

Infiltration Reduction Plan

Pillhill Pan Parishes covering:

Kimpton
Fyfield
Thrupton
Monxton
Amport
Quarley
Abbotts Ann
Upper Clatford

December 2024

Version 7.1



from
**Southern
Water** 

Contents

1.	Background	5
2.	Groundwater Infiltration in the Parishes	8
2.1.	The significance of groundwater infiltration	8
3.	Investigation & repairs	11
3.1.	Outline Plans to Investigate Sources of Infiltration	11
3.2.	Investigation and Repairs	11
3.3.	Private Drainage	13
4.	Groundwater treatment	14
4.1.	Circumstances that lead to mitigation	14
4.2.	Steps to prevent discharges and alternatives to over-pumping	16
4.3.	3rd Party Communications about groundwater treatment	16
5.	Options to Reduce Infiltration	17
5.1.	Sewer Rehabilitation Programme	17
5.2.	Property Level Protection	19
5.3.	Pumping Stations	19
5.4.	Monitoring	19
6.	Action Plans	22
	Appendix	30

Document Control

Version	Date
D1	July 2014
1.0	December 2014
2.0	February 2016
3.0	April 2017
4.0	July 2018
5.1	August 2021
5.2	August 2021
5.3	September 2021
5.4	October 2021
5.5	March 2022
6	January 2024
7	August 2024
7.1	December 2024

Glossary

AMP – Asset Management Programme
CCTV - Closed-circuit television
EA - Environment Agency
GW – Ground Water
IRP - Infiltration Reduction Plans
l/s - litres per second
MH – Manhole
ODI – Outcome delivery Incentive
PE - polyethylene
RPS - Regulatory Position Statement
SW – Southern Water
WaSC - Water and Sewerage Companies
WC – Water Closet
WPS - Wastewater Pumping Station
WTW - Wastewater Treatment Works

1. Background

The original Infiltration Reduction Plan for this area was titled Fyfield and covered the villages Fyfield, Kimpton, Thruxton and Monxton. The revised edition now includes the parishes forming the Pan Parish areas of Kimpton (including Fyfield), Thruxton, Monxton, Quarley, Amport, Abbots Ann and Upper Clatford.

The original format of these plans included a lot of general information relating to infiltration reduction approach that was applicable to all areas in the South East region plus specific details for the area of concern. In 2021 it was agreed with the Environment Agency, that plans would be revised such that a generic plan is held as a general over-arching document to which all detailed Infiltration Reduction Plans would refer.

The generic plan can be found at the Southern Water website at [infiltration-reduction-plans-introduction-summary.pdf](#)

This document is the detailed plan for the Pan Parish area. All Infiltration Reduction Plans (IRP) have been prepared in response to the Environment Agency's (EA) Regulatory Position Statement (RPS). Southern Water has been carrying out work for many years to survey and repair sources of infiltration in the catchment for Fullerton Wastewater Treatment Works (WTW) in Hampshire.

The villages making up the Pan Parish as listed above, are near Andover in Hampshire and have been combined into a single IRP because they are on the same sewerage network. The Parishes concerned are shown in Figure 1.0 below.

The map in Figure 1.1 shows that gravity flows from Fyfield and Kimpton villages are pumped from Stanbury Road wastewater pumping station (WPS) to Thruxton and then to Mullen's Pond WPS. The flows are then pumped to Furzedown Lane, Amport WPS, where it is joined by flows from Quarley WPS, Grateley Village and Grateley Station WPS. The resultant flows are pumped to Monxton WPS and onwards to Fullerton wastewater treatment works (WTW) south of Andover. Groundwater infiltration into the sewerage system in any of these villages contributes to an increase in the potential for flooding in the villages downstream.

The map also shows the villages of Appleshaw and Penton Mewsey which are also in the Fullerton WTW catchment, but are on a separate branch of the sewerage network and therefore are covered in a separate IRP.

The repairs carried out by Southern Water improve the integrity of the sewerage system. Southern Water has been working with the following organisations and is dependent on their support to achieve the objective of reducing non-sewage flows into the sewers.

- Environment Agency,
- Hampshire County Council,
- Test Valley Borough Council,
- Fyfield Parish Council
- Kimpton Parish Council
- Thruxton Parish Council
- Monxton Parish Council
- Amport Parish Council
- Quarley Parish Council
- Abbots Ann Parish Council
- Upper Clatford Parish Council

SW also communicates regularly with:

- Campaign to Protect Rural England
- Federation of Small Businesses
- Hampshire Wildlife Trust
- Hampshire Constabulary
- Monxton Neighbourhood Watch
- Natural England
- Monxton Flood Action Group

Southern Water has consulted with the Pan Parish Multi-agency Group which includes representatives from the EA and the local Parishes.

