) have included 'look & lift' surveys, CCTV and where necessary dye tracing to confirm connectivity.

A table of the work undertaken is included in the appendix to this report.

Monitoring

Sewer Depth Monitors have been installed in the catchment. These devices are telemetered and provide real time data on the level of flow in the sewer.

The purpose of these units is to act as alerts for high groundwater impact in the sewer, calibration of the zones of infiltration risk and to demonstrate benefit gained from work undertaken to reduce infiltration. They will also provide evidence in the future of further need to manage the impact of infiltration.

Mitigation

On occasions to avoid flooding of properties or to manage the risk of damage to the environment we may undertake tankering from (manholes) points on the network, make use of pumps to manage flows or deploy settlement tanks to part treat sewage before release to the environment.

With regard to Markyate we do not envisage needing to undertake mitigation work within the network.

Updates

Work on the Groundwater infiltration management plan will continue, and we will aim to provide updates annually by the end of October each year.

Appendix

Groundwater infiltration potential analysis

The sewer network classified by the groundwater infiltration risk zones. The lengths of sewers within these zones are presented in the table below.

Risk category	Description	Length (km)	Percentage
High	Predicted groundwater extreme >1m above pipe invert	5.12	23.2
Medium	Predicted groundwater extreme 0-1m above pipe invert	1.57	7.1
Low	Predicted groundwater extreme 0-1m below pipe invert	1.98	8.9
Very Low	Predicted groundwater extreme >1m below pipe invert	13.46	60.8
Total		22.13[6]	100

In addition, the table below presents the surface water flood risk classification for manholes within the catchment.

Manholes by Surface Water Inundation Risk Category

Risk category	Description	Number	Percentage
High	Inundation risk in 3.3% AEP fluvial or pluvial event	96	17.1
Medium	Inundation risk in 1% AEP fluvial or pluvial event	29	5.2
Low	Inundation risk in 0.1% AEP fluvial or pluvial event	58	10.3
Very Low	All other manholes	380	67.5
Total		563	100

[6] Total of sewer length is for length of mapped sewers only and will not include unmapped S105a transferred sewers in all cases.

Investigations & remedial work undertaken since 2019/20 and future plans

At the time of writing we are currently on-site undertaking lift and look and CCTV surveys in the Markyate system. A summary of findings will be provided in the next update of this report.

Glossary of terms

AEP – Annual Exceedance Potential

AMP – Asset Management Plan

CCTV – Closed Circuit Television

EA - Environment Agency

IRP – Infiltration Reduction Plans

MH – Manhole

STW – Sewage Treatment Works

WINEP – Water Industry National Environment Programme

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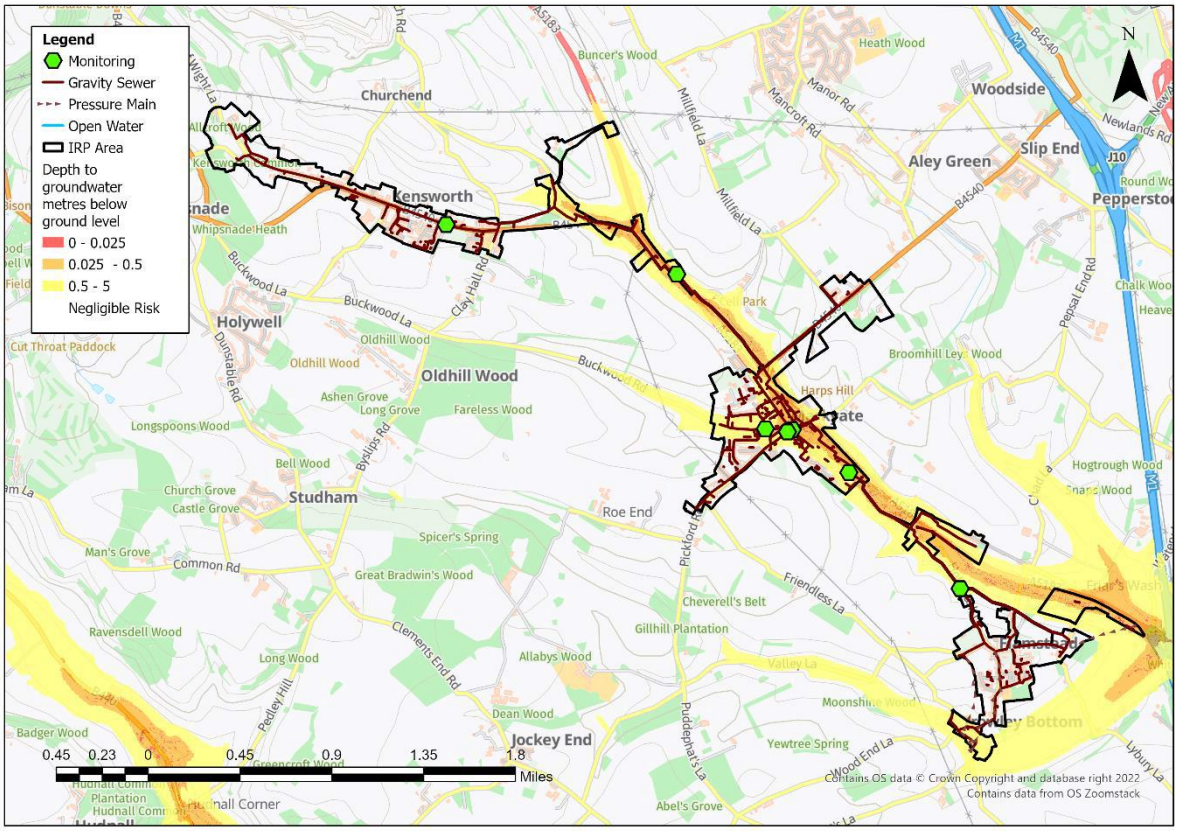
Overview

This addendum to the Markyate Groundwater Impacted System Management Plan 2021 (GISMP) provides an update on performance/work undertaken in the Hydrological Year October 2021 to September 2022. The key points covered include:

- Hydrological conditions
- How the sewerage system has performed over this period
- Mitigation / remedial measures progressed over the last year and being planned
- Summary and plan for 2022/23

Figure 1 – Markyate Monitoring Plan



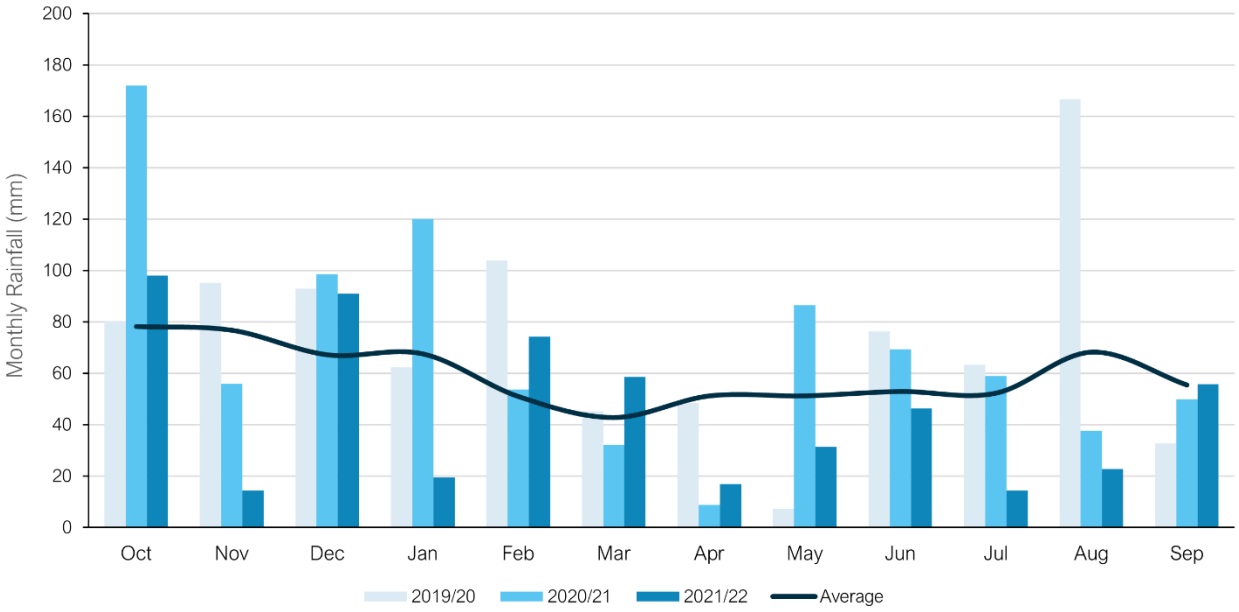
Hydrological Review – 2021-2022

This section summarises the hydrological conditions within the Markyate catchment within the period under investigation and provides comparison against previous year's performance to put the annual performance into context. The hydrological review has been undertaken based on the Hydrological Year which runs October 1st to September 30th.

Catchment Rainfall

Representative Radar rainfall has been used to generate monthly data at catchment level for comparison with average data generated by local Met Office Weather Station Records. Figure 2 presents the comparison of this data for the last three hydrological years to support longer term trends within the local system.

Figure 2 – Monthly Rainfall Performance



Average Values taken from Met Office Weather Station at Rothamsted based on the period 1991-2020

The total rainfall for the 2021/22 hydrological year is 23% below the annual average total. Total rainfall values are presented in Table 3 below.

Table 3 –Total Rainfall Based on Hydrological Year

Average (mm)	2019/20 (mm)	2020/21 (mm)	2021/22 (mm)
715	874	844	552

Groundwater / Local River Level

The Markyate catchment is situated in the Chilterns East – Colne water resources area. It sits in the Holywell Nodular Chalk Formation and New Pit Chalk Formation as well as the Lewes Nodular Chalk Formation and Seaford Chalk Formation. These are designated principal aquifers within the UK.

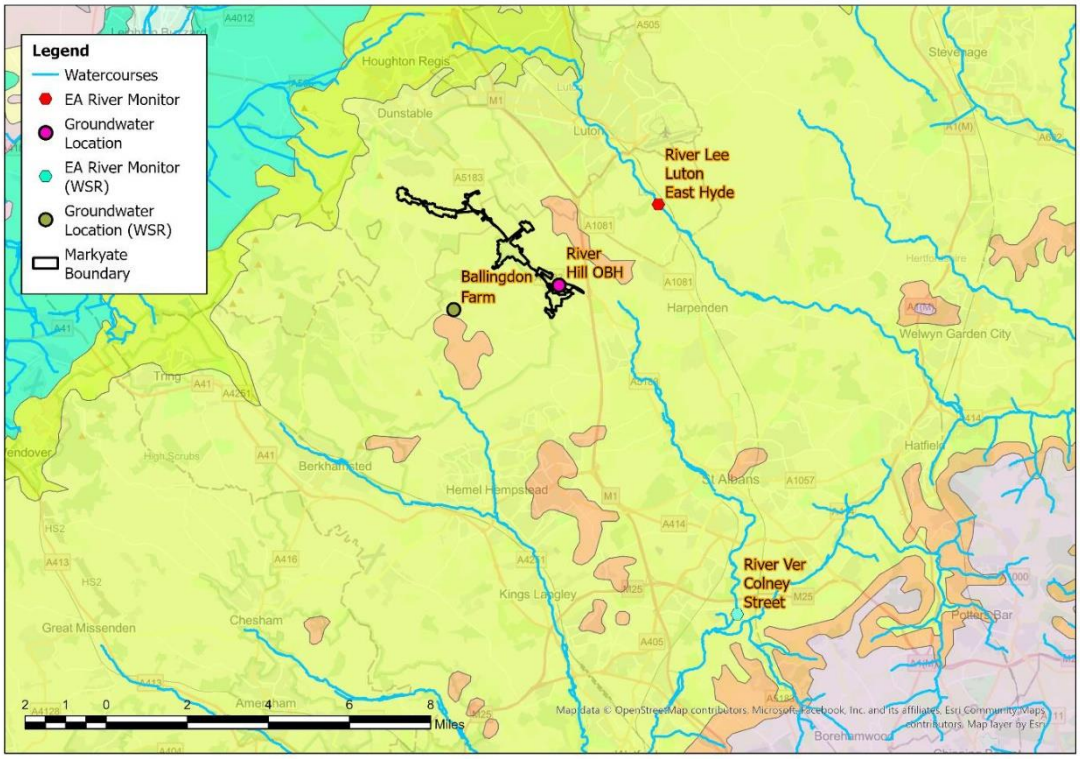
The Environment Agency has gauging stations on local watercourses measuring stage and observation boreholes measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

From previous investigations we have identified the following sites are good indicators of groundwater levels within the catchment.

- River Hill OBH.
- River Lee, Luton East Hyde.

These sites are illustrated in the figure below, alongside the closest groundwater reference station and closest gauging station from the Water Situation Report.

Figure 4 – Local Monitoring Stations



The following figures represent the last three hydrological years of level information at the indicator sites to build a picture of the relative conditions prevalent in the current year. It is presented against both the daily total rainfall values for the catchment and a rolling 15 day total rainfall.

