Infiltration Reduction Plan
Nailbourne

February 2017
Version 7.1

WATER for LIFE

from Southern Water

Contents

Document Control

Version	Date	Prepared by (Author)	Reviewed by	Approved by
D1	Sept 2013	MWH	Graham Purvis	Graham Purvis
2	6 January 2014	Richard Andrews	Graham Purvis	Martin Banks
2.1	21 February 2014	P Kent		
3.0	24 March 2014	André Bougard	Paul Kent	Richard Andrews
4.0	August 2014	André Bougard	Paul Kent	Graham Purvis
5.0	8 October 2014	Richard Andrews	André Bougard	Paul Kent
6.0	21 November 2014	Richard Andrews	André Bougard	Paul Kent
6.1	4 December 2014	Richard Andrews	Paul Kent	Mark Thompson
6.2	8 December 2014	Richard Andrews	Paul Kent	Mark Thompson
7.0	10 February 2016	Matthew Sadie	Richard Andrews	Paul Kent
7.1	February 2017	Richard Andrews	Mike James	Graham Purvis

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

RPS - Regulatory Position Statement

SW – Southern Water

WaSC - Water and Sewerage Companies

WC – Water Closet

WPS - Wastewater Pumping Station

WTW - Wastewater Treatment Works

Executive Summary

In the last four years Southern Water has invested £1.65 million in surveying and repairing the local sewer network. The improvements in the Newnham Valley, from Ottinge in the south to Littlebourne in the north, formed a significant part of the £14 million being invested by Southern Water during 2013 to 2016 to improve the performance of the sewers in sixty towns and villages affected by high groundwater levels across the company's region.

In this update of the Nailbourne IRP, Southern Water has taken the opportunity to streamline the structure of the plan to lead the reader through the steps taken to reduce infiltration and to explain the success of the programme. The sections of the IRP follow the current version of the Environment Agency's Regulatory Position Statement.

Section 1 explains how the sections of the Dec 2014 version of the IRP are mapped to sections in the current version. It also explains which IRP sections address which sections of the RPS.

A significant number of unusually wet winters in recent years resulted in exceptionally high flows in the Nailbourne and high groundwater levels for extended periods of time. During the winters of 2012/13 and 2013/14 (the wettest winter on record), flows in the sewers exceeded their capacity and unfortunately in both years, it was necessary to make discharges from the sewers to the Nailbourne in order to maintain services to SW customers. The history of recent flooding is quantified in Section 2, together with an acknowledgement by SW that infiltration was sufficiently significant that action was required to reduce it.

The generic approach adopted by SW for its Infiltration Reduction Programme is explained in Section 3, together with a description of new plans included in Appendix A, which show surveys, infiltration points and repairs all on a single plan for each area. A table of key dates for surveys and repairs is included in Section 3.

The work carried out has made a significant improvement to the resilience of the sewerage system to resist infiltration. The difference in relation to over-pumping and tankering is described in Section 4, together with an explanation of steps that SW is taking to prevent discharges needing to be made to the watercourse during high groundwater conditions. The pros and cons of tankering and over-pumping are included; as are the factors considered when having to decide whether over-pumping is required to avoid danger to health and to maintain sewerage services to customers. This section also summarises SW's plans for communications and arrangements for monitoring water quality, if over-pumping is required.

SW has also carried out other work to reduce the requirement for over-pumping (such as installing some property level protection for vulnerable properties), which is described in Section 5. Since January 2014, SW has been running a winter groundwater monitoring programme. Weekly reports are shared with the EA and the information is used to help plan responses should flooding occur. Taking a longer-term view, analysis of the benefits of the investment are also included. Since the repair works have been carried out, there has been a noticeable difference in the way the sewerage network behaves during periods of high groundwater levels. Analysis of long-term data supports the view that infiltration to the sewage network has decreased since the repair work has been carried out. It was found that in the Newnham Valley catchment, for a given groundwater level, flows within the sewer network are lower than that before the repairs. Indeed, the repairs appear to provide resilience against an additional 1.5m – 3m of groundwater (as measured at Little Bucket).

1. Background

The Environment Agency's (EA) Regulatory Position Statement (RPS) requires Water and Sewerage Companies (WaSC), which are aware of sewerage systems in their area which are vulnerable to infiltration, to submit Infiltration Reduction Plans (IRP) to the EA for approval. This document is produced in response to the RPS.

The purpose and nature of the IRP is that it will be updated by Southern Water (SW) annually and show the latest information regarding the progress of work in the area to reduce infiltration. Therefore there will not be a 'final issue' of the plan; it is a working document, which will be updated as required.