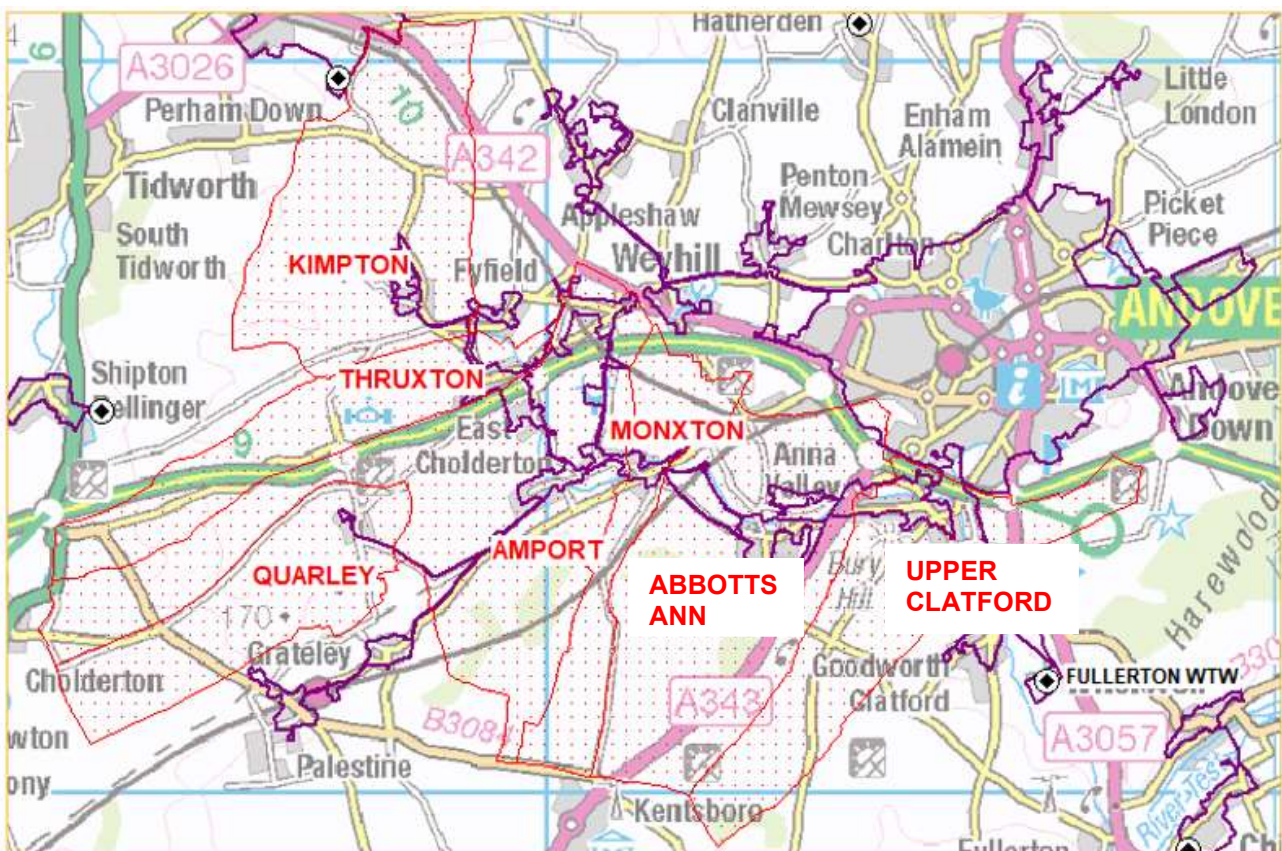


Figure 1.0 – Parishes included in the Pan Parish IRP

From 2013 to 2023 the infiltration reduction action plan for this area was similar to all other plans. However, in 2023 the Pan Parish Forum was established and Southern Water trialled a new way of working called Pathfinder to better understand the complexities of sub-surface flows to sewers, the role the private drainage system plays and the extent of work required to address issues more effectively. This document includes the work undertaken by the Pathfinder project team.

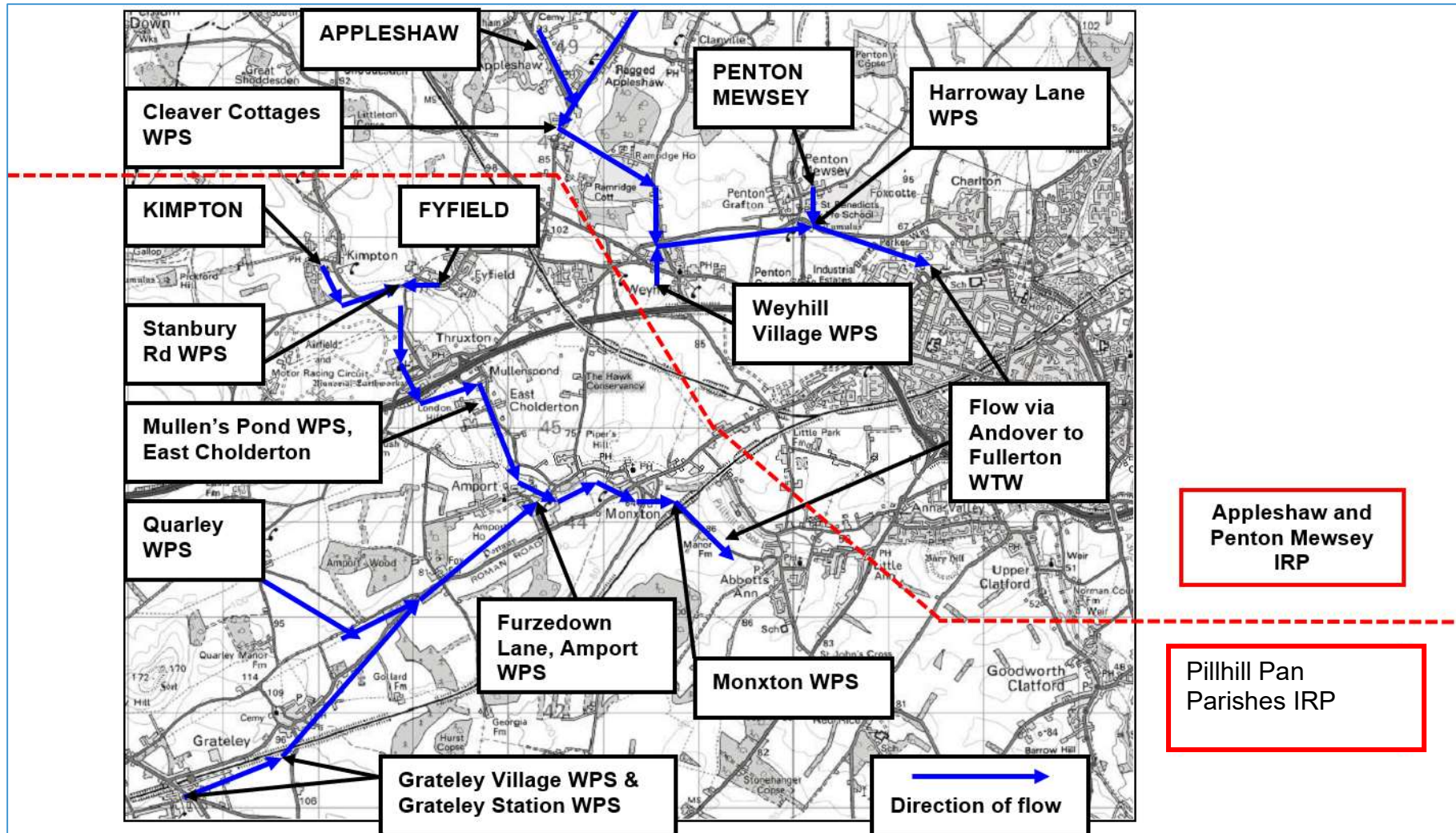


Figure 1.1 - Representation of the sewerage system serving the villages west of Andover in the Fullerton WWTW catchment

2. Groundwater Infiltration in the Parishes

2.1. The significance of groundwater infiltration

The villages forming the Pan Parish area to the west of Andover is one of a number of areas in Southern Water's operating area where, during excessively wet winters, customers have been inconvenienced by the effects of groundwater infiltration into sewers. Such effects can include flooding and restricted toilet use (RTU).

Southern Water strives to maintain services for customers by a programme of investigation, repair, maintenance and mitigation. Mitigation measures include the use of tankers and local groundwater treatment. Such mitigation measures are not sustainable, so during the last three years SW has invested in surveys and improvements to the integrity of the sewers and manholes in the Pan Parish area in order to minimise the occasions on which mitigation is required.

2.2. What would happen if Southern Water did not take action?

Despite the significant groundwater flow through the valley during these conditions, incidents of property flooding either internally or to gardens of properties have been relatively infrequent. Table 2.1 below shows reported incidents of sewer flooding since April 2010.

Flooding affecting public spaces, highways and agricultural land also occurs and these are included in table 2.2.

Table 2.1 shows that there have been 26 incidents (22 external flooding and 3 Restricted Toilet Use) since 2010; six occurred in both of the years 2013/2014 and 2019/2020.. It should also be noted however that February 2020 was the wettest February on record and the winter the 5th wettest winter on record as per the [Met Office](#).