Figure 5A – River Hill OBH

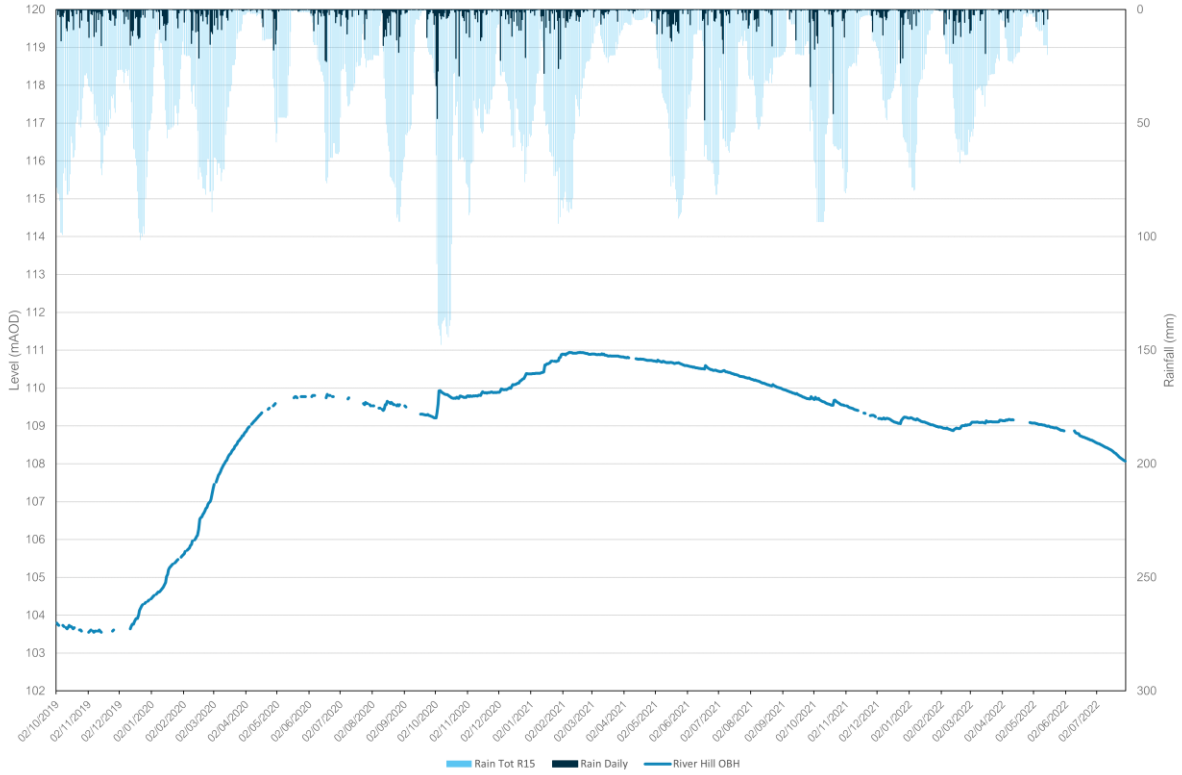
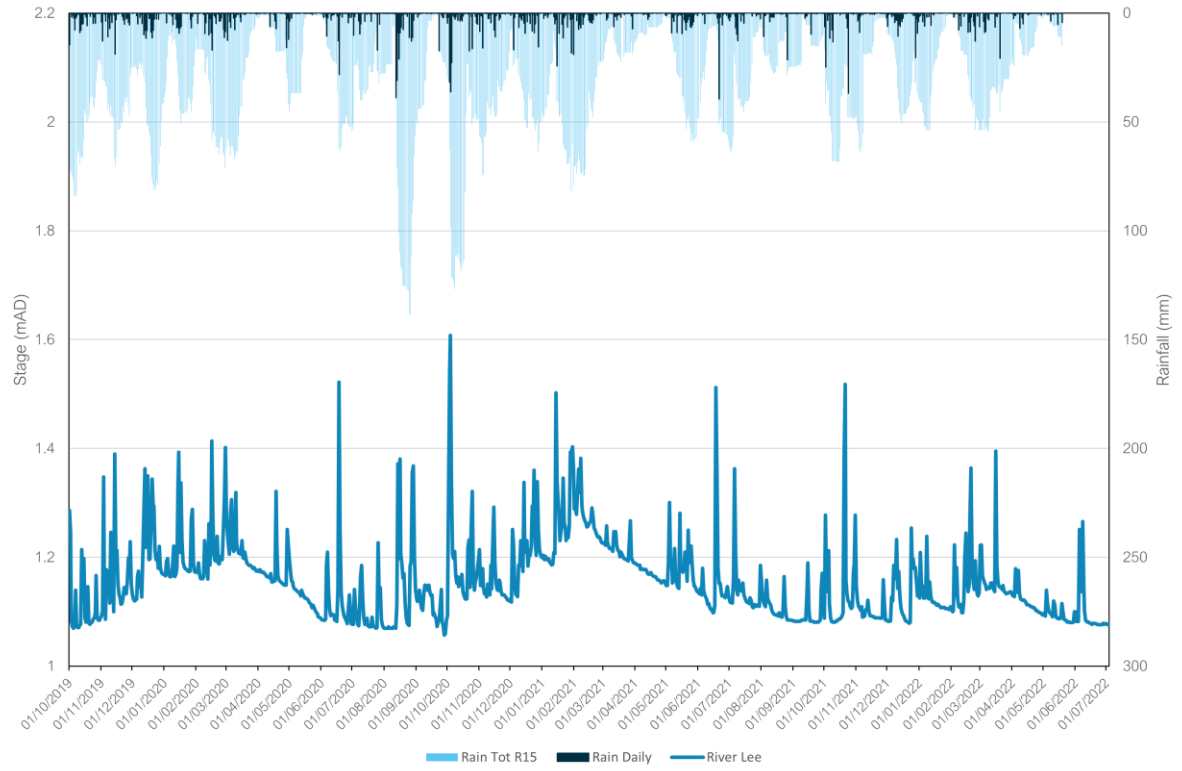
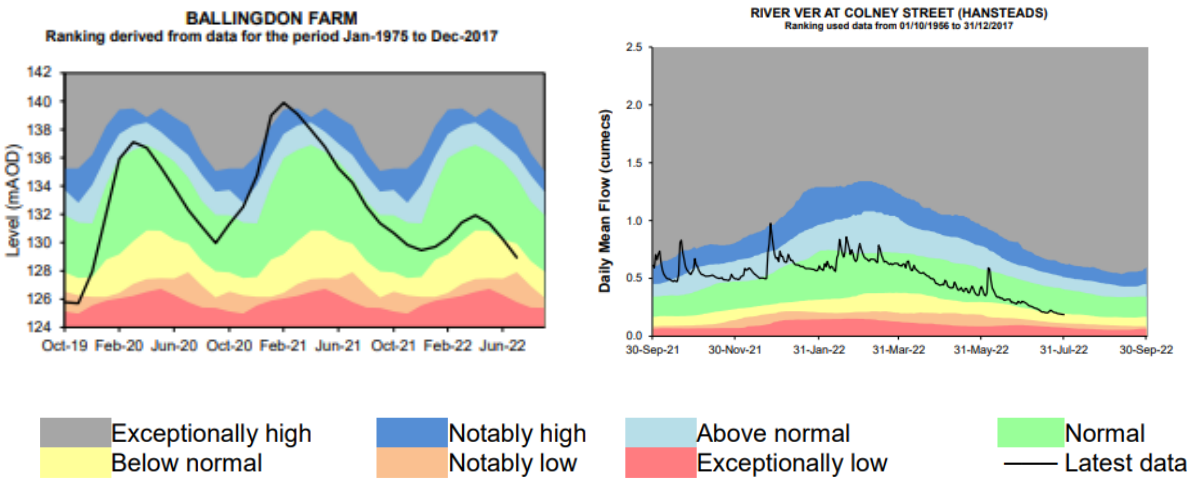


Figure 5B – River Lee, Luton East Hyde



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Chilterns East - Colne. The nearest groundwater reference station is Ballingdon Farm. This site shows significantly lower overall groundwater than the previous year. This can be seen in the figure below alongside the river indicator location at Colney Street on the River Ver.

Figure 6 – Water Situation Report



Extract from - [Water Situation Report (publishing.service.gov.uk)]

Network Performance

Within the Markyate catchment there is one site detailed within the Environment Agency Consents Database which has an Event Duration Monitor (EDM) fitted.

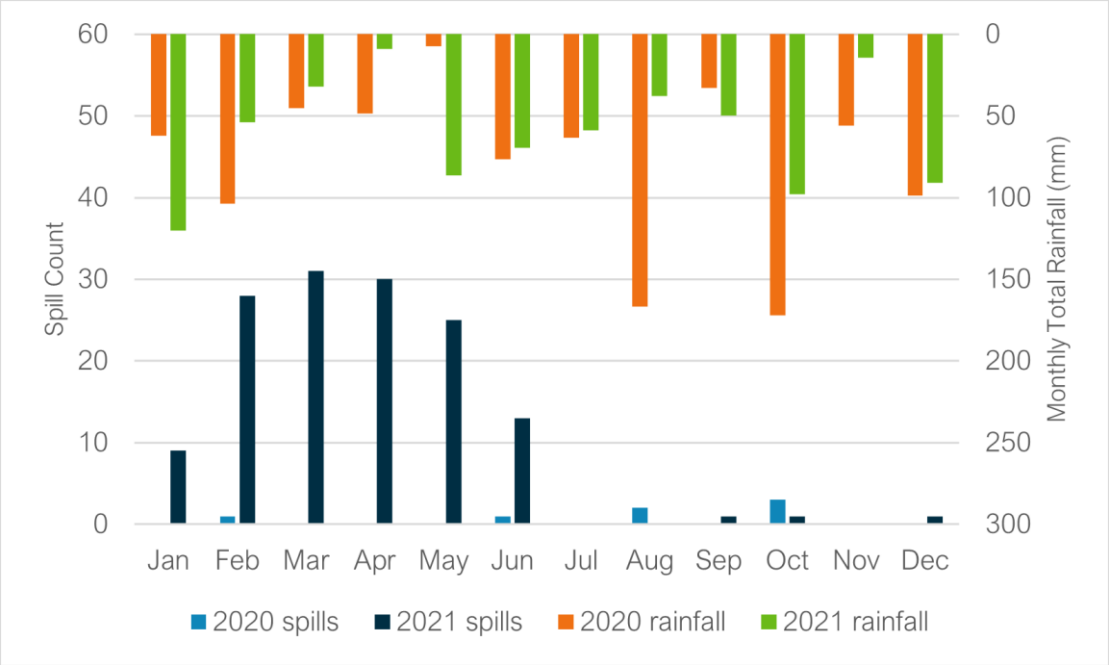
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

Overflow	2020		2021	
	Spills	Duration (hours)	Spills	Duration (hours)
Markyate STW	7	16.73	139	2641.63

A critical part of the assessment of EDM performance and its relation to groundwater inundation is to review the month-on-month spill performance, against previous years and the monthly total rainfall values to give context to the performance. Figure 8 below presents the EDM performance trend and rainfall for recent years. Note that in 2021, an asset maintenance issue was confirmed at the site which was resolved in June 2021. This accounts for the significantly higher number of EDM spills recorded in 2021 compared to 2020. In addition, the reported spill count of 7 in 2020 is higher than the published figure of 5. The EDM data has been re-validated and the revised figure of 7 will be included in the 2020 re-submission.

Figure 8 – EDM Monthly Performance



Due to the asset maintenance issues in 2021 significantly impacting the monthly spill counts, the EDM data for the site cannot currently be used to indicate a wider relationship between rainfall, elevated groundwater levels and spill frequency. The full 2022 data will be analysed when available to determine whether the EDM data is indicative of the impact of elevated groundwater levels.

Investigations & Interventions

This section details the activities that have been undertaken within the catchment within the Hydrological Year 2021-22.

Monitor Installations

The sewer depth monitor (SDM) programme supports long term groundwater understanding within GISMP catchments. Currently, there are a total of 7 monitors installed within the Markyate catchment. There are currently no further monitor installs planned.

The data from these will be cross-referenced with other long-term records (where available) within the catchment.

Remediation Works Undertaken this Hydrological Year

Table 9 below provides a summary of the investigations and remediation works undertaken or planned within the Markyate catchment in the 2021-22 Hydrological Year.

Table 9 – Works Undertaken in the 2021/22 Hydrological Year

Investigation/ remediation type	Number/ length undertaken
CCTV survey	N/A
Look and lift survey	N/A
Sewer lining	N/A
Patch lining	N/A
Manhole sealing	2 manholes
Manhole sealing plates	N/A
Manhole covers and frames replaced	N/A

With the seasonal trends in groundwater having been low in comparison with previous years and the SDM installations generally not showing significant groundwater presence, the larger scale survey, identification and remediation of the sewer system has not been possible within the 2021/2022 hydrological year.

Summary

Rainfall in the Markyate catchment over the 2021/22 hydrological year has been below average, with groundwater levels in the aquifer beneath Markyate not reaching the levels seen in previous years which triggered groundwater ingress into the sewerage network and elevated flow/depth readings at monitoring sites.

Lift and look and CCTV surveys will continue throughout the remaining wet winter periods with the aim of finding further priority locations for remediation and investigating/justifying the need for future larger scale lining as part of our Price Review (PR) process if required.

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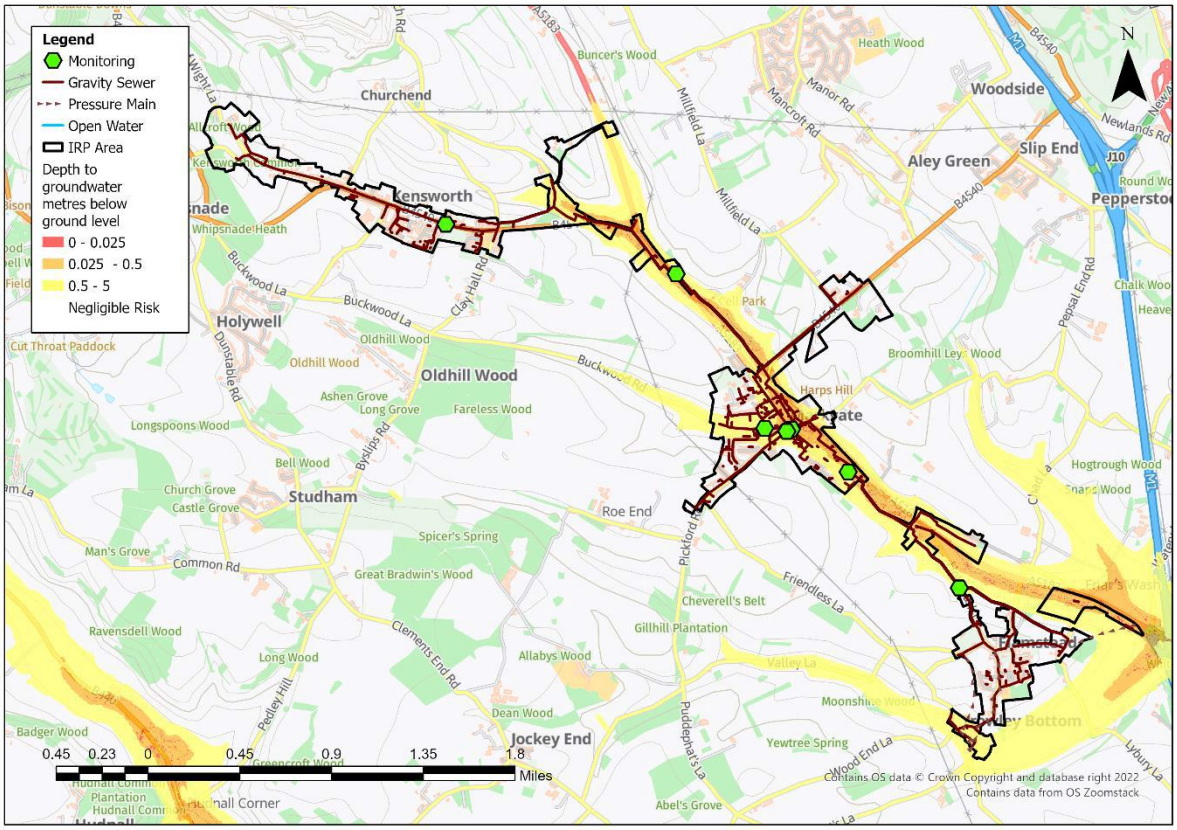