SW has been carrying out work for many years to survey and repair sources of infiltration in the catchment for Newnham Valley Wastewater Treatment Works (WTW) in Kent. The extent of the catchment is represented in the map on the following page. Flows from Barham gravitate northwards through Kingston, Bishopsbourne, and Bridge. The resultant flow gravitates in a north-easterly direction to School Lane WPS in Bekesbourne from where it is pumped to Newnham Valley Works. Flows from Littlebourne gravitate to Nargate St WPS from where it is pumped to join the gravity flow downstream of the rising main from School Lane WPS. The resultant flow gravitates in a north-easterly direction to Newnham Valley WTW in Preston. Sewage flows from adjacent sub-catchments to the north and east are also received by Newnham Valley WTW.
The villages of Elham and Ottinge are south of Barham and lie within the catchment of Hythe WTW which is represented in a second map. Flows from Elham are pumped southwards from The Orchards WPS to Ottinge WPS. Flows from Lyminge also gravitate to Ottinge WPS from where the resultant flow is pumped southwards to Etchinghill and on to Hythe WTW.
Southern Water (SW) communicates with other agencies. In particular during flooding events, SW works closely with these bodies to minimise the inconvenience to residents.

The repairs carried out by SW improve the integrity of the sewerage system. SW 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,
- Kent County Council,
- Canterbury City Council
- Shepway District Council
- Little Stour & Nailbourne River Management Group

Southern Water has consulted with representatives of these parties in the meetings of the Little Stour & Nailbourne Multi-Agency Group and also, through the river management group, with all of the local parish councils.