Table 2.1 – Reported Flooding Incidents to properties (internal and curtilage)

Year	Internal Flooding	External Flooding (within property curtilage)	Restricted Toilet Use	Total
2010_2011	0	0	0	0
2011_2012	0	0	0	0
2012_2013	0	5	0	5
2013_2014	0	5	1	6
2014_2015	0	0	0	0
2015_2016	0	0	0	0
2016_2017	0	0	0	0
2017_2018	0	0	0	0
2018_2019	0	0	0	0
2019_2020	0	4	2	6
2020_2021	0	0	0	0
2021_2022	0	0	0	0
2022_2023	0	0	0	0
2023_2024	1	8	0	9
Totals	1	22	3	26

Table 2.2– Reported Flooding Incidents outside of property boundaries

Year	Public open space	Highways	Agriculture	Total
2010_2011	6	3	1	10
2011_2012	1	2	0	3
2012_2013	11	8	1	20
2013_2014	12	8	2	22
2014_2015	2	1	0	3
2015_2016	2	2	1	5
2016_2017	1	1	2	4
2017_2018	4	5	0	9
2018_2019	5	8	1	14
2019_2020	11	5	1	17
2020_2021	2	1	0	3
2021_2022	0	1	1	2
2022_2023	0	0	0	0
2023_2024	6	3	1	10
Totals	63	48	11	122

2.3. The objectives of the plan

The over-arching objective of the Infiltration Reduction Plan is to remove the need for managing wastewater flows by tankering and groundwater treatment during periods of high groundwater. Six commitments specific to the Pan Parish Forum have been agreed:

1. Capital investment for wastewater infrastructure fit for current and evolving future wastewater needs.
2. A commitment to stop groundwater treatment.
3. Assurances regarding the quality of the water in the Pillhill Brook and transparency of the water test regime and results that demonstrate this.
4. Compliance with the EA regulatory requirements during monitoring of water quality, and through their Infiltration Reduction Plan (IRP).
5. Consultation with Pillhill Pan Parish Forum before the execution of any further temporary works (such as tanker operations and highway restrictions).
6. Engagement with their customers now and continued engagement and communications with them and with Pillhill Pan Parish Forum and TVBC representatives through the execution of their future plans.

This document deals with commitment number 4 to ensure activity is compliant with the EA Regulatory requirements. The document also discusses commitment 1 by explaining the capital investment made and to be made to reduce infiltration into the system.

In periods of dry weather outside of high groundwater season the system operates with no issues despite the hydraulic check points at the pumping stations in the catchment. We know therefore that the system can cater for flows up to the capacity of these pumping stations and that it is only at times of prolonged inflow above the pumping rate that issues occur. By understanding the historical groundwater treatment operation we are able to put a figure on the magnitude of flow reduction required. The two key sites are Stanbury Road WPS and Mullens Pond WPS. The table below shows the domestic flow rate, the estimated wet weather flow rate, the rate of flow pumped forward and the groundwater treatment rates and therefore the required rate of infiltration flow.

Site	Dry Weather Flow	Wet weather flow	Pump rate	Over pump rate	Infiltration
Stanbury Road WPS	4	11	15	15 – 20	15 - 20
Mullens Pond WPS	9	16	25	15 - 20	15 - 20

Table 2.2 – indicative infiltration rates

Success of the plan will be a reduction in the groundwater flow in the system leading to reduced tankering activity to maintain a sewerage service, relative to the groundwater level. This would likely require a reduction in infiltration by around 20 l/s during high groundwater seasons. However, it is not possible to measure success in terms of a rate of infiltration reduced as the rate is dependent of groundwater level. We need to identify an outcome based success measure.

Historically, tankering has commenced when the groundwater level exceeds 86mAOD at Clanville Gate borehole. This level has been exceeded 9 times in the last 14 years since 2009. It is recognised that as with all systems there will be a time when design parameters of this type are exceeded and particularly so when we have the variable of climate change influencing this measure. Following sealing work it is anticipated that tankering will not be required until the groundwater exceeds 88mAOD. If achieved this would halve the frequency at which tankering would be required moving from 9 times in 14 years to 4 times. On three occasions the groundwater table has exceeded 90mAOD, it is possible in these circumstances that all drains in the

affected catchments were surrounded by ground water in these high events hence the need for mitigating action. Analysis will be undertaken annually to determine the benefit of sealing work undertaken and the total length of sewer in various groundwater level bands to determine the practicality and likely cost associated with sealing sewers in these bands. This will then allow a measure of cost benefit to be determined. Part of the plan must be to determine this level of beneficial expenditure and then to identify mitigation measures required to enact on exceedance events.

3. Investigation & repairs

3.1. Outline Plans to Investigate Sources of Infiltration

The Generic Plan describes Southern Water’s Infiltration Reduction process. The specifics of the investigations and repairs in the Pan Parish are captured in Section 3.2 below, and include the following elements:

- Manhole Inspections and CCTV Surveys
- Flow Monitoring Surveys
- Manhole and Sewer Repairs
- Follow-Up Surveys and Repairs

3.2. Investigation and Repairs

Groundwater infiltration into sewers has been a long-running issue in the Pan Parish villages. Southern Water has been making significant investments over many years to minimise infiltration and reduce the need for intrusive mitigation measures.

SW recently completed a major programme of survey and repairs to the sewers in the area. The investigations and repairs followed the process set out in the Generic Plan (Appendix D). The timing and status of each step is in Table 3.1 below.

Table 3.1 – Summary of Survey and Repairs in in Pan Parish Villages

Step.	Description	Approx. Date	Status
1.	Manhole lifting followed by CCTV Investigation	Spring 2013	Completed
2.	Determination of required repairs	Summer 2013	Completed
3	Dry Weather Flow Survey (Fyfield and Kimpton)	07 August 2013 – 04 September 2013	Completed
4	Dry Weather Flow Survey (Mullen’s Pond/Thrupton)	08 August 2013 – 18 September 2013	Completed
5a.	Repairs at Mullen’s Pond/Thrupton (543m of sewer and 7 manholes repaired)	28 October 2013 – 24 January 2014	Complete

Step.	Description	Approx. Date	Status
5.b.	Repairs at Fyfield and Kimpton (892m of sewer and 3 manholes repaired)	14 August 2014 – 23 October 2014	Complete
6.	Wet Weather Flow Survey		Not carried out
7.	Limited follow up CCTV survey	Spring 2014 – Autumn 2014	Complete
8.	Further Targeted Repairs in Kimpton and Monxton	Winter 2015/16	Complete
9.	Ongoing monitoring	Commenced January 2015	Ongoing. Positive results: see below and Section 5.3.
10.	Electroscan surveys	November 2020	Complete
11.	Further surveys and subsequent repairs	Summer 2021 – Spring 2022	Complete
12.	Cover lifting on private laterals – Mullen’s Pond area	Summer 2020 – Spring 2021	Completed with results showing some locations of lateral drains leaking and further surveys identified
13.	Electroscan Surveys	2022	Complete
14.	Sewer sealing following electroscan	2023	Complete
15.	Include as a “Pathfinder” catchment and adopt a more intensive approach to reducing infiltration	2023	Complete
16.	Install temperature and level sensors in the system	2023	Complete
17.	Review data returned to target further investigation and sewer sealing activity	2023	Complete
18.	Seal sewers using appropriate techniques. Including leaking Private Laterals	2023/24	Complete
19.	Review the benefits delivered by the intensive approach with a view to recommending a similar approach elsewhere	2024	In progress
20.	Ongoing monitoring of the effectiveness of the approach	2024 onwards	In progress

Repairs carried out at the end of 2013 and in 2014 were successful in reducing infiltration; the initial planned repair programme was completed in October 2014. Completion of this work reduced flows to Monxton pumping station. The extent of the repairs is shown in the plans in Appendix A.