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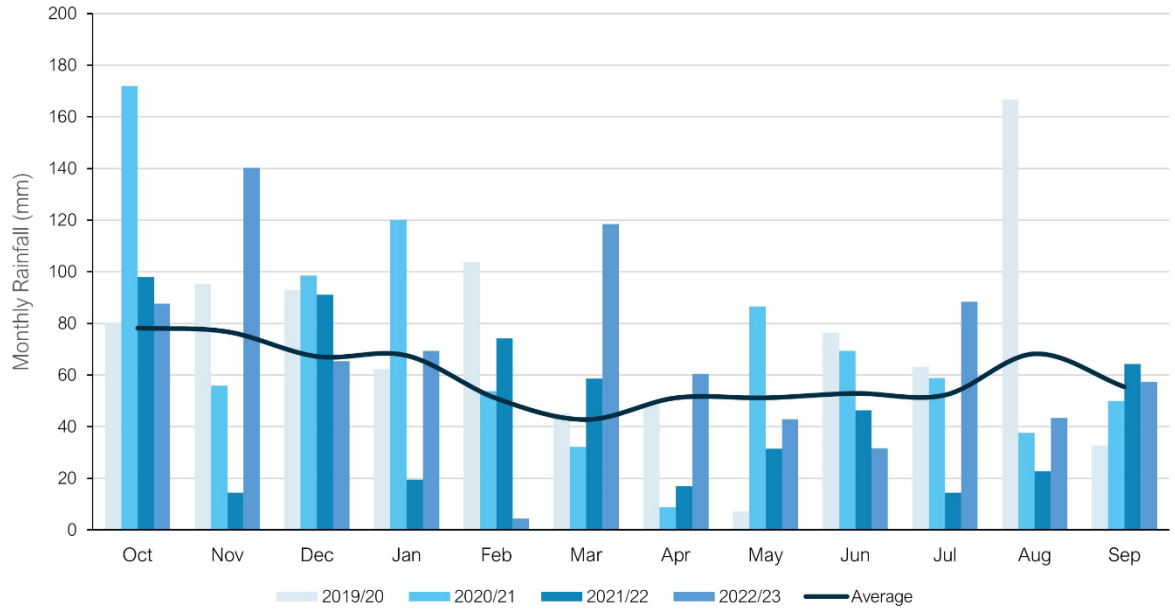

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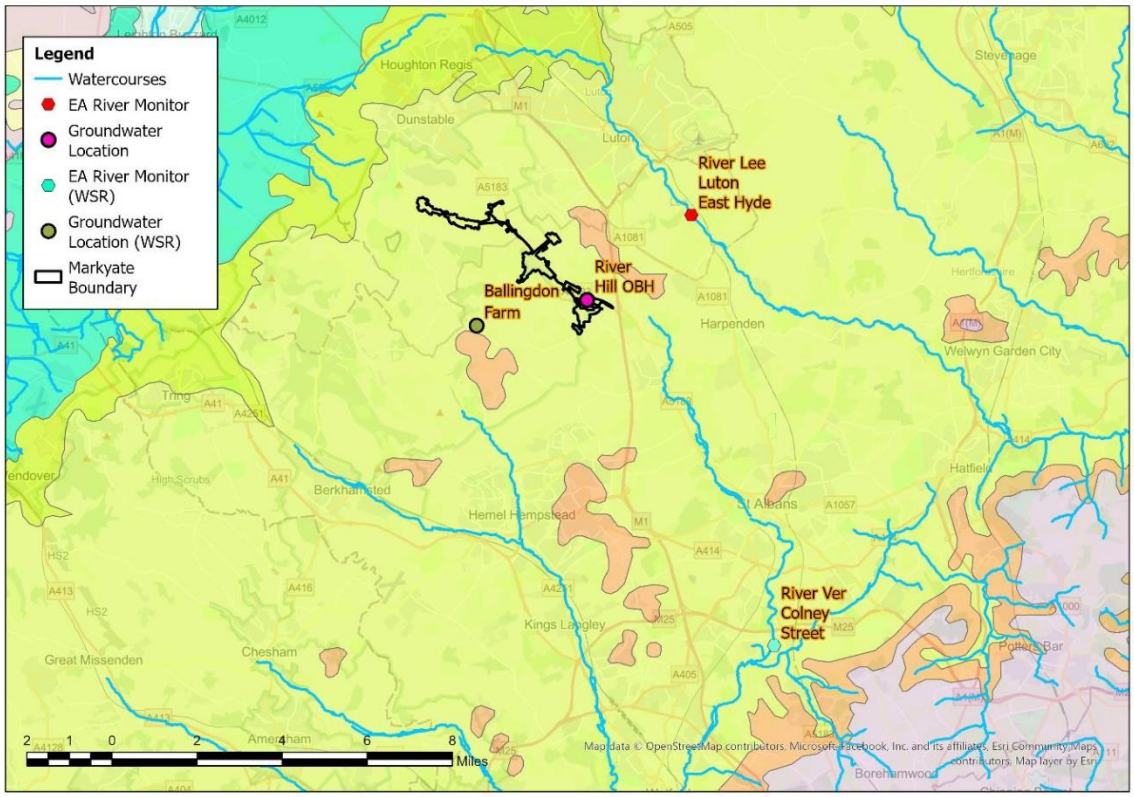

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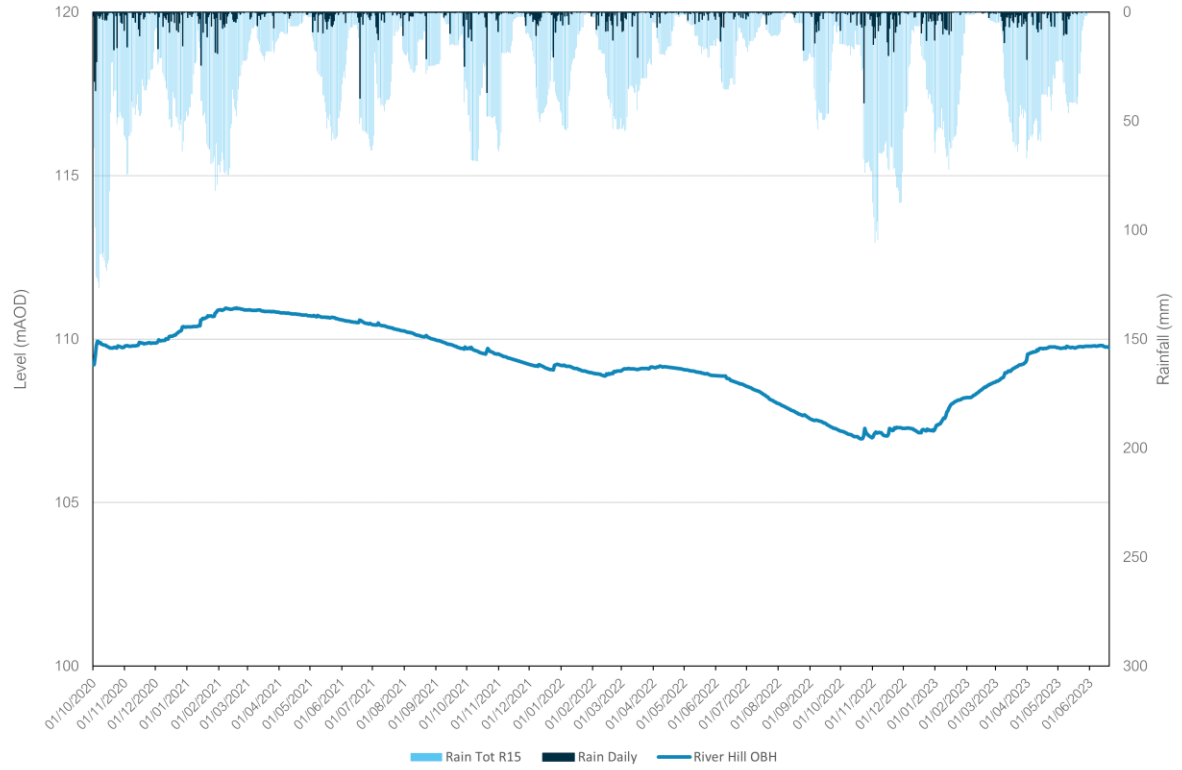
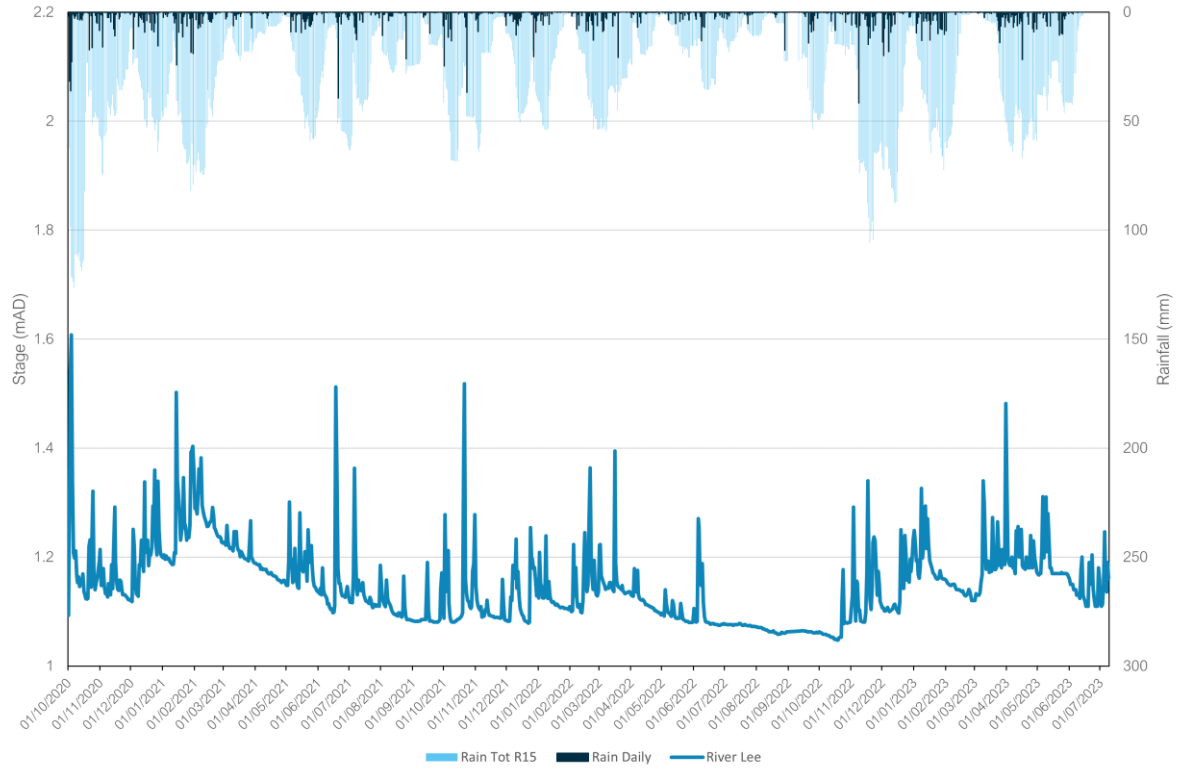


Figure 5B – River Lee, Luton East Hyde



Network Performance

Within the Markyate catchment there is one site detailed within the Environment Agency Consents Database which has an Event Duration Monitor (EDM) fitted.

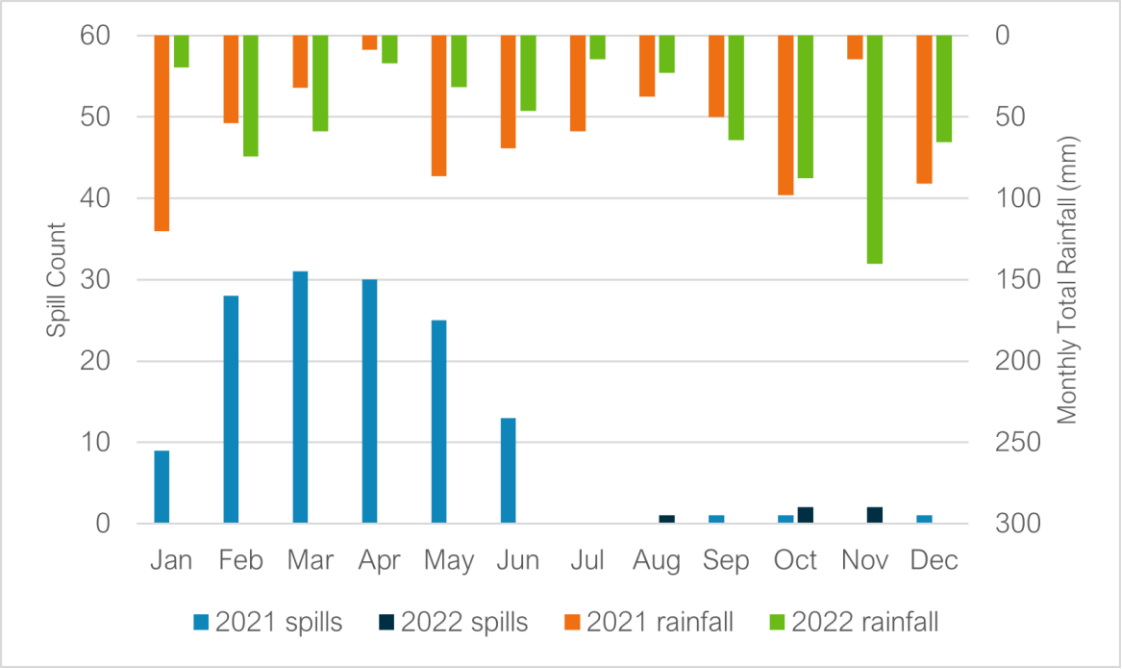
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

Overflow	2021		2022	
	Spills	Duration (hours)	Spills	Duration (hours)
Markyate STW	139	2641.63	5	9.06

A critical part of the assessment of EDM performance and its relation to groundwater infiltration is to review the month-on-month spill performance, against previous years and the monthly total rainfall values to give context to the performance. Figure 8 below presents the EDM performance trend and rainfall for recent years. Note that in 2021, an asset maintenance issue was confirmed at the site which was resolved in June 2021. This accounts for the significantly higher number of EDM spills recorded in 2021 compared to 2022.