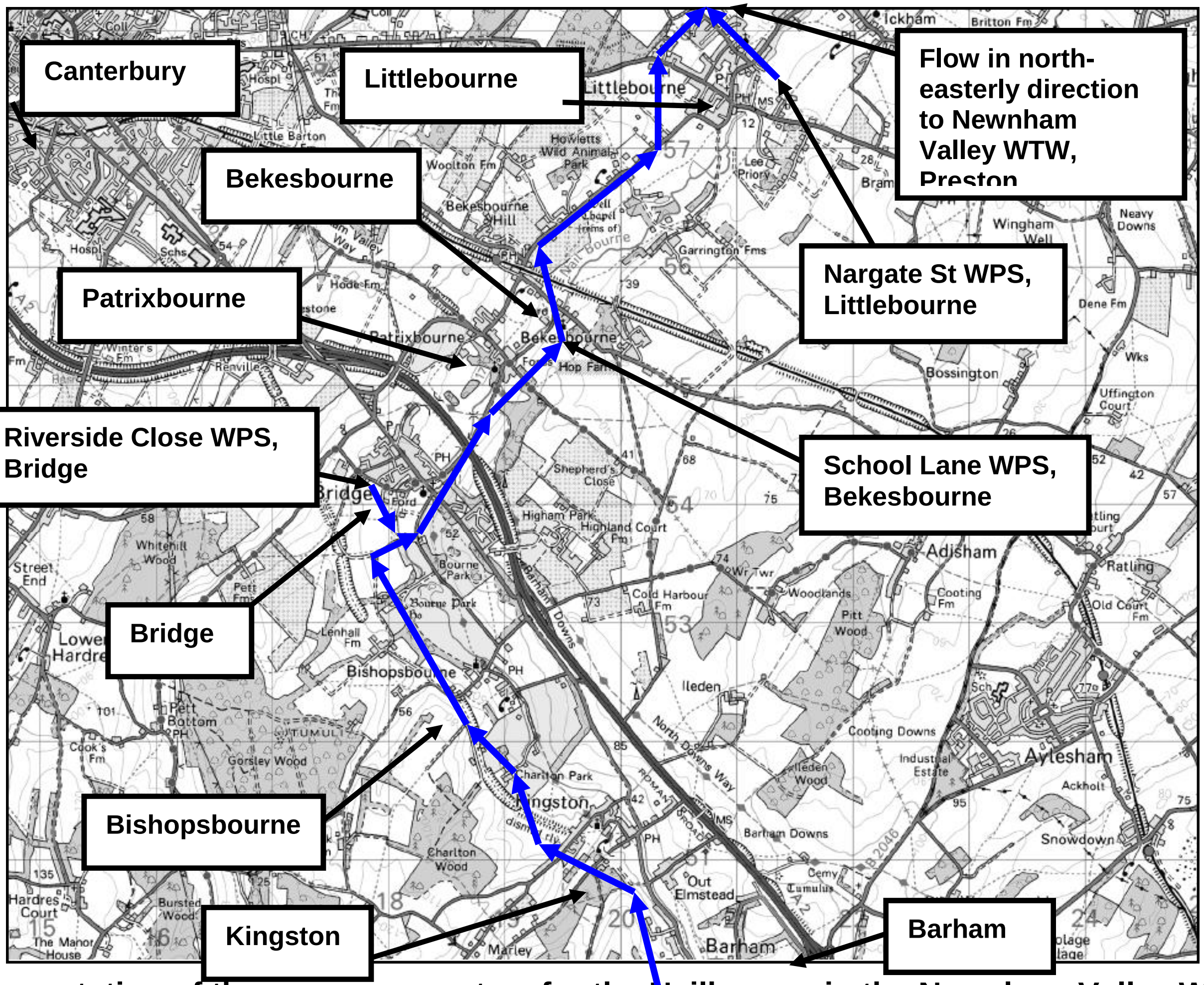

Figure 1 - Representation of the sewerage system for the Nailbourne in the Newnham Valley WTW catchment

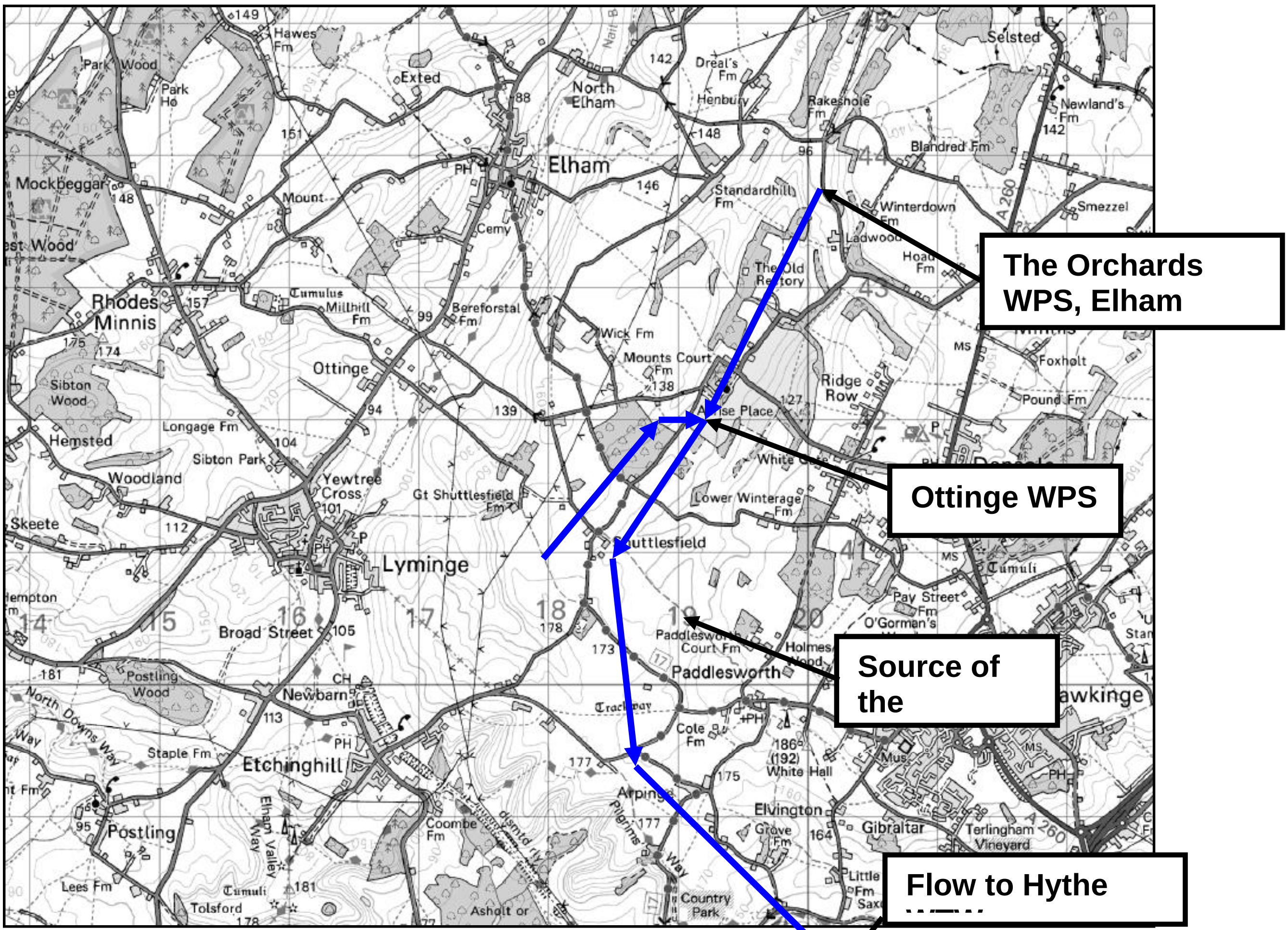

Figure 2 - Representation of the sewerage system for the Nailbourne in the Hythe WTW catchment

2. Groundwater Infiltration at Nailbourne

2.1. The significance of groundwater infiltration at Nailbourne.

Nailbourne 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. Excess groundwater which gets into the sewers prevents sewage from customers' properties being able to be conveyed satisfactorily to the treatment works. During these conditions, some customers suffer restriction in use of their bathroom, toilet and kitchen facilities. 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 over-pumping.