SW acknowledged that some infiltration remained, and therefore further targeted repairs were carried out in 2018 at points along the sewer network. This completed the second phase of sewer rehabilitation. Further work recently undertaken are CCTV surveys at Little Ann Bridge in 2019 and surveys of parts of Kimpton and Fyfield in 2020 using a technique called Electroscan. This innovative technique allows leaking sewers to be detected outside of a high groundwater season and has great potential to better understand the integrity of sewer networks.

In addition to physical investigations on site, SW has instigated a long-term monitoring programme in critical catchments, including the Pan Parish villages'. In the winter periods of 2014/15 to 2018/19 inclusive groundwater levels have not risen to the levels that they did in the winter of 2013/14. However, analysis of the flows and groundwater levels before and after the repairs, showed that in this catchment, for a given groundwater level, flows within the sewer network are lower than before the repairs. Indeed, the repairs appear to provide resilience against an additional 2-3m of groundwater (as measured at Clanville Gate borehole). Refer to Section 5.5 for details.

3.3. Private Drainage

It is important to note that infiltration into the sewerage system will occur where the groundwater level is above the invert level of sewers in the holistic drainage system. This is regardless of sewer ownership and may apply equally to the private lateral drainage system as to the public sewer network. However, the consequence of the infiltrating flow is most often manifest in the public network particularly at low points and where there are flow controls such as pumping stations. From a legal point of view it is the responsibility of property owners to ensure that private laterals are maintained in an adequate state of repair to avoid infiltration. As part of this sewer rehabilitation programme where privately owned lateral drains are found to be leaking discussion will be held with the Parish and District Council to agree the process whereby these issues are addressed and rectified. It may in some circumstances be preferable for Southern Water to undertake these repairs on a non-prejudicial basis.

In Fyfield, Kimpton and Monxton it was decided to progress the sealing of private drainage as part of our Pathfinder trial to understand the benefit this has on the infiltration rates. Detail about the sewers sealed is included in Section 5.

4. Groundwater treatment

4.1. Circumstances that lead to mitigation

Since 2013, SW has made significant investment to reduce infiltration and to protect specific properties at risk of flooding, with the objective of improving the service to customers at times of high groundwater and reducing the interruption to the sewerage service. Historically our action plans have included the use of groundwater treatment and overpumping into the watercourse to reduce the impact of groundwater on the system. However, this is no longer a viable option and in the future we will mitigate by the use of tankers only and will not divert excess flow through a groundwater treatment process, discharges to the watercourse will therefore no longer occur.

If groundwater levels rise to above pre-determined trigger levels mitigation measures at certain locations will be required. The requirement for tankering is driven by levels in the manholes locally. Based on experience in 2013 and 2014, tankering could be expected to be required when the groundwater level at Clanville Gate BH reaches 88m (as illustrated in Figure 4.1). However, to allow time for investigation and preparation, SW is using lower 'trigger levels' as part of planning operational response. Trigger levels of 84m in Thruxton, Fyfield, Kimpton and Monxton are used. Figure 4.1 also shows the levels at which over-pumping was required during the 2013-14 period at 88 mAOD. In 2021 and 2022 this trigger level was not attained and tankering was not required. However, following the wet summer, through autumn into winter 2023 groundwater levels in November 2023 were at their highest for the time of year since the IRP was developed in 2013.

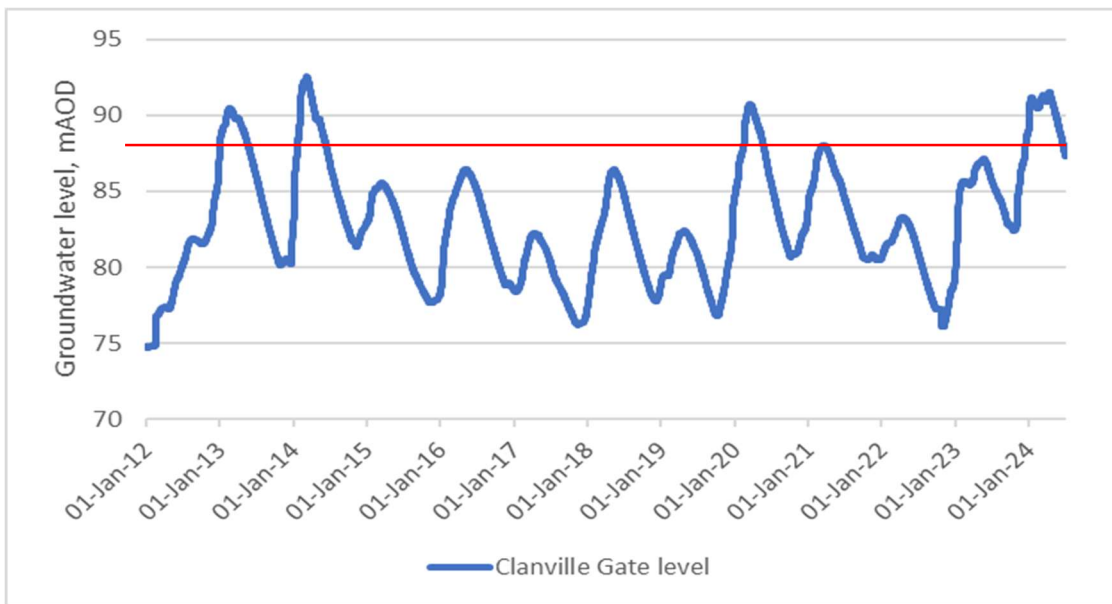


Figure 4.1 – Groundwater levels from 2012 to 2023

Due to the work undertaken in autumn and winter of 2023 to seal leaking sewers in both the public and private systems the tankering operation in 2023/24 was a much lower scale and duration than has been required in previous years. In addition no over-pumping to watercourses was undertaken.

In the wettest winter recorded in 2023/24 the excess infiltration flow was managed by tankering with no requirement to treat and discharge groundwater. The option to treat groundwater has now been discounted as a mitigation activity.

Details of tanker locations are given in Appendix B.

4.2. Steps to prevent discharges and alternatives to over-pumping

The Generic Plan details the typical activities that Southern Water undertakes to minimise the requirement for discharges to watercourses. Since 2013, SW has undertaken extensive surveys and repaired sewers and manholes where infiltration had been found (the extent of the work is shown in Appendix A). This built on the repairs that had been carried out in previous years (also shown in Appendix A).

Following the main repairs, further targeted repairs were completed. In addition to this work, SW also carries out other activities to minimise the requirement for discharges to watercourses.

In 2023 we embarked on a more holistic approach in the Pan Parish as a trial for other systems with similar issues. This Pathfinder approach can be viewed in more detail on our website address: [Pathfinder: Pan Parishes - Southern Water](#). This involved extensive survey and investigation work during the high groundwater period to identify leaks in public and private sewers starting at the upstream of the system in Fyfield, Kimpton and Thrupton and then to seal these leaks whilst groundwater was high. This approach has been highly effective and the areas of sealing are shown in Appendix A.