Figure 8 – EDM Monthly Performance



Due to the asset maintenance issues in 2021 significantly impacting the monthly spill counts, EDM data for the site cannot currently be used to indicate a wider relationship between rainfall, elevated groundwater levels and spill frequency. Spill data for 2023, once available, will be compared to the 2022 spill data to help to understand the impact of elevated groundwater levels on overflow spills in the catchment.

Investigations & Interventions

This section details the activities that have been undertaken within the catchment within the Hydrological Year 2022-23.

Monitor Installations

The sewer depth monitor (SDM) programme supports long term groundwater understanding within GISMP catchments. Currently, there are a total of 7 monitors installed within the Markyate catchment. There are currently no further monitor installs planned.

The data from these will be cross-referenced with other long-term records (where available) within the catchment.

Remediation Works Undertaken this Hydrological Year

Table 9 below provides a summary of the investigations and remediation works undertaken or planned within the Markyate catchment in the 2022-23 Hydrological Year, as well as works undertaken in the 2021-22 Hydrological Year.

Table 9 – Works Undertaken in the 2022/23 Hydrological Year & in the 2021/22 Hydrological Year

Investigation/ remediation type	Number/ length undertaken 2021/22	Number/ length undertaken 2022/23
CCTV survey	N/A	N/A
Look and lift survey	N/A	N/A
Sewer lining	N/A	N/A
Patch lining	N/A	N/A
Manhole sealing	2 manholes	N/A
Manhole sealing plates	N/A	N/A
Manhole covers and frames replaced	N/A	N/A

No interventions/ investigations were undertaken in the catchment over the 2022/23 hydrological year. Based on indicator site data, groundwater levels in the catchment did not reach high threshold level (assigned as 110.50 mAOD at River Hill OBH), over the winter 2022/23 period, providing less opportunity for investigations to be carried out. However, the system will continue to be monitored and investigations/ interventions carried out as appropriate and when conditions allow.

An upgrade is also planned for Markyate STW. This will improve its ability to treat the volumes of incoming sewage, reducing the need for untreated discharges to the environment. The scheme is due to be completed in 2025.

Summary

Indicator site data suggests groundwater levels in the Markyate catchment were generally lower in 2022 than in 2021, however due to asset maintenance issues encountered at Markyate STW in 2021 which impacted overflow spills, the EDM data for 2021 cannot be compared to the EDM data for 2022 to help improve understanding of the relationship between groundwater levels and overflow spills in the catchment. This hydrological year (October 2022 – September 2023), groundwater levels in the catchment have reached higher levels than the previous hydrological year, and EDM data for 2023 will be analysed once available to continue to examine the relationship between groundwater levels and overflow spills in the catchment.

Lift and look and CCTV surveys will be undertaken in remaining wet winter periods if conditions allow. The aim of this is to find further priority locations for remediation and investigating/justifying the need for future larger scale lining as part of our Price Review (PR) process if required.

Addendum - Annual Update 2024

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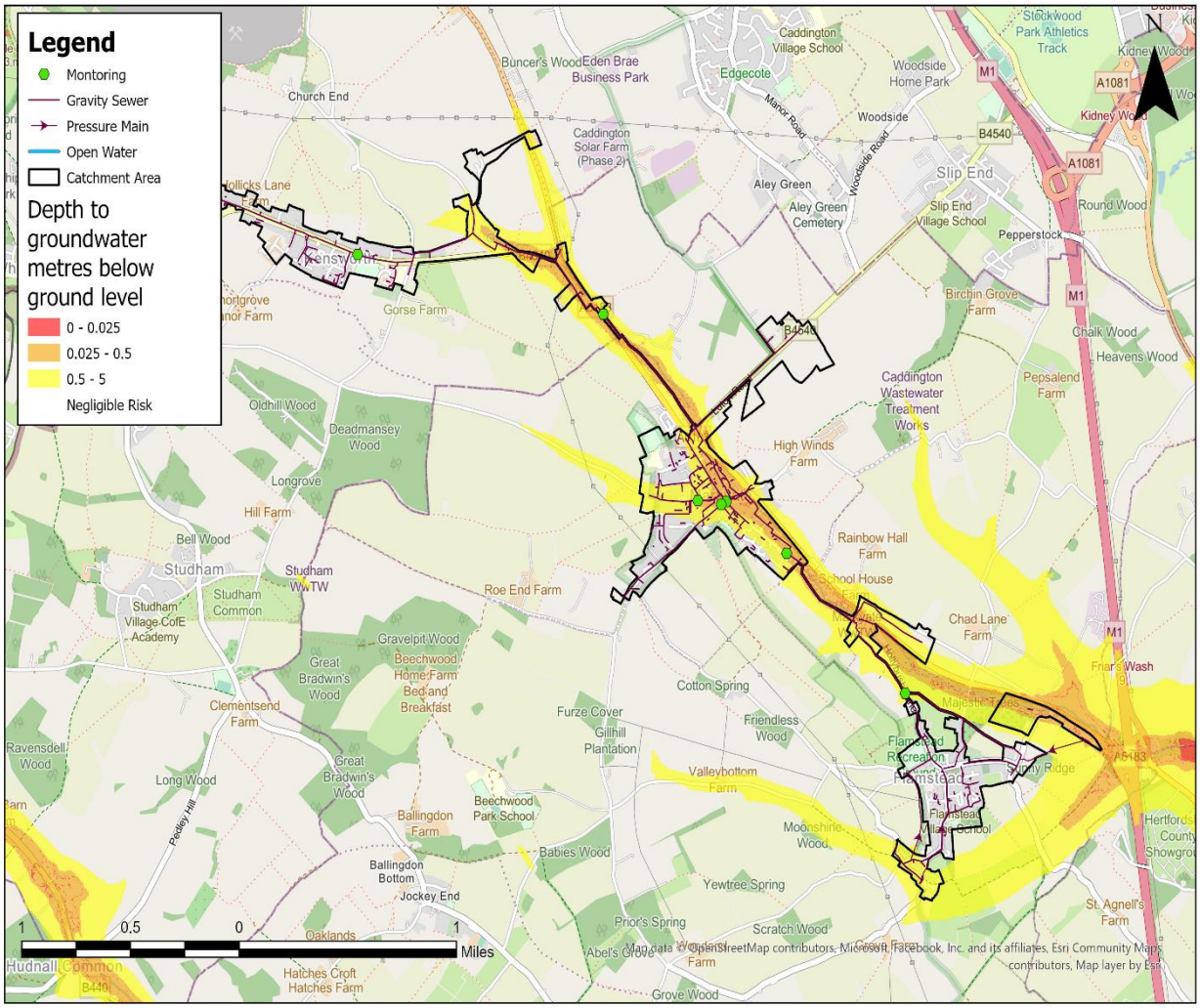
Overview

This addendum to the Markyate Groundwater Impacted System Management Plan 2021 (GISMP) provides an update on performance/work undertaken in the Hydrological Year October 2023 to September 2024. The key points covered include:

- Hydrological conditions
- Performance of the sewerage system
- Mitigation / remedial measures progressed over the last year and being planned
- Summary and plan for 2024/25

Figure 1 – Markyate Monitoring Plan



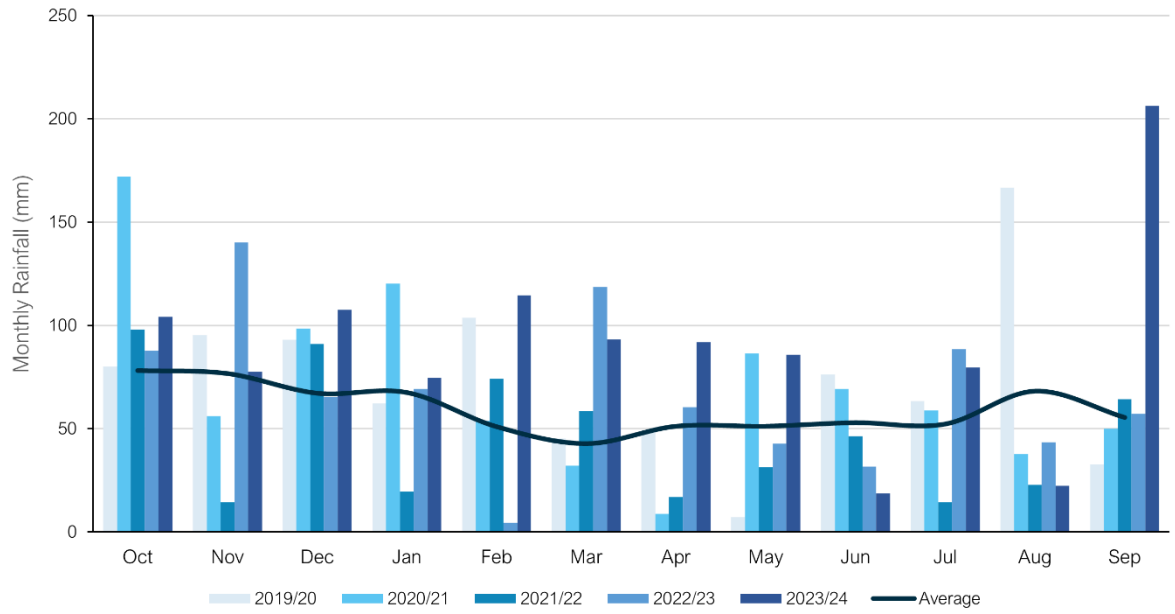
Hydrological Review – 2023-2024

This section summarises the hydrological conditions within the Markyate catchment within the period under investigation and provides comparison against previous year's performance to put the annual performance into context. The hydrological review has been undertaken based on the Hydrological Year which runs October 1st to September 30th.

Catchment Rainfall

Representative Radar rainfall has been used to generate monthly data at catchment level for comparison with average data generated by local Met Office Weather Station Records. Figure 2 presents the comparison of this data for the last five hydrological years to support longer term trends within the local system.

Figure 2 – Monthly Rainfall Data



Average Values taken from Met Office Weather Station at Rothamsted based on the period 1991-2020

The total rainfall for the 2023/24 hydrological year is 51% above the annual average total. Total rainfall values are presented in Table 3 below.

Table 3 –Total Rainfall Based on Hydrological Year

Average (mm)	2019/20 (mm)	2020/21 (mm)	2021/22 (mm)	2022/23 (mm)	2023/24 (mm)
715	874	844	552	810	1077

Groundwater / Local River Level

The Markyate catchment is situated in the Chilterns East – Colne water resources area. It sits in the Holywell Nodular Chalk Formation and New Pit Chalk Formation as well as the Lewes Nodular Chalk Formation and Seaford Chalk Formation. These are designated principal aquifers within the UK.

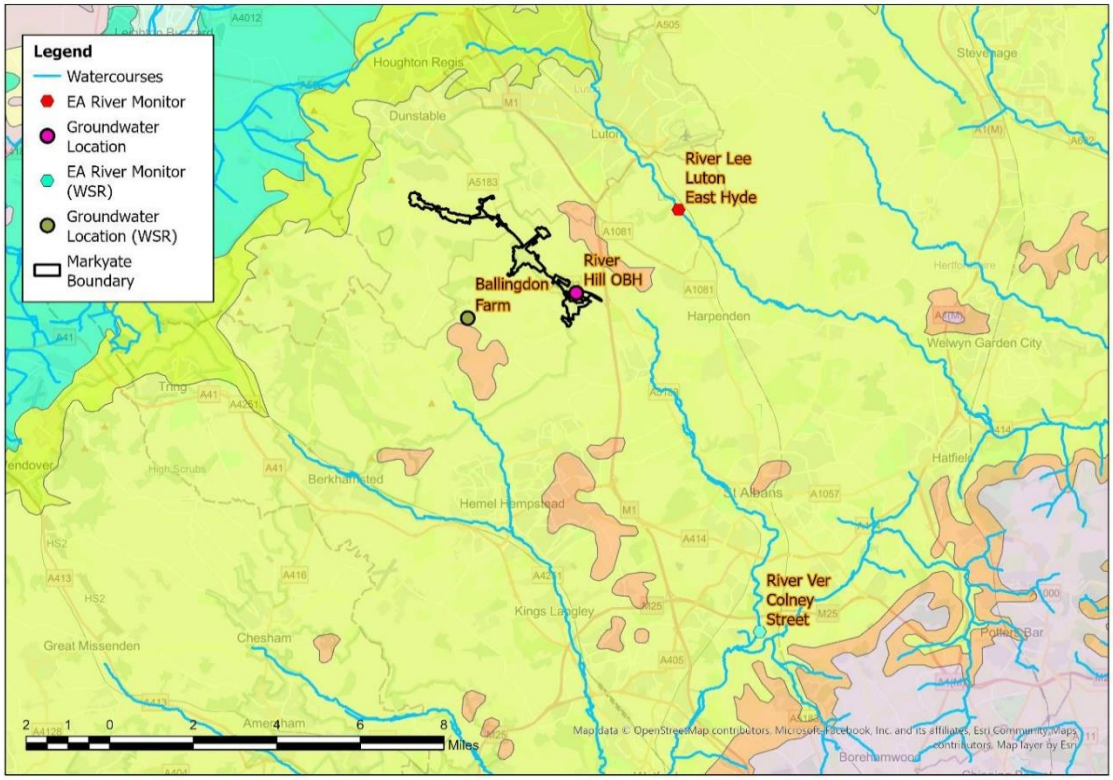
The Environment Agency has gauging stations on local watercourses measuring stage and observation boreholes (OBH) measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

From previous investigations we have identified the following sites are good indicators of groundwater levels within the catchment.

- River Hill OBH.
- River Lee, Luton East Hyde.

These sites are illustrated in the Figure 4, alongside the closest groundwater reference station and closest gauging station from the Water Situation Report.

Figure 4 – Local Monitoring Stations



Figures 5A-5B represent the last three hydrological years of level information at the indicator sites to build a picture of the relative conditions prevalent in the current year. It is presented against both the daily total rainfall values for the catchment and a rolling 15 day total rainfall.