Such measures are not popular, so during the last three years SW has invested £1.65m carrying out major improvements to the integrity of the sewers and manholes in the vicinity of the Nailbourne in order to minimise the occasions on which over-pumping 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 sewer flooding have been relatively infrequent. Table 2.1 and Figure 2.1 below show reported incidents of sewer flooding since April 2000. Average winter rainfall is also included in Figure 2.1.

Sewers are designed to accommodate normal flows, which includes an allowance for groundwater. However, during particularly wet winters, the capacity of the sewers is exceeded, resulting in spillages and sewer flooding. In addition to repairs to the sewers, Southern Water has a standard process which it follows each autumn/winter to ensure sewers are flowing freely. Consequently, it is difficult to assess what the effects of groundwater infiltration would be if no action were taken. It is likely that more customers would suffer loss of sanitation, and more manholes would spill if SW did not carry out the pre-winter checks and rehabilitation of the sewers.

In some catchments, SW has hydraulic models of the sewers which can be used to predict the locations where the sewers are expected to flood during certain storm conditions. A model of the Nailbourne catchment was developed in 2014, as part of the investigation into the potential use of a Control Structure - which is described in Section 5.5. However from experience, SW is aware of the villages and properties which are likely to be the first to suffer from the effects of flooding.

Table 2.1 shows that there has been two reported instances of internal sewer flooding since 2000, both of which occurred in winter 2013/14 - the wettest winter on record. Incidents of External Flooding and Restricted Toilet Use occurred more frequently; external flooding has been reported on seventeen occasions since April 2000 and restricted toilet use, ten times. Again, it can be seen that most of these incidents occurred in the winter of 2013/14.

Definitions of Categories of Flooding

Internal Flooding occurs when sewers either back-up to such an extent that dilute effluent floods inside dwellings from low connections to the drains (for example through WCs or shower drains) or when contaminated surface water enters the building where this is a direct consequence of sewer flooding.

External flooding at a property is defined as flooding to external areas within the curtilage of the property, due to sewers becoming surcharged. The flooding will normally be from a surcharged manhole or gully. External flooding can be contaminated surface water entering the grounds of the property. There are two other categories of external flooding: Highway flooding refers to flooding on roads or footpaths. ‘Other’ external flooding refers to non-residential buildings and public open spaces.

Restricted Toilet Use may be experienced by customers as the sewers become surcharged. Toilet facilities still function, but effluent will be slow to drain away and sometimes facilities can only be used for limited periods – for instance after a tanker has removed dilute effluent from the local sewers.

Year	External Flooding	Internal Flooding	Restricted Toilet Use	Total
2000_2001	0	0	0	0
2001_2002	0	0	0	0
2002_2003	0	0	0	0
2003_2004	0	0	0	0
2004_2005	0	0	0	0
2005_2006	0	0	0	0
2006_2007	0	0	0	0
2007_2008	0	0	0	0
2008_2009	0	0	0	0
2009_2010	1	0	0	1
2010_2011	0	0	2	2
2011_2012	0	0	0	0
2012_2013	4	0	0	4
2013_2014	10	2	7	19
2014_2015	2	0	1	3
2015_2016	0	0	0	0
Totals	**17**	**2**	**10**	**29**