4.3. 3rd Party Communications about groundwater treatment

Since the start of the Infiltration Reduction Programme in 2013, Southern Water has been active in communicating with stakeholders and customers about planned and completed work to improve the integrity of the sewerage system. Stakeholders have been kept informed of progress on survey and sealing work via emails and or face-to-face meetings.

SW attends and convenes meetings with a number of local groups. In particular the Pan –Parish Multi-Agency Group which has recently been active in co-ordinating the issues in the catchment. During the winters of 2014/15 and 2015/16, SW and the EA held weekly conference calls to discuss locations where total flows in the sewers were reaching the point where SW would need to respond imminently with tankering or over-pumping..

Despite the repair work being undertaken it may be that higher groundwater levels than have been recorded may trigger the need for further mitigation measures in the form of tankering points in addition to those in Appendix B. If required these will be discussed with the Pan Parish forum in advance of deployment.

2023/24 was the most prolonged period of high groundwater we have seen following the extremely wet autumn/winter period. As shown in Figure 4.1 the peak groundwater level was close to that of 2013/14 and the levels remained high for longer. Despite this, the mitigation measures needed this winter were far less than previous years and no groundwater treatment measures were used. We do not propose to use groundwater treatment as a mitigation measure in the future. All mitigation required will be by tankering from the locations shown in Appendix B.

A very important lesson learned from the Pathfinder approach has been that community engagement is critical to the success of the project. We are very grateful to the Pillhill Pan Parish Forum for facilitating our engagement activities on this project and assisting in the smooth delivery of the improvement work undertaken.

5. Options to Reduce Infiltration

5.1. Sewer Rehabilitation Programme

Infiltration reduction is an on-going and iterative process. In recent years, SW has surveyed 9.1km of sewers and sealed 1.9km which were found to be allowing groundwater into the system. In addition 18 manholes where groundwater was leaking in through brickwork or concrete rings have been sealed. See Appendix A for the location of repairs completed.

In 2021/22 surveys by a technique called electro-scanning were undertaken. A further 7.1km of sewer was surveyed using this technique and defects identified are currently being repaired by lining the leaking sewers.. The sewers where electroscanning has been undertaken are shown in figure 5.1 below. These sewers were selected due to their proximity to the watercourse and elevation relative to groundwater table and are the most likely to be susceptible to infiltration. The survey results were reviewed on completion and all defects identified were rectified in a sewer lining programme in 2023.

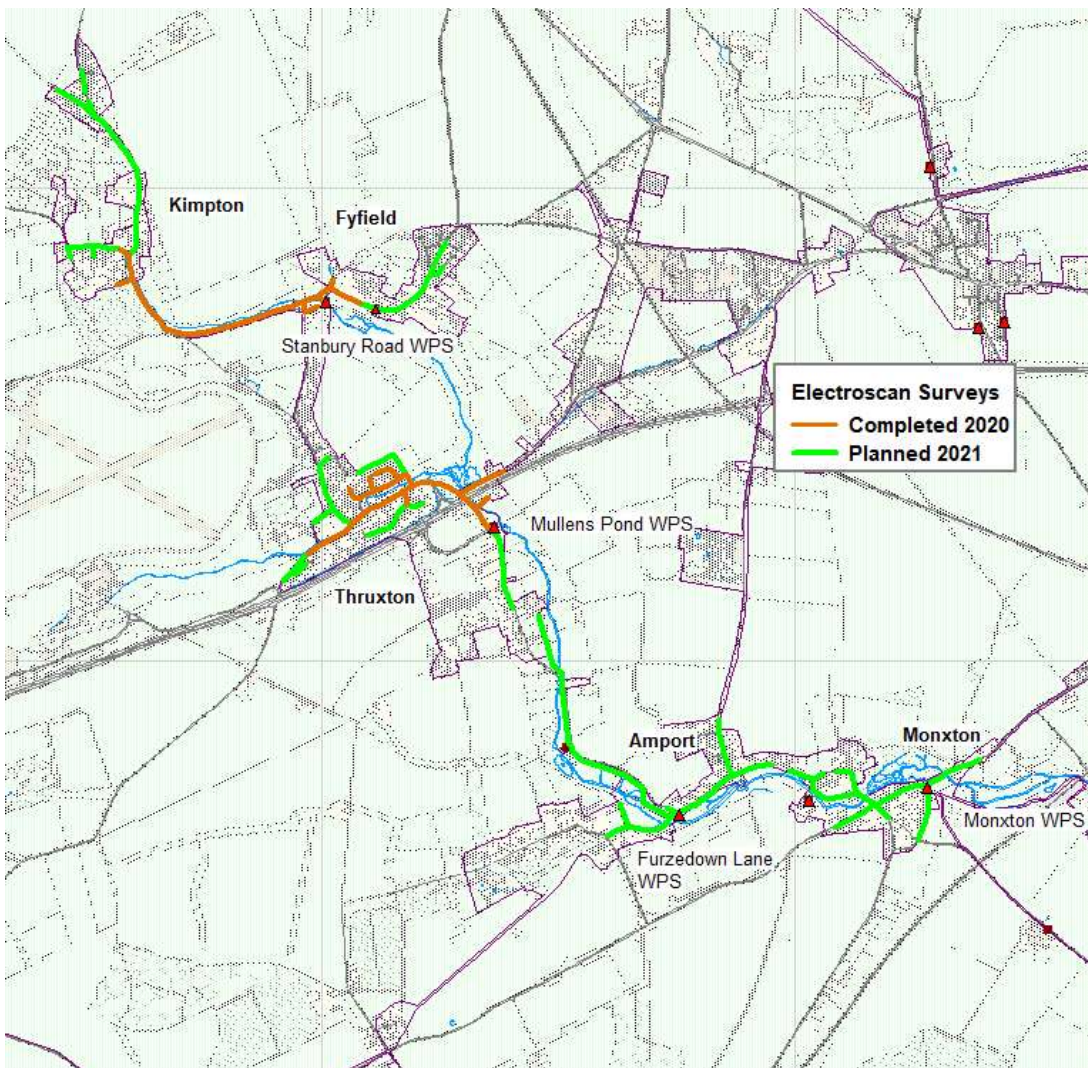


Figure 5.1 – Locations of electroscan surveys

In addition to the lining of public sewers in 2023 we embarked on a new pilot approach called Pathfinder. Using this approach we undertook surveys when the groundwater was high to identify other leaks in both the public and private sewers and sealed these leaks immediately following inspection. This approach was used at the upstream part of the system in the villages of Kimpton, Fyfield and Thruxton which drain to Mullens Pond pumping station. In total around 5km of sewer were sealed, approximately 2.5 km of public sewer and 2.5 km of private sewer. This had a significantly beneficial impact on the system and we were able to manage the residual groundwater flow with 5 tankers and no groundwater treatment. In the past before any sewer repairs we managed the flow by the use of 38 tankers and groundwater treatment leading to discharges to the watercourse.

See Appendix A for the location of repairs undertaken and planned. Table 5.1 below summarises the work completed through the Pathfinder Project.