Figure 5A – River Hill OBH

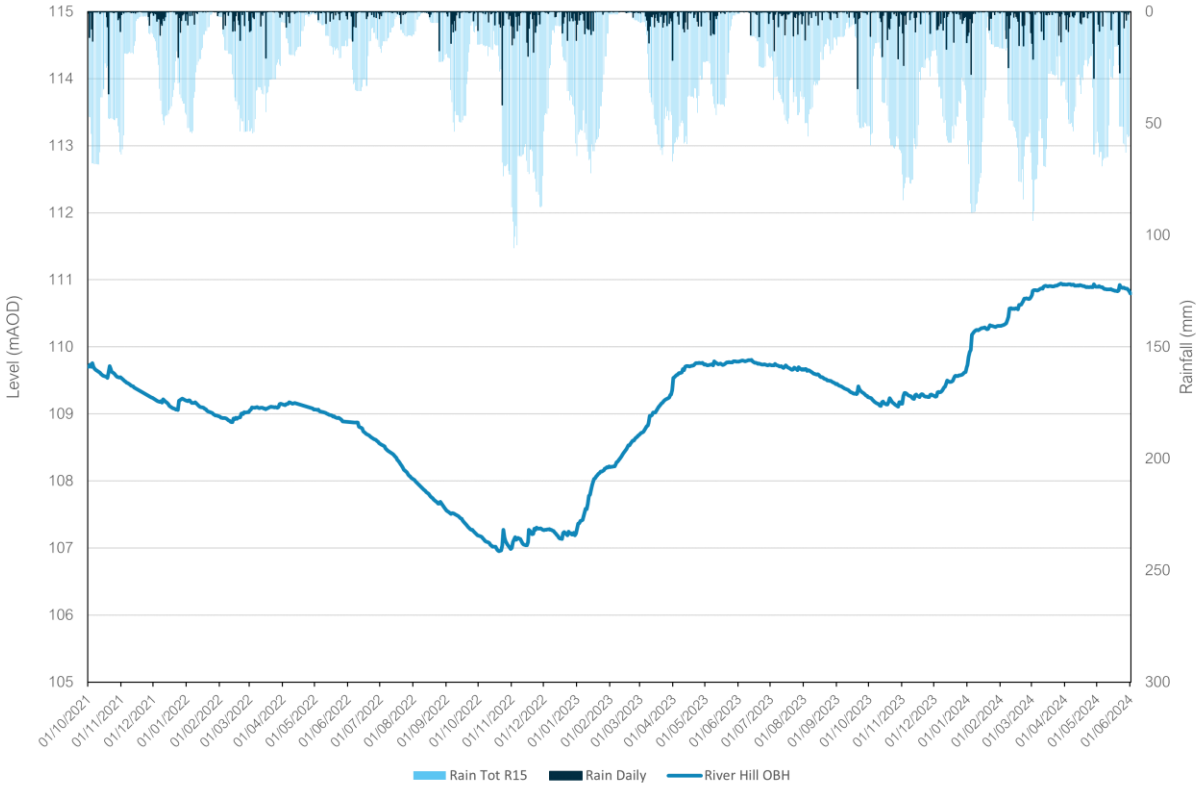
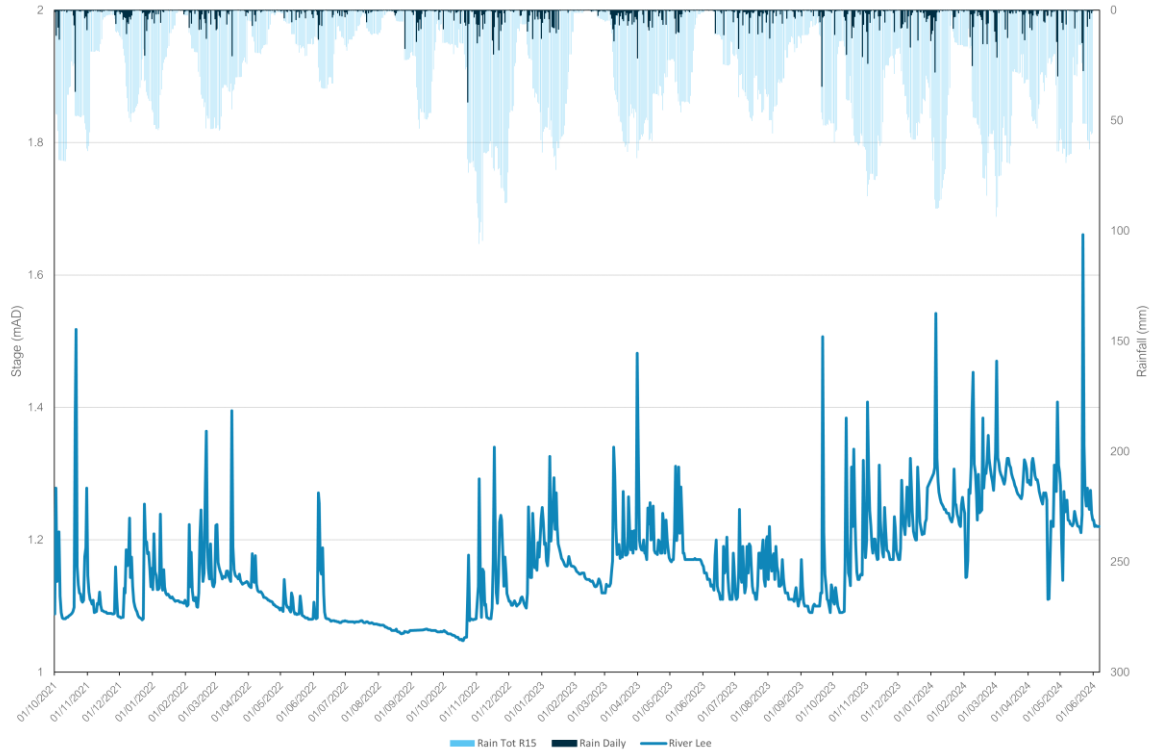
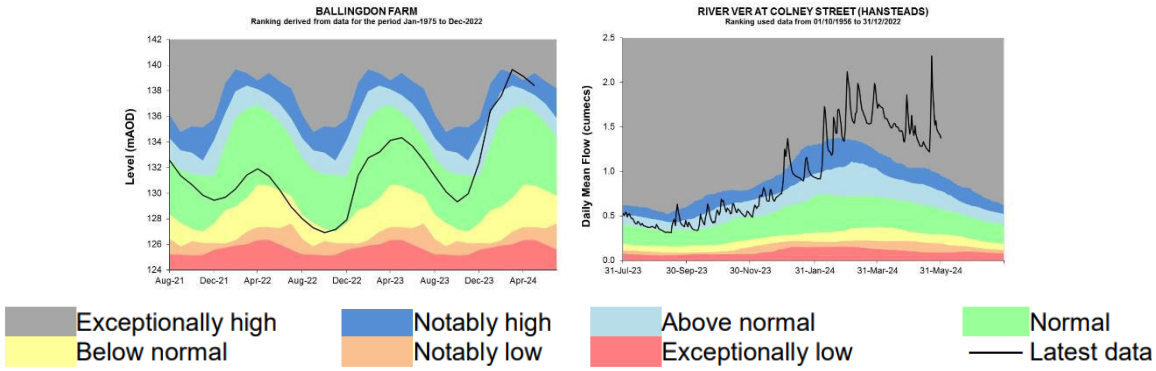


Figure 5B – River Lee, Luton East Hyde



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Chilterns East - Colne. The nearest groundwater reference station is Ballingdon Farm. This site shows groundwater levels to be at normal levels throughout 2023. Groundwater levels are observed to rise towards the end of the year and notably high / exceptionally high groundwater levels are recorded in 2024. This can be seen in the figure below alongside the river indicator location at Colney Street on the River Ver.

Figure 6 – Water Situation Report



Extract from - [Water Situation Report (publishing.service.gov.uk)]

Network Performance

Within the Markyate catchment there is one site detailed within the Environment Agency Consents Database which has an Event Duration Monitor (EDM) fitted.

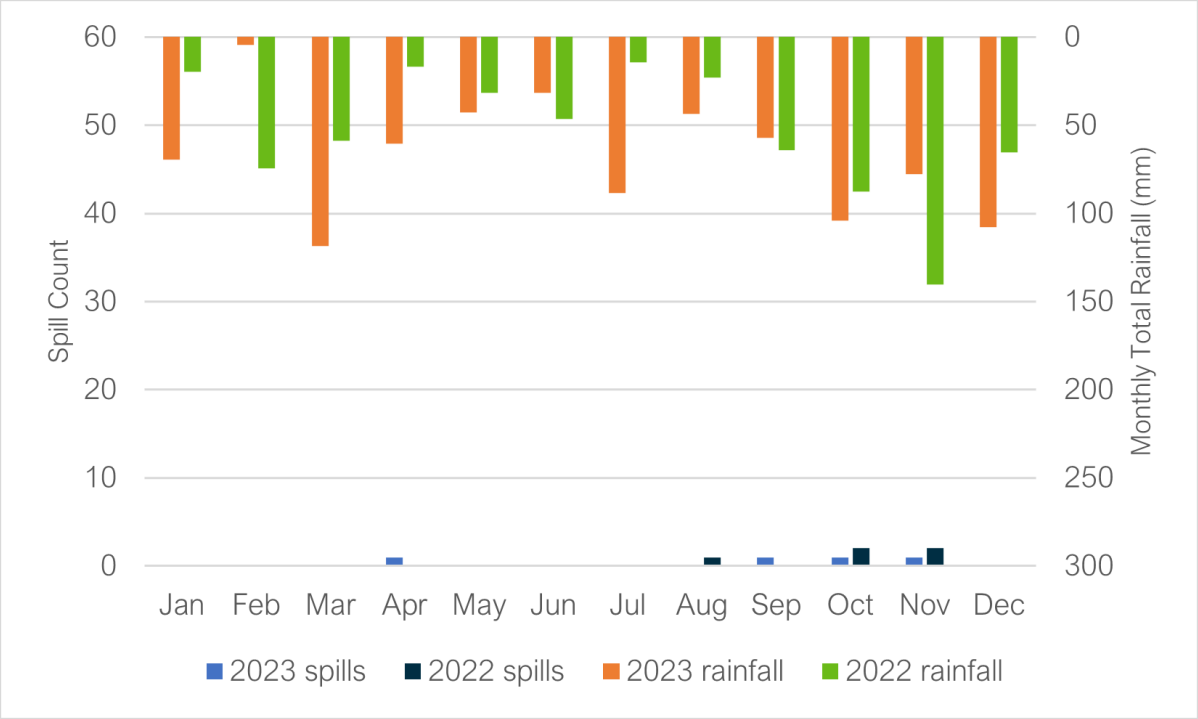
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

Overflow	2022		2023	
	Spills	Duration (hours)	Spills	Duration (hours)
Markyate STW	5	9.06	4	10

A critical part of the assessment of EDM performance and its relation to groundwater infiltration is to review the month-on-month spill performance, against previous years and the monthly total rainfall values to give context to the performance. Figure 8 below presents the EDM performance trend and rainfall for recent years.

Figure 8 – EDM Monthly Performance



Due to the low number of spills recorded at Markyate STW in both 2022 and 2023, it is difficult to establish the existence of a wider relationship between rainfall, elevated groundwater levels and spill frequency at Markyate STW. A low number of spills were also recorded at the site in 2020 (see the 2022 Addendum Report included in this PDF document). Although a high number of spills occurred in 2021, this was due to an asset maintenance issue at Markyate STW. The EDM data for 2024 will be analysed once available to further understand if elevated groundwater levels impact spill frequency at the overflow.

Investigations & Interventions

This section details the activities that have been undertaken within the catchment within the Hydrological Year 2023-24.

Monitor Installations

The sewer depth monitor (SDM) programme supports long term groundwater understanding within GISMP catchments. Currently, there are a total of 7 monitors installed within the Markyate catchment. There are currently no further monitor installs planned.

The data from these will be cross-referenced with other long-term records (where available) within the catchment.

Remediation Works Undertaken this Hydrological Year

Table 9 below provides a summary of the investigations and remediation works undertaken or planned within the Markyate catchment in the 2023-24 Hydrological Year, as well as works undertaken in the previous two hydrological years.

Table 9 – Works Undertaken in the 2023/2024, 2022/23 & 2021/22 Hydrological Year

Investigation/ remediation type	Number/ length undertaken 2021/22	Number/ length undertaken 2022/23	Number/ length undertaken 2023/24
CCTV survey	N/A	294 metres	N/A
Look and lift survey	N/A	N/A	N/A
Sewer lining	N/A	N/A	N/A
Patch lining	N/A	N/A	N/A
Manhole sealing	2 manholes	N/A	N/A
Manhole sealing plates	N/A	N/A	N/A
Manhole covers and frames replaced	N/A	N/A	N/A

In addition to investigations previously detailed, 294 metres of CCTV survey was undertaken in the catchment during the summer 2023 period. The purpose of these surveys was to assess the structural condition of sewers predicted to be at high risk of groundwater infiltration, rather than to identify locations of groundwater infiltration into the network. All the surveyed network was identified as being in a good structural condition.

No interventions/ investigations were carried out in the catchment in the 2023/24 Hydrological Year. However, the system will continue to be monitored and future investigations/ interventions carried out as appropriate and when conditions allow.

An upgrade is also planned for Markyate STW. This will improve its ability to treat the volumes of incoming sewage, reducing the need for untreated discharges to the environment. The scheme is due to be completed in 2026, however, delivery dates are being managed at a programme level, delivery dates stated are based upon current views and are subject to change.

It is expected that the Markyate catchment will meet government targets for storm overflows by 2030.

Summary

Indicator site data suggests groundwater levels in the Markyate catchment were generally higher in 2023 than in 2022, however similar spill frequencies were recorded across both years. This hydrological year (October 2023 – September 2024), indicator site data suggests that groundwater levels in the catchment have reached higher levels than the previous hydrological year, and EDM data for 2024 will be analysed once available to continue to examine the evidence for a relationship between groundwater levels and overflow spills in the catchment.

Lift and look and CCTV surveys will be undertaken in remaining wet winter periods if conditions allow and subject to funding and available capacity. Theaim of this is to find further priority locations for remediation and investigating/justifying the need for future larger scale lining as part of our Price Review (PR) process if required.

Addendum - Annual Update 2025

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Colne river basin summary

The Thames Water region covers the length of the River Thames from its source down to Tilbury including all its tributaries. The sewer network has overflows that discharge along the River Thames and its associated tributaries. The role of storm overflows in the network is to protect against property flooding from the sewerage system. Storm overflows, which may be augmented with settlement tanks, are employed to optimise the split between wastewater treatment and the management of rainfall. Storm separation is typically designed in accordance with regulatory guidance.