Village	No. Properties addressed	Length private sewer sealed (m)	Length of public sewer sealed (m)	Total
Kimpton	97	795	570	1365 m
Fyfield	128	1027	632	1659 m
East Cholderton	19	196	1125	1321 m
Thruxton	57	439	39	478 m
Monxton	-		175	175 m
Total	301	2457	2541	4998 m
Manholes sealed				120 manholes

Table 5.1 – Summary of work completed by Pathfinder

Reporting Year	Length CCTV'd (km)	Length electroscanned (km)	Length repaired (km)	Manholes repaired
2014	1.8	0m	0.8	12
2015	0.2	0m	0.7	2
2016	0.4	0m	0.3	1
2017	0.9	0m	0.2	0
2018	0.1	0m	0m	0
2019	0m	0m	0.4	1
2020	0m	0m	0m	0
2021	0m	0m	0m	0
2022	0m	6.2	0.4	0
2023	0m	0m	0.8	0
2024	0m	0m	3.3	3
Post 2024	0m	0m	0.3	0

Table 5.2 - annual summary of work completed

5.2. Property Level Protection

Non-return valves have always been part of Southern Water's armoury for dealing with infiltration, but they are only effective if infiltration is under control on both the lateral and the main sewer. In December 2013, a micro-pumping station incorporating a non-return valve was installed to protect a group of properties near Stanbury Road WPS. This has provided successful property level protection for the local residents.

Whilst there are no plans currently to install further non-return valves, the potential benefit of property level protection will be investigated, if it is deemed appropriate following completion of the current repairs.

5.3. Pumping Stations

In order to minimise the effects of infiltration, SW is continuing to ensure that design discharge rates are maintained at pumping stations. At Monxton WPS, the pumps were replaced in spring 2014 with a greater output flow and later in the year a bund was constructed around the pumping station to contain spillage from the station in the event of spills occurring.

A number of additional modifications have been carried out to the pumping station in order to reduce problems of vibration which have been felt nearby. A number of specialist contractors have assessed the site along with further technical consultation with pump manufacturers. Trials of installing baffles, changes to the pump impellers, and installing variable speed drives, and other acoustic measures to reduce vibration and noise have been undertaken and no complaints have been received since the work was completed.

The rising main from Monxton WPS was replaced in 2001 with a 280mm outer diameter (OD) SDR17 polyethylene (PE) pipe. It is 814m long, then drops into a gravity 355 mm OD PE sewer which was laid at the same time as a 'pressure sewer' from Manor Farm onward. The capacity for the rising main is 82 l/s with a design velocity of 1.8m/s and the capacity for the gravity 355 OD sewer is just over 200 l/s max. However, there is a valve to control the flow rate in the gravity section at Abbots Ann. This is essentially a service valve to ensure access can be gained to the vacuum main but it can also be used to regulate flows transitioning between the vacuum main and the gravity system below by partially opening the second valve to allow more flow through. The normal position of the valve is partially closed as allowing too much flow through significantly increases the risk of flooding downstream.

5.4. Monitoring

The Pan Parish area is one of ten locations, where groundwater levels have been monitored via electronic data since January 2015. This monitoring helps inform SW's response, in terms of when tankering and over-pumping are required. The Generic Plan has more detail on the overall monitoring strategy.

The graph below, in Figure 5.2, is an example of those used for predicting the earliest, average, and latest dates for when the trigger levels are forecast to be breached. This graph shows groundwater levels and an indication of flows. Despite the groundwater level in 2023/24 exceeding the groundwater treatment trigger level due to the sewer sealing work in the area we did not need to resort to groundwater treatment and mitigated any high sewer flows by tankering. We will continue to use these trigger points in the future with a view to revising them over time based on the effectiveness of the sewer sealing programme.

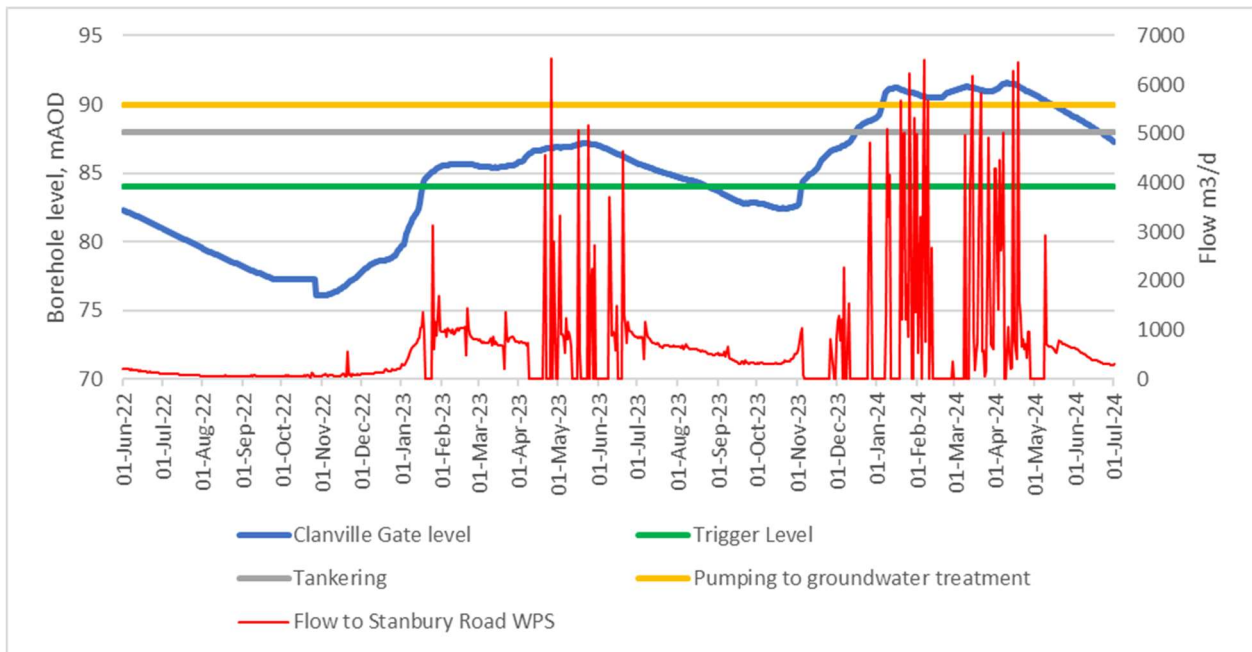


Figure 5.2 – Groundwater and trigger levels

In addition to the groundwater flooding forecasts explained above, SW is also looking at longer-term trends to monitor the effectiveness of the completed rehabilitation work. Figure 5.3 shows the groundwater levels at Clanville Gate borehole plotted against flows at Mullen’s Pond WPS.

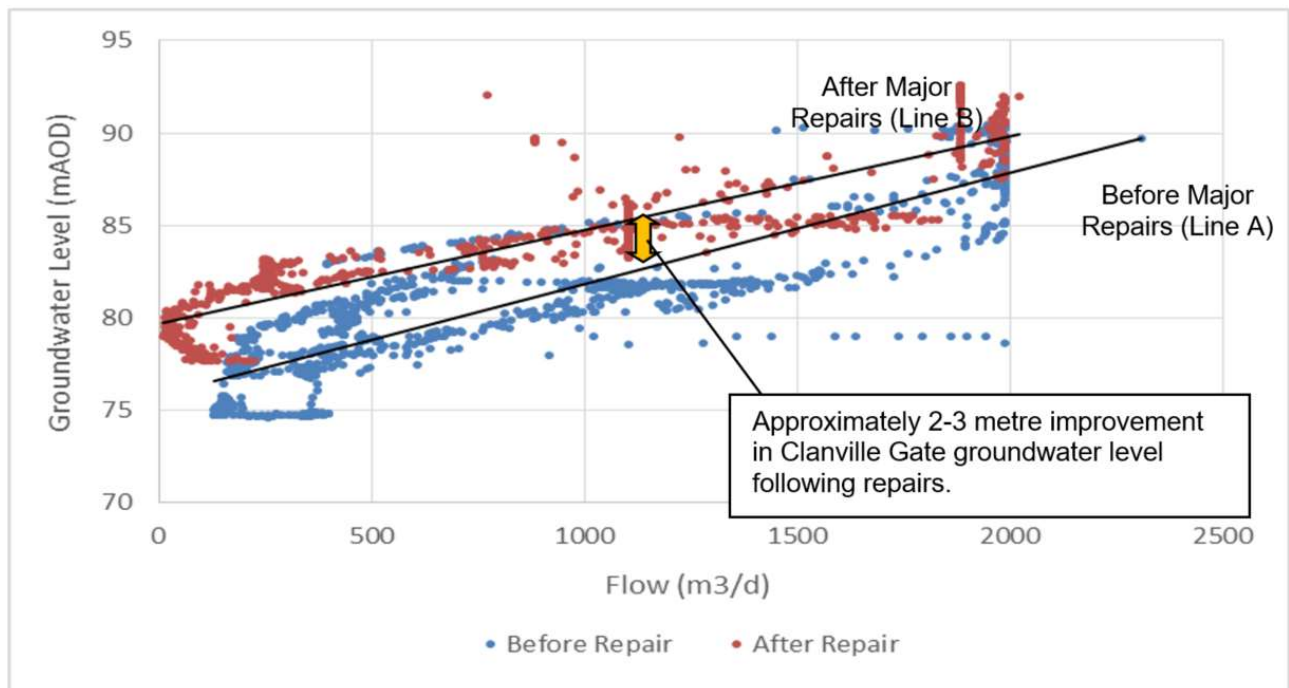


Figure 5.3 – Long Term Monitoring (Aug 2010 to Nov 2015)

Figure 5.3 quantitatively illustrates how flow varies with groundwater levels, based on data between August 2010 and November 2015. There is a reasonable correlation that as groundwater levels increase, the rate of infiltration increases. Therefore Figure 5.3 can be used to assess how effective the repairs have been. In

Figure 5.3 two distinct periods are outlined: Aug 2010 – Oct 2013 (blue dots and lower trend line before the major repairs at Mullen’s Pond), and Feb 2014 – Nov 2015 (brown dots and higher trend line after the major repairs).

Lines A and B in Figure 5.3 show how values of flow for a given groundwater level vary before and after the repairs. At the point with the yellow arrow before repairs (the lower trend line) we were recording around 1200 m³ of flow per day when the groundwater level was around 82.5m. After the repairs the groundwater level had to be above 85 m to give the same flow in the sewers. As the groundwater now has to be at a higher level before infiltrating the system this shows the sealing approach has been effective. However, the graph also shows that there is work to do as infiltration is still entering the system at higher levels.

This analysis will be repeated following the extensive Pathfinder sewer sealing work to determine the effectiveness of the repairs which are to be completed in the period 2021-2024.

Historically, prior to any major sealing programme we needed to deploy tankers to extract flow from the system when groundwater was at 84mAOD. Due to the sealing work we are finding that groundwater now needs to be at a higher level before tankers are required.

Our revised trigger levels following sealing work to date are bulleted below. We will review these annually to take account of latest data following further sewer sealing work. Over time we should see the trigger levels rise as sewers are sealed and the need for tankering to reduce.

- 84mAOD and rising, we prepare for responding to groundwater
- 88mAOD we anticipate requiring tanker support until groundwater levels subside
- 90mAOD is included as a reference point as this is the level at which we have previously sought permission to over pump. However, we no longer plan to use this mitigation option.

6. Action Plans

A significant amount has been achieved in the Pan Parish area in the last eight years. Some actions are ongoing which reflects the continuous improvement process for dealing with infiltration due to groundwater. To make it easy to track progress, the following tables set out the actions to reduce infiltration and also to mitigate the effects of it, if the infiltration cannot be controlled at economic cost. Tables 6.1 and 6.2 cover the actions by SW and by other parties, respectively, to reduce infiltration. Tables 6.3 and 6.4 cover mitigation of the effects of flooding (Communication and other activities).

Southern Water is committed to continuing to reduce infiltration to reduce the frequency of mitigation action such as tankering flows. This IRP describes the work that has been done by SW to improve the situation. In addition, it also describes what is being done to monitor flows, the 'winter preparation' work to be carried out to ensure assets are operating correctly, and the work to be developed with other agencies to improve an integrated plan to address flooding.

Colour coding of actions in tables:

- Green – completed
- Orange – imminent action required
- Red – overdue
- White – on-going actions with no specific end dates.

Table 6.1 – Southern Water Current Activities to Reduce Groundwater Infiltration

Ref.	Item	Actions	Timescale and Status	Outcomes
1.1	Develop an approach for reduction of infiltration and maintenance of reduced levels of infiltration.	Refer to Section 3 above and the report in Appendix A.	Summer 2013, Complete	The steps are being followed to deliver results.
1.2	'Dry weather' flow surveys (to measure background levels of infiltration during low groundwater periods)	Identify suitable measurement points, carry out survey over four week period in Summer, match rainfall records with flow data.	August/September 2013 - Complete	Groundwater infiltration is greater than would be expected for summer conditions.
1.3	CCTV etc. survey of sewers	Identify Strategic Manholes, survey manholes to identify clear flow and infiltration. Carry out CCTV survey where clear flow was identified.	Spring 2013 - Complete	Identify major sources of infiltration to determine scope of rehabilitation work.
1.4	Carry out sewer rehabilitation work	Use various techniques to seal infiltration points in manholes and sewers	Mullen's Pond/Thrupton October 2013 – January 2014 – Completed Fyfield and Kimpton	Structural integrity of sewers restored.

Ref.	Item	Actions	Timescale and Status	Outcomes
			14 August 2014 – 23 October 2014 Completed	
1.5	Further surveys (CCTV or alternative techniques), if required, where 'wet weather' flow surveys show areas of high infiltration remaining	Further surveys in areas where high infiltration flows remain.	Spring 2014 – Autumn 2014	Determine scope and carry out further rehabilitation if identified as required from the survey results.
1.6	Further sewer rehabilitation work, if required, in areas where surveys carried out.	As above, use various techniques to seal infiltration points in manholes and sewers	Kimpton and Monxton Winter 2015/16 – Completed	Reduced infiltration, leading to reduced requirement for tankers.
1.7a	Maintain IRP as a live document	Review text of the IRP and update if appropriate to describe work carried out and/or developments	Annually	To be issued by 30 September each year
1.7b	Maintain IRP as a live document	Review Tables 6.1 to 6.5 and as appropriate amend to show progress on individual activities.	Quarterly	Up to date tables of Actions. To be issued every 3 months following the annual update. End each December, March, June, September
1.8	Consider alternative solutions that involve some risk	Investigate unconventional options such as vacuum sewers or consider conventional combined sewer overflows	2020	Ongoing.