Aligned with our Drainage and Wastewater Management Plan (DWMP) approach, the Thames Water region has been split into River Basins, each contains a varying number of localised sewer networks. Taking this approach allows alignment to the different drivers in each river basin and provides and efficient way to investigate, tackle performance and protect the environment. This report covers the performance of the sewer networks within the Colne River Basin which are heavily influenced by groundwater infiltration into the network.

The Colne River Basin covers the upper reaches of the River Thames including its associated tributaries and streams. The river basin contains four heavily groundwater impacted Thames Water localised sewer systems that interact with various rivers and streams forming the tributaries to the River Thames. Each localised sewer system contains one or more storm overflows located at sewage treatment works (STW) and/or in the network. Figure 1 shows the relationship between the sewer systems and the associated rivers and streams. Figure 2 shows the location of each localised sewer system within the Colne River Basin with an insert showing the location of the Colne River Basin in relation to the Thames Water Region.

Sewer System	Associated River / Stream	Relationship to the River Thames
Berkhamsted STW	River Bulbourne	Indirect tributary of the River Thames via River Colne
Chesham STW	River Chess	Indirect tributary of the River Thames via River Colne
Maple Lodge STW	River Colne	Direct tributary of the River Thames
Markyate STW	River Ver	Indirect tributary of the River Thames via River Colne

Figure 1: Relationship of the Sewer Systems to Associated Rivers

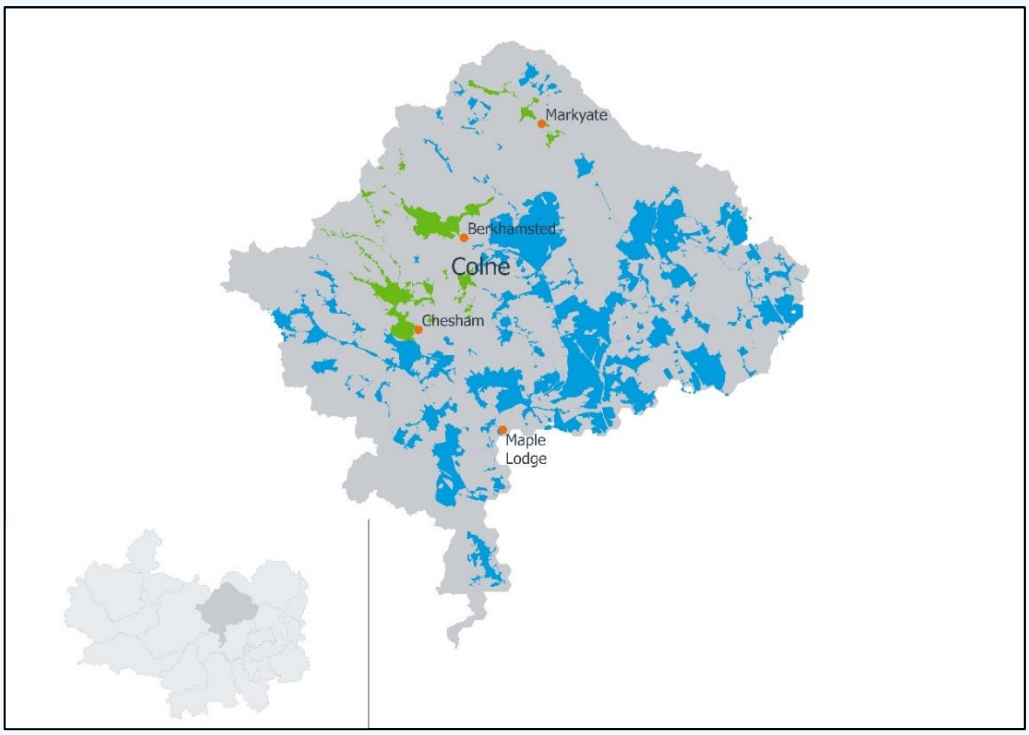


Figure 2: Location of Sewer Systems Within the Colne River Basin

Berkhamsted

Berkhamsted is located in the Bulbourne Valley, Hertfordshire, approximately 5 miles West of Hemel Hempstead.

This addendum provides an update on work undertaken in the hydrological year October 2024 to September 2025 for the Berkhamsted sewerage system. The key points covered include:

- Hydrological conditions
- Performance of the sewerage system
- Mitigation / remedial measures progressed over the last year

Figures 1 to 5 illustrate the relationship between rainfall and spills at CSOs. As shown in Figure 1, the decrease in rainfall from 2023/24 to 2024/25 correlates with reduced river levels (Figures 2 and 3), as well as a decline in the number and duration of CSO spills shown in Figure 5.

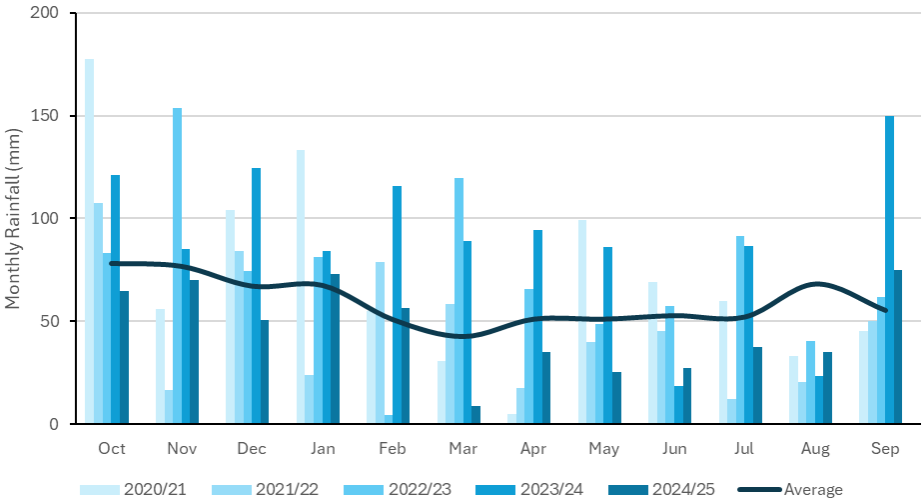


Figure 1: Monthly rainfall data 2020/21 to 2024/25

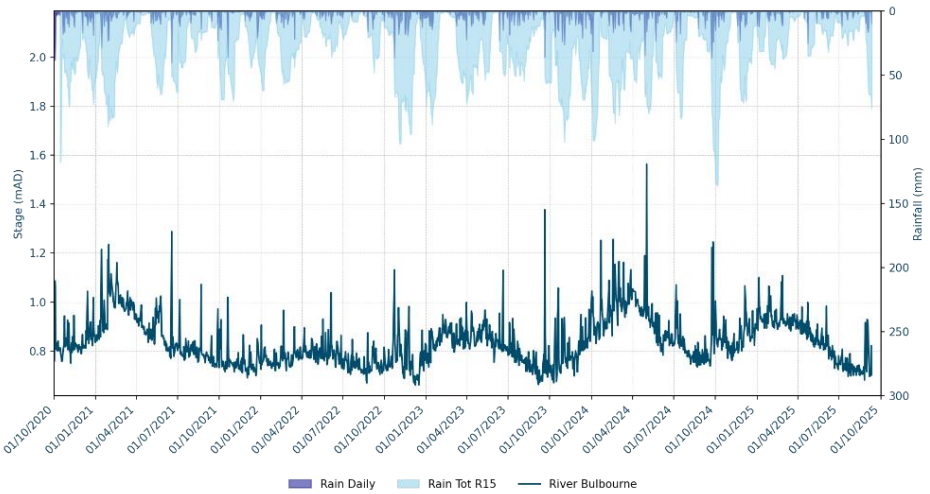


Figure 2: Rivel Level data for River Bulbourne, Hemel Hempstead, Old Fishery Lane

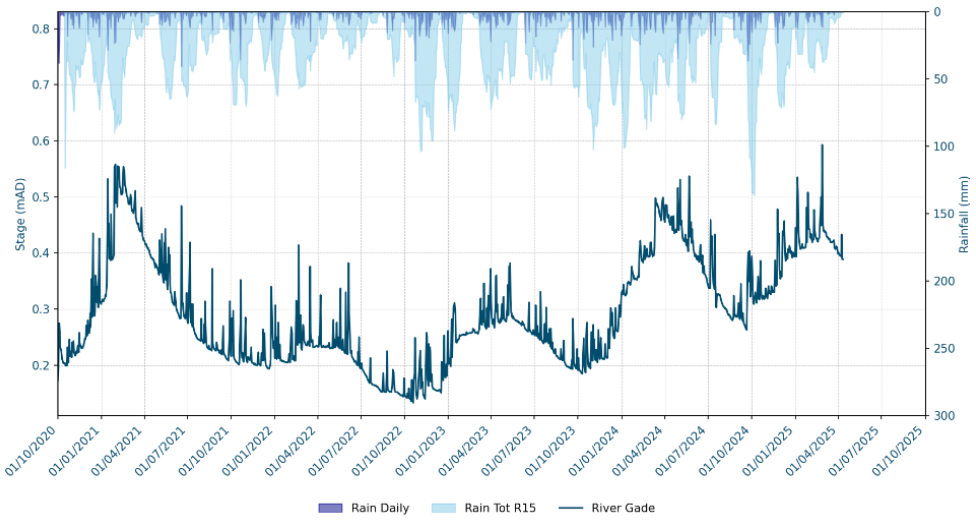
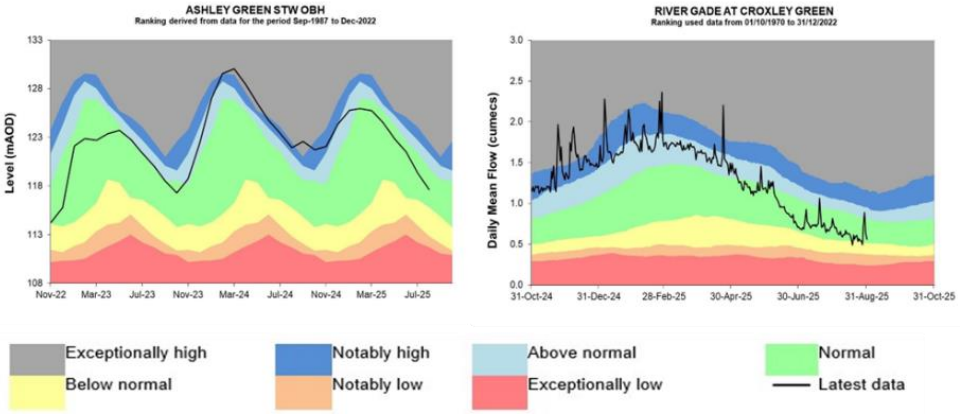


Figure 3: River Level data for River Gade Hemel Hempstead, Bury Mill



Extract from - Water Situation Report (publishing.service.gov.uk)

Figure 4: Ground Water situation Report

Table 1 below details the last 2 years performance of overflows in the catchment. To assess EDM performance and its relation to groundwater infiltration, a review of the month-on-month spill performance in 2023 and 2024 against the monthly total rainfall values has been undertaken, as observed in Figure 5.

Event Duration Monitoring	2023		2024	
Overflow	Annual Spills	Duration (hours)	Annual Spills	Duration (hours)
Berkhamsted STW	33	227.25	157	1775.45

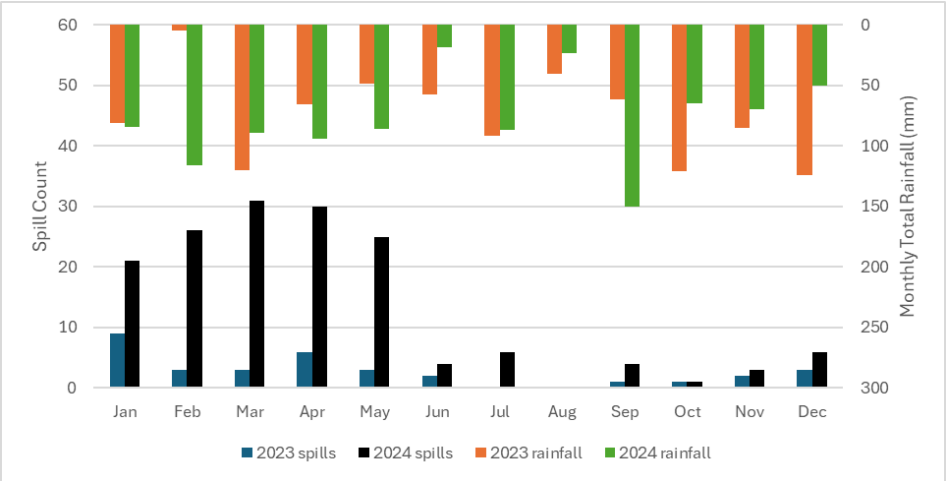


Figure 5: Monthly rainfall data versus monthly spill count for 2023 and 2024 – Berkhamsted STW

Table 2 below outlines the remediation works undertaken to address infiltration in the catchment, and enhancements to treatment works and/or pumping stations. Please note that this table only refers to work completed in the previous year.

Investigation / remediation type	2020/21	2021/22	2022/23	2023/24	2024/25
CCTV surveys	-	-	-	-	-
Look and lift surveys	-	-	-	-	-
Sewer lining	-	104m	-	-	-
Patch lining	-	-	-	-	-
Manhole sealing / plates / covers and frames replaced	-	3	-	-	-
ATAC unit deployment	-	-	-	-	-
Treatment Works / Pumping Station Upgrades	-	-	-	Increased STW capacity	Upgraded treatment processes

Summary

The groundwater and river level has increased in 2023/24 compared to previous years. This increase is due to higher average rainfall in 2024 compared to the average rainfall levels of the previous year. The number and duration of spills have increased in 2024 compared to 2023. The higher number of annual spills and river and groundwater levels could be a result of the increased rainfall in 2024 (seen in Figure 5).

To mitigate any potential spills that do not comply with government targets, Thames Water has introduced a scheme. The first was completed in 2023, it provides a major increase in treatment capacity, reducing the need for untreated discharges to the environment. The second scheme completed in 2024 upgraded treatment processes to increase the quality of treated effluent discharging into the river.

Chesham

Chesham is located in the Chiltern Hills, Buckinghamshire, 11 miles Southeast of the County town of Aylesbury. This addendum provides an update on work undertaken in the hydrological year October 2024 to September 2025 for the Chesham sewerage system. The key points covered include:

- Hydrological conditions
- Performance of the sewerage system
- Mitigation / remedial measures progressed over the last year

Figures 1 to 5 illustrate the relationship between rainfall and spills at CSOs. As shown in Figure 1, there is decrease in rainfall from 2023/24 to 2024/25. However, river levels follow a similar pattern as previous year (Figures 2 and 3), along with a decline in both the number and duration of CSO spills shown in Figure 5.