Ref.	Item	Actions	Timescale and Status	Outcomes
1.9	Over-pumping Sites: improve effluent quality	Investigate potential for improved screening and basic treatment at points of discharge into watercourse.	SW, Summer/Autumn 2014	Improved arrangements for discharges when required.
1.10	Over-pumping Sites: minimise flow	Add level control to pumps to reduce durations for pumping	SW, 2014, Complete	Establish whether seasonal discharge (s) will be necessary in order to maintain use of sewerage services for customers during periods of very high groundwater levels.
1.11	Standards for emergency discharges	SW to discuss with EA about best practice set up for over-pumping arrangements.	SW, 2014, included in this IRP	Agree with EA acceptable treatment for discharges and acceptable flow rates.
1.12	Flow, location, screening arrangements for emergency discharges	Determine potential flow rates and screening arrangements and most appropriate locations,	SW, included in this IRP	Agree with EA, Hampshire CC, Test Valley Borough Council and local Parish Councils acceptable arrangements for future emergency discharges.
1.13	Action Plans	Develop SW action plans documenting set up of pumps, tankers, etc. for emergency situations.	SW, Summer 2014- Complete	Action Plan available for planning sessions with other authorities in preparation for repeat flooding events. Engagement with the local community about the potential arrangements for dealing with excess flows into sewers to mitigate disruption to customers.
1.14	Identification of lengths of sewer to survey or resurvey in the period 2021-25	Review sewer records with available ground water profile data	Summer 2021	Complete surveys to take place from September 2021

Ref.	Item	Actions	Timescale and Status	Outcomes
1.15	Surveys by CCTV or electroscan lengths of sewer potentially at risk	Compare historical survey coverage with results of 1.15 and produce a survey schedule.	Summer/Autumn 2021	Complete
1.16	Survey result review	Review results of surveys undertaken in 1.16 to determine sewer sealing work.	Autumn/winter 2021	Complete
1.17	Undertake required sewer sealing	Seal sewers and manholes by most appropriate technique. Phase 1 - committed repairs – 350m by end Oct 21 Phase 2 – to be completed end Dec 21 Phase 3 – to follow on from surveys	From Autumn 2021 as conditions allow	Phase 1 to commence end September 21 Phase 2 to progress on completion of phase 1
1.20	Holistic drainage review as a Pathfinder project approach	Consider the whole drainage system and interactions to identify opportunities to improve drainage and resilience	From summer 2023	Complete
1.18	Review effectiveness of any sealing work	Analyse monitoring data and groundwater data to determine benefit of investment	From summer 2024	In progress
1.19	Review further options for property protection and alternative tanker points	Consider improvements at Manor Farm	From Summer 2024	In progress

Table 6.2 – Multi-Agency Activities to Reduce Groundwater Infiltration

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
2.1	Long-term Monitoring	SW will monitor sewer flow to identify significant increases in inflows.	Ongoing	Early identification of areas where infiltration has increased
2.2a	Investigate highway ‘mis-connections’	Where non-sewage flow is identified, check highway drainage relative to sewers to ensure road drainage is not a source of flow into the SW sewers	Hampshire County Council with support from SW, 2014 onwards. To be pursued as and when required.	Reduced flow of surface water (if connections are found). Complete – no highway drainage connections found to the foul sewer.
2.2b	Investigate groundwater infiltration on domestic drains	Where non-sewage flow is identified from domestic properties, investigate to identify source of flow into SW sewers	SW, with assistance from Test Valley County Council where required, 2014 onwards. To be pursued as and when required.	Reduced flow of surface water (if connections are found). Complete in Fyfield, Kimpton and Thruxton
2.3	Consider effects of proposed new developments on infiltration.	District Council to continue to consult with SW on development applications.	District Council, Ongoing.	Developments in areas which would be detrimental to sewer flooding, to have conditions recommended by SW and applied, as appropriate, by the City and District Councils. Ongoing day to day activity
		SW to determine threshold above which they require to be consulted.	District Council, Ongoing. SW wish to be consulted on all proposed development.	
		Sewerage materials for new developments	SW & District Council, when developments are at planning approval stage. Ongoing.	

*Note: Southern Water does not have powers to require residents to repair private drains. Hence the support of the other agencies is required. It is acknowledged that customers may not be aware of infiltration in their private drains, so SW will consider ways of obtaining information to demonstrate the presence of infiltration. District Councils would only be able to instigate action under Section 59 of the Building Act where proof/evidence is provided of the defect.

Table 6.3 – Publicity / Communication Activities to Reduce / Mitigate the Effects of Groundwater Infiltration.

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
3.1	Public meetings about reducing groundwater infiltration into sewerage system	Attend public meetings with other agencies as appropriate.	SW, as required	Inform stakeholders of progress and planned activities and receive feedback. Ongoing
3.2	Comms from SW to stakeholders about reducing groundwater infiltration into the sewerage system	Send comms at regular intervals to communicate progress and planned activities	SW, as required	Inform stakeholders of progress and planned activities. Ongoing
3.3	Multi-Agency Group meetings	Discuss and agree actions to reduce requirements for tankering and emergency discharges to watercourses.	All Parties now as part of the Pan Parish multi Agency meeting	Improved understanding and appreciation of issues. Agreement to actions to help reduce the need for tankering - ongoing
3.4	Implement local campaign to discourage misconnections	Publicise through parish councils. Include article in Parish magazines. **	District and Parish Councils, Summer 2014 Complete	Article included in Hampshire County Council magazine.

** SW can provide base information to councils to include in articles publicising the role that everyone can play in minimising non-sewage flows into sewers, and the importance of doing so to reduce the incidence of restricted toilet use during periods of high groundwater.

Table 6.4 – Activities to Mitigate the Effects of Groundwater Infiltration/ Other Flood Protection Mechanisms

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
4.1	Early Warning system	Joint continuous monitoring of groundwater levels and sewer levels/flows.	SW, EA, 2014. Ongoing. Commenced Jan 2015. Re-commenced annually	Develop trigger levels by comparing historic customer complaints and tankering with BH levels (or other reference). In place and ongoing monitoring
4.2	Tankering arrangements	Investigate options for improving location of tankers and over-pump units for future events. e.g. by use of longer hoses/ pumping	SW, Spring 2014, Complete	Potentially less disruption to residents when tankering / pumping is essential.
4.4	Flooding Management Plan	Develop plan to address the flooding issues caused by high groundwater. Implement recommendations.	Hampshire County Council & Test Valley Borough Council with inputs from SW, EA, and Parish Councils	Plan including actions for participating authorities, which in unison will reduce the extent of flooding and the impact of flooding.
4.5	Maintenance of watercourses	Riparian owners to carry out their responsibilities to maintain adequate flow through watercourses by clearing vegetation, desilting, etc.	Riparian owners with input from District and Parish Councils – ongoing responsibility	Maximise the flow along watercourses in order to minimise surface flooding, which results in inundation of manholes to the sewerage system.

Appendix

A Survey Findings and Rehabilitation Completed

B Emergency Discharge Sites