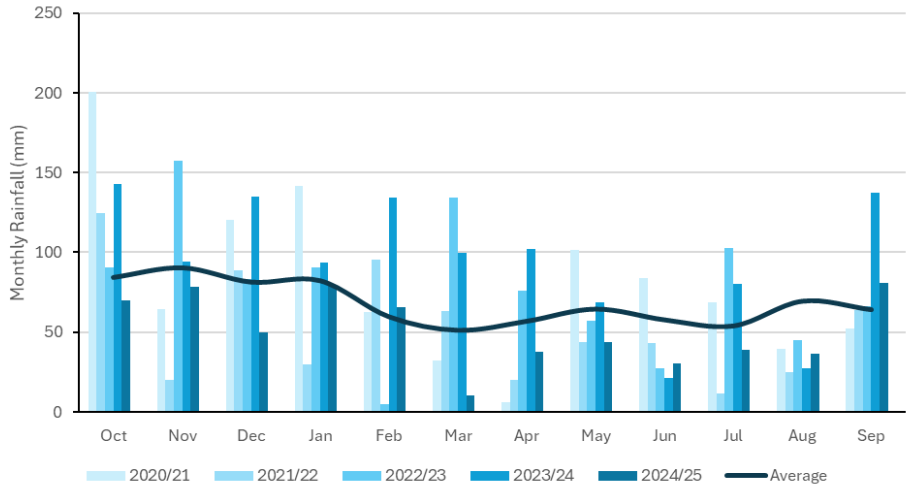


Figure 1: Monthly rainfall data 2020/21 to 2024/25

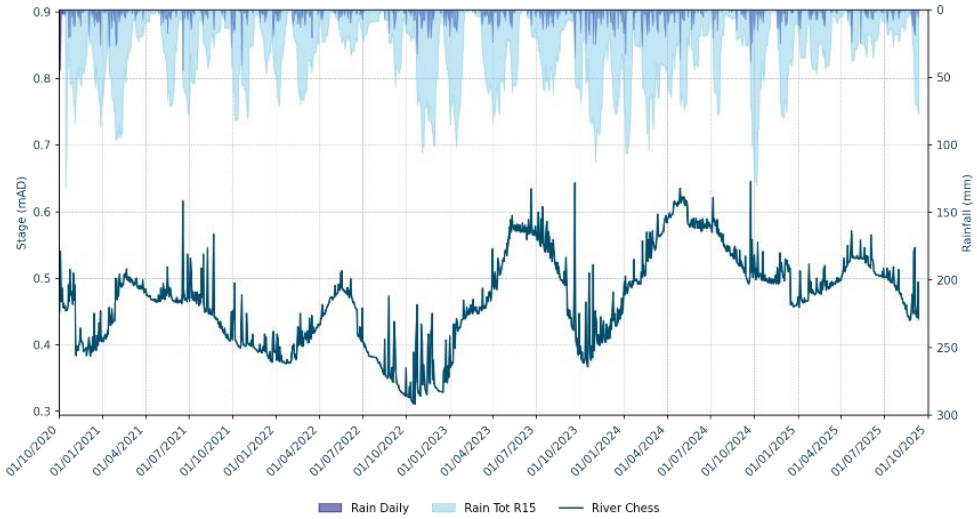


Figure 2: River Level data for River Chess, Chesham

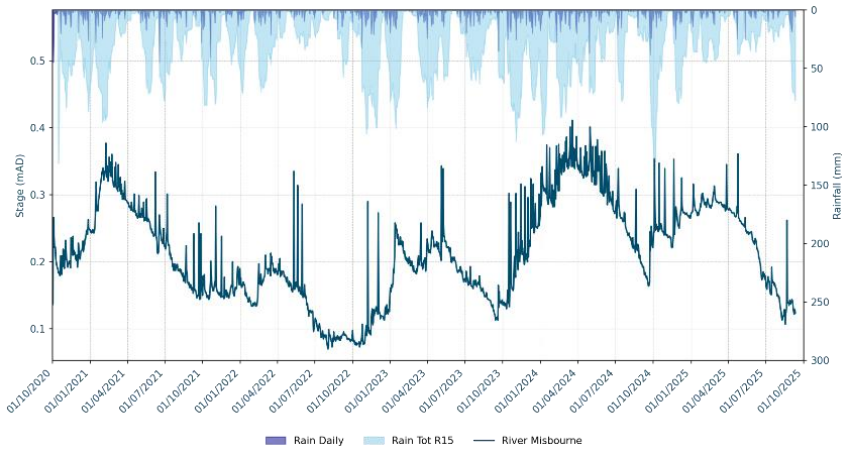
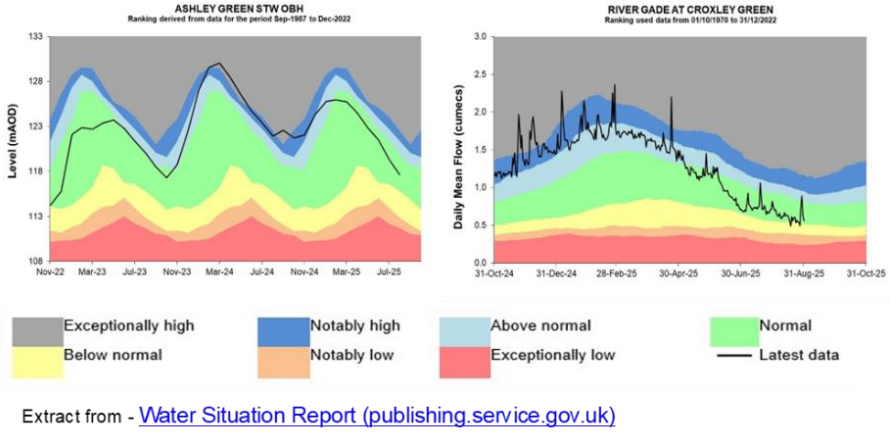


Figure 3: River Level data for River Misbourne, Missenden



Extract from - Water Situation Report (publishing.service.gov.uk)

Figure 4: Ground Water situation Report

Table 1 below details the last 2 years performance of overflows in the catchment. To assess EDM performance and its relation to groundwater infiltration, a review of the month-on-month spill performance in 2023 and 2024 against the monthly total rainfall values has been undertaken, as observed in Figure 5.

Event Duration Monitoring	2023		2024	
Overflow	Annual Spills	Duration (hours)	Annual Spills	Duration (hours)
Chesham STW	5	19.25	141	2681.15

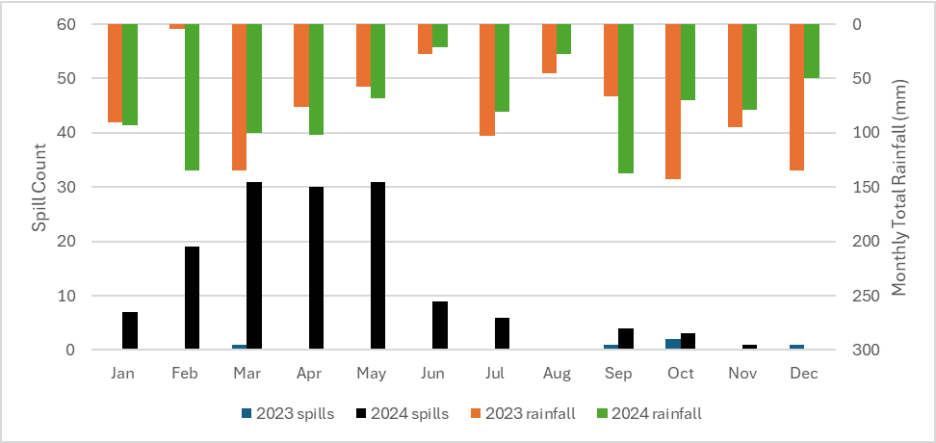


Figure 5: Monthly rainfall data versus monthly spill count for 2023 and 2024 – Chesham STW

Table 2 below outlines the remediation works undertaken to address infiltration in the catchment, and enhancements to treatment works and/or pumping stations. Please note that this table only refers to work completed in the previous year

Investigation / remediation type	2020/21	2021/22	2022/23	2023/24	2024/25
CCTV surveys	-	-	696m	1,000m	-
Look and lift surveys	-	-	34	12	550m
Sewer lining	104m	40m	-	-	-
Patch lining	3	-	-	-	-
Manhole sealing / plates / covers and frames replaced	-	287	470	-	-
ATAC unit deployment	-	-	-	-	-
Treatment Works / Pumping Station Upgrades	-	-	-	STW Upgrade	-

Summary

The groundwater and river level has increased in 2023/24 compared to previous years. This increase is due to higher average rainfall in 2024 compared to the average rainfall levels of the previous year. The number and duration of spills have increased in 2024 compared to 2023. The higher number of annual spills, river and groundwater levels could be a result of the increased rainfall in 2024 (seen in Figure 5). Following significant investment in the STW we are now in a stage of monitoring performance.

Maple Lodge

Maple Lodge is located in the Colne Valley, Hertfordshire, south of Rickmansworth.
This addendum provides an update on work undertaken in the hydrological year October 2024 to September 2025 for the Maple Lodge sewerage system. The key points covered include:

- Hydrological conditions
- Performance of the sewerage system
- Mitigation / remedial measures progressed over the last year

Figures 1 to 7 illustrate the relationship between rainfall and CSO spills. As shown in Figure 1, the reduction in rainfall from 2023/24 to 2024/25. However, river levels follow a similar pattern as previous year (Figures 2 to 5), along with a decline in both the number and duration of CSO spills shown in Figure 7.

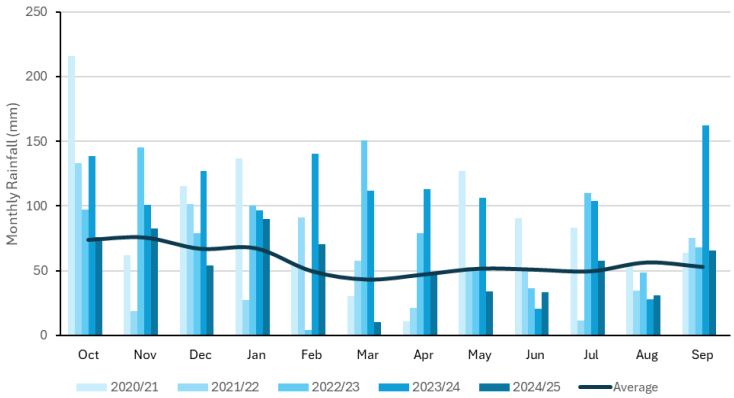


Figure 1: Monthly rainfall data 2020/21 to 2024/25

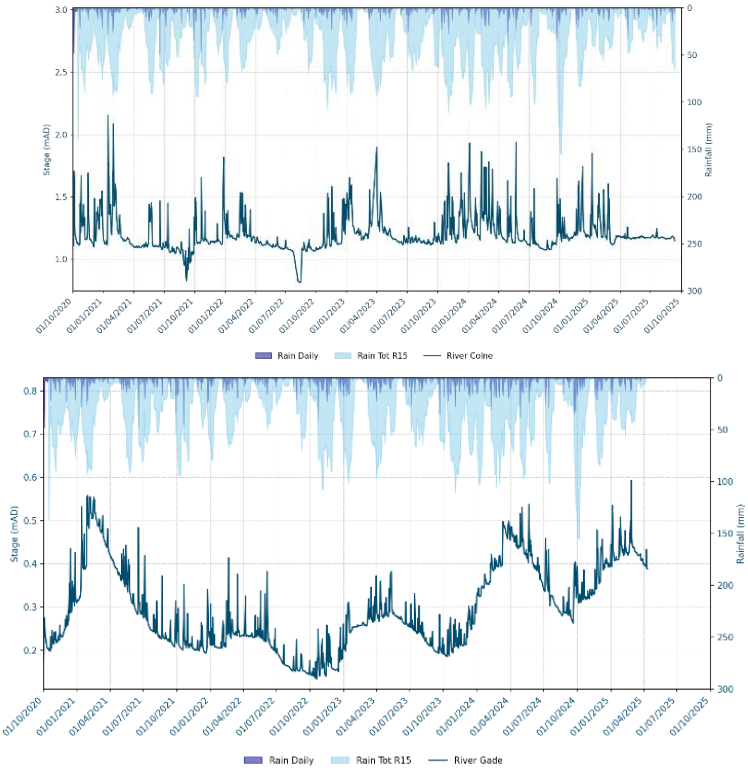


Figure 2: River Level data for River Colne, London Colney / Figure 3: River Level data for River Gade, Hemel Hempstead, Bury Mill

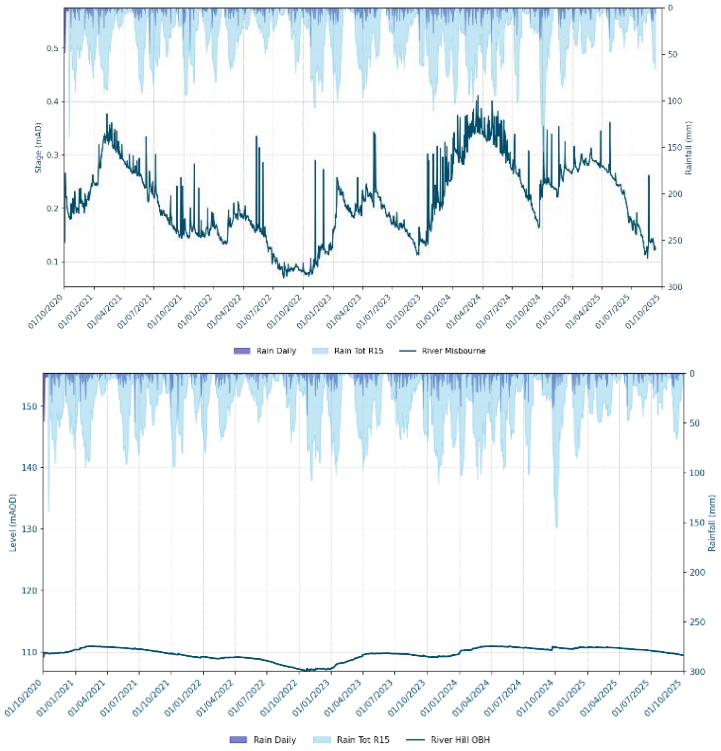


Figure 4: River Level data for River Misbourne, Missenden / Figure 5: River Level data for River Hill OBH

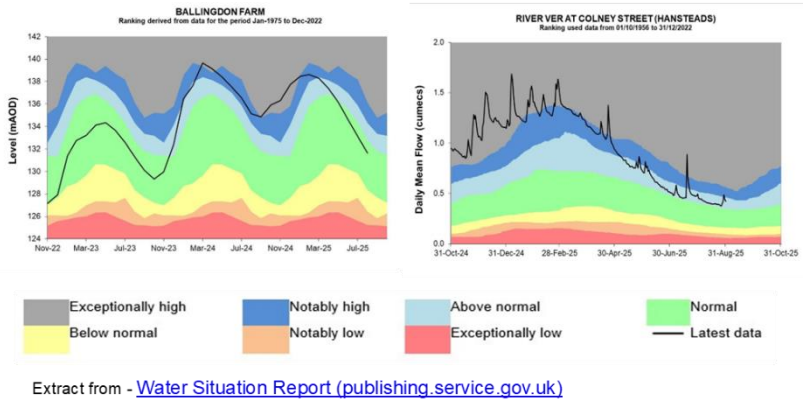


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Figure 6: Ground Water situation Report

Table 1 below details the last 2 years performance of overflows in the catchment. To assess EDM performance and its relation to groundwater infiltration, a review of the month-on-month spill performance in 2023 and 2024 against the monthly total rainfall values has been undertaken, as observed in Figure 7.

Event Duration Monitoring	2023		2024	
Overflow	Annual Spills	Duration (hours)	Annual Spills	Duration (hours)
Maple Lodge STW STK8/STK9	52	650.5	124	1916.15

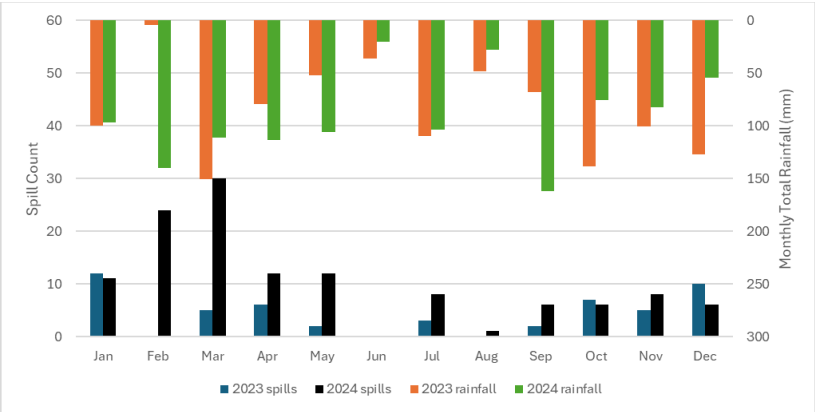

Figure 7: Monthly rainfall data versus monthly spill count for 2023 and 2024– Maple Lodge STW

Table 2 below outlines the remediation works undertaken to address infiltration in the catchment, and enhancements to treatment works and/or pumping stations. Please note that this table only refers to work completed in the previous year.

Investigation / remediation type	2020/21	2021/22	2022/23	2023/24	2024/25
CCTV surveys	-	-	-	408m	1,606m
Look and lift surveys	-	-	2	-	-
Sewer lining	-	90m	-	-	-
Patch lining	-	-	-	-	-
Manhole sealing / plates / covers and frames replaced	-	18	-	-	29
ATAC unit deployment	-	-	-	-	-

Summary

The groundwater and river levels have increased in 2023/24 compared to previous years. This increase is due to higher average rainfall in 2024 compared to the average rainfall levels of the previous year. The number and duration of spills for STK9 and STK8 have increased in 2024 compared to 2023. The higher number of annual spills, river and groundwater levels could be a result of the increased rainfall in 2024 (seen in Figure 5).

Works are underway for Amersham Balancing Tanks as described in the Maple Lodge 2024 update.

Markyate

Markyate is located in north-west Hertfordshire, approximately 3 miles southwest of Luton. This addendum provides an update on work undertaken in the hydrological year October 2024 to September 2025 for the Markyate sewerage system. The key points covered include:

- Hydrological conditions
- Performance of the sewerage system
- Mitigation / remedial measures progressed over the last year

Figures 1 to 5 illustrate the relationship between rainfall and CSO spills. As shown in Figure 1, the decrease in rainfall from 2023/24 to 2024/25. However, River levels follow a similar pattern as previous year (Figures 2), along with a decline in both the number and duration of CSO spills shown in Figure 5.

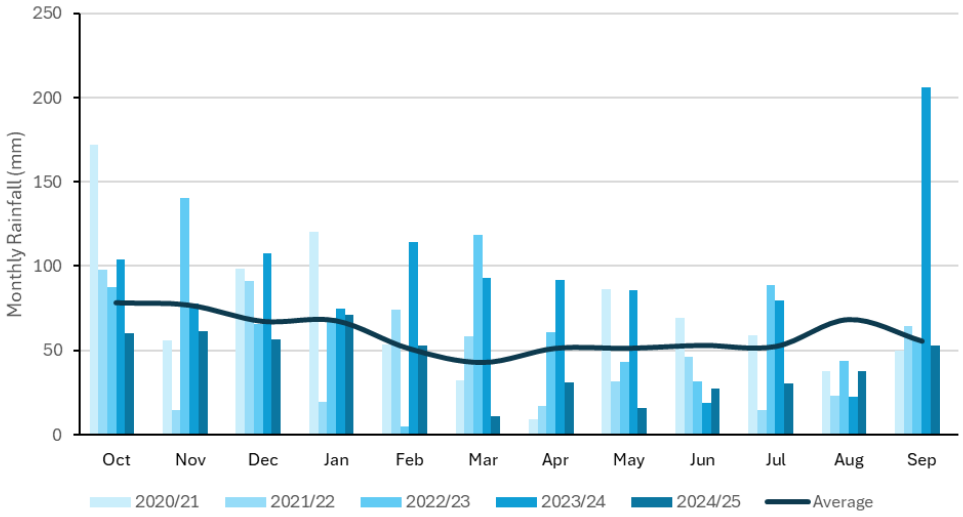

Figure 1: Monthly rainfall data 2020/21 to 2024/25

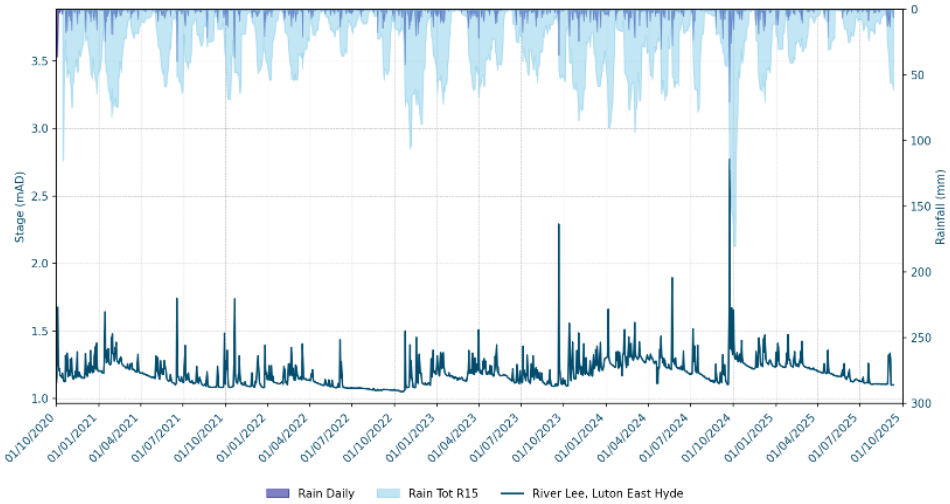

Figure 2: River Level data for River Lee, Luton East Hyde

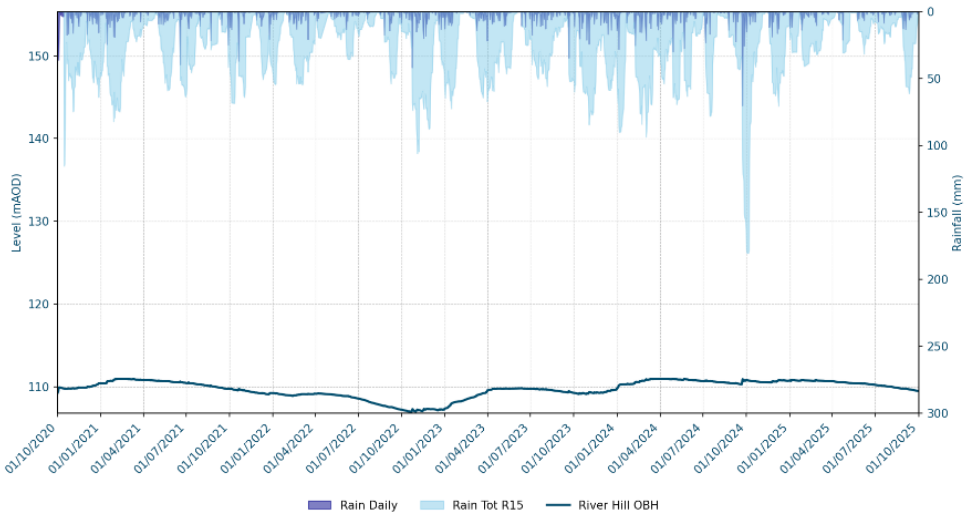

Figure 3: River Level data for River Hill OBH

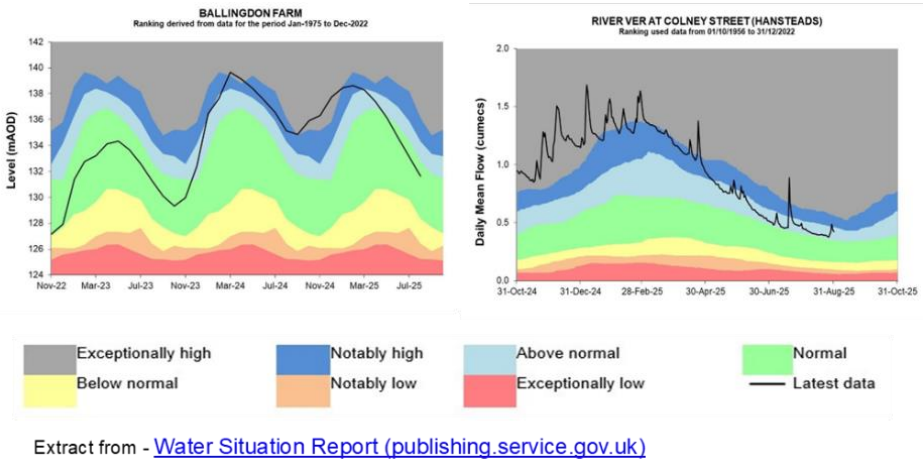

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Figure 4: Ground Water situation Report

Table 1 below details the last 2 years performance of overflows in the catchment. To assess EDM performance and its relation to groundwater infiltration, a review of the month-on-month spill performance in 2023 and 2024 against the monthly total rainfall values has been undertaken, as observed in Figure 5.

Event Duration Monitoring	2023		2024	
Overflow	Annual Spills	Duration (hours)	Annual Spills	Duration (hours)
Markyate STW	4	10	187	3383

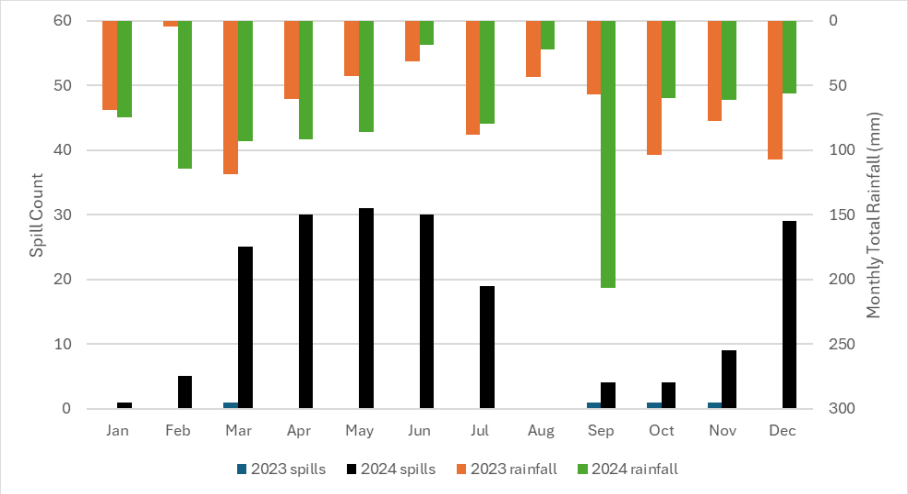

Figure 5: Monthly rainfall data versus monthly spill count for 2023 and 2024– Markyate STW

Table 2 below outlines the remediation works undertaken to address infiltration in the catchment, and enhancements to treatment works and/or pumping stations. Please note that this table only refers to work completed in the previous year.

Investigation / remediation type	2020/21	2021/22	2022/23	2023/24	2024/25
CCTV surveys	-	-	294m	-	-
Look and lift surveys	-	-	-	-	-
Sewer lining	-	-	-	-	-
Patch lining	-	-	-	-	-
Manhole sealing / plates / covers and frames replaced	-	2	-	-	-
ATAC unit deployment	-	-	-	-	-

Summary

A review of river level data over 2023/24 shows a similar pattern being followed compared to previous years. However, groundwater levels have increased in 2023/24 compared to previous years. This increase is due to higher average rainfall in 2024 compared to the average rainfall levels of the previous year. The number and duration of spills increased in 2024 compared to 2023. The higher number of annual spills and groundwater levels could be a result of the increased rainfall in 2024 (seen in Figure 5).

However, months March to July 2024 (Figure 5) show no strong correlation between rainfall and number of spills as spill count stays at an average of 30 spills throughout that period, while rainfall decreases significantly in some months. We can deduce that rivel levels have a correlation with the number of spillages, as the highest number of spillages happened during a period of high river levels (see Figure 2 & 3). Tankering has been undertaken at the STW during 2024 due to high groundwater levels.

Strategic level improvements to the sewer network identified as part of the GISMP approach, to reduce infiltration, are currently being undertaken and are due to be completed in 2026. These works include sealing 97 manholes and replacing 44 standard manhole covers and frames, in locations where rainwater can potentially accumulate with leak tight covers and frames. The works also include sealing an estimated 6.1km of sewers with “Leak Tight” Cured in Place Pipelining in locations where the risk of high ground water levels has been identified.


Thames
Water