Table 2.1 – Reported Flooding Incidents by Category, in Newnham Valley Catchment

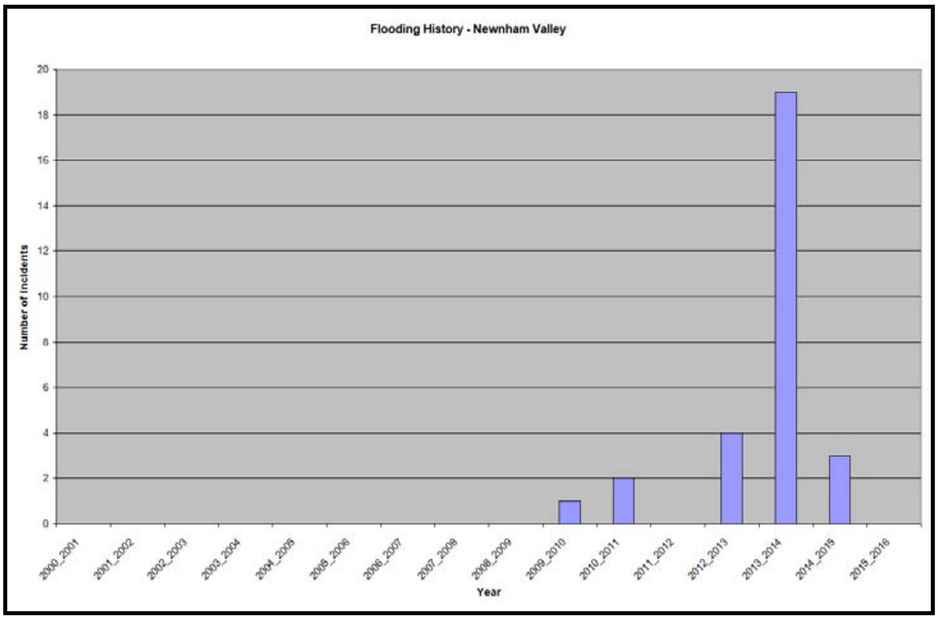

Figure 2.1 – Historic Flooding Records

3. Investigation & repairs

3.1. Outline Plans to Investigate Sources of Infiltration

This section (3.1) describes the generic process developed by Southern Water for the Infiltration Reduction Programme in 2013. Steps 1 - 7 are complete. Step 8 - long-term monitoring - continues. The specifics of the investigations and repairs at Nailbourne are in Section 3.2. Southern Water's approach to minimise infiltration into sewers is shown in Figure 3.1 below.

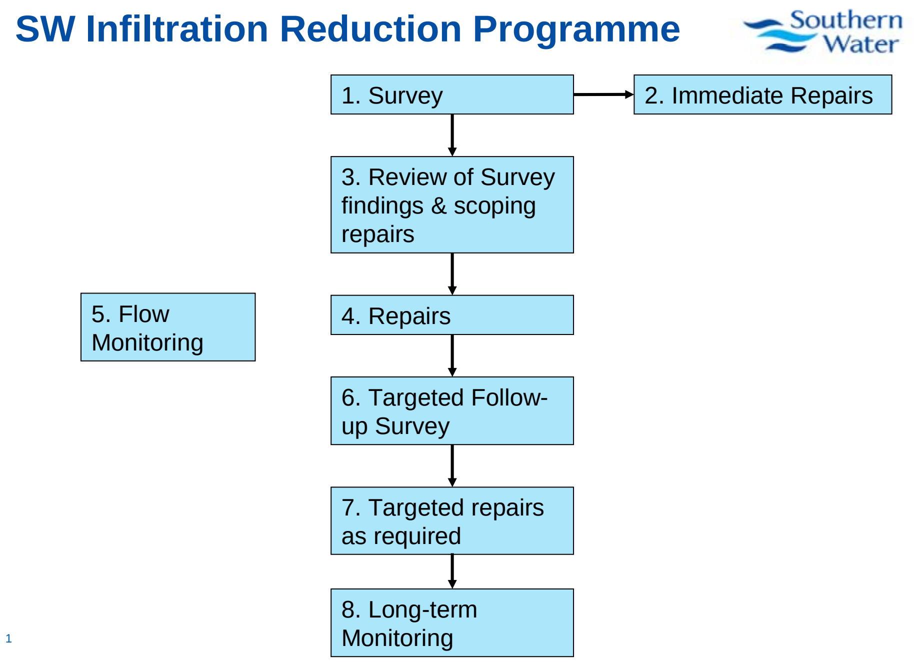

Figure 3.1 – Infiltration Reduction Process

1. survey (manhole lifting followed by CCTV)
2. immediate repairs of major points of infiltration.
3. review of data and commercial arrangements for repairs
4. carrying out repairs
5. flow monitoring in wet and dry weather conditions
6. targeted follow-up survey
7. repairs if required
8. ongoing monitoring

Steps 1 to 7 are described below. Step 8 is covered in Section 5.6. Plans in Appendix A show the sewers identified for investigation, those surveyed, where infiltration was found, and where repairs were carried out. An example, using part of a plan from another catchment, is shown in Figure 3.2 below. The plans show how the survey and repair steps follow a process of refining the area from where data shows infiltration originates, to the precise locations where groundwater is getting into the pipes, and the lengths of sewer and manholes repaired. The plans are generated from Southern Water's updated records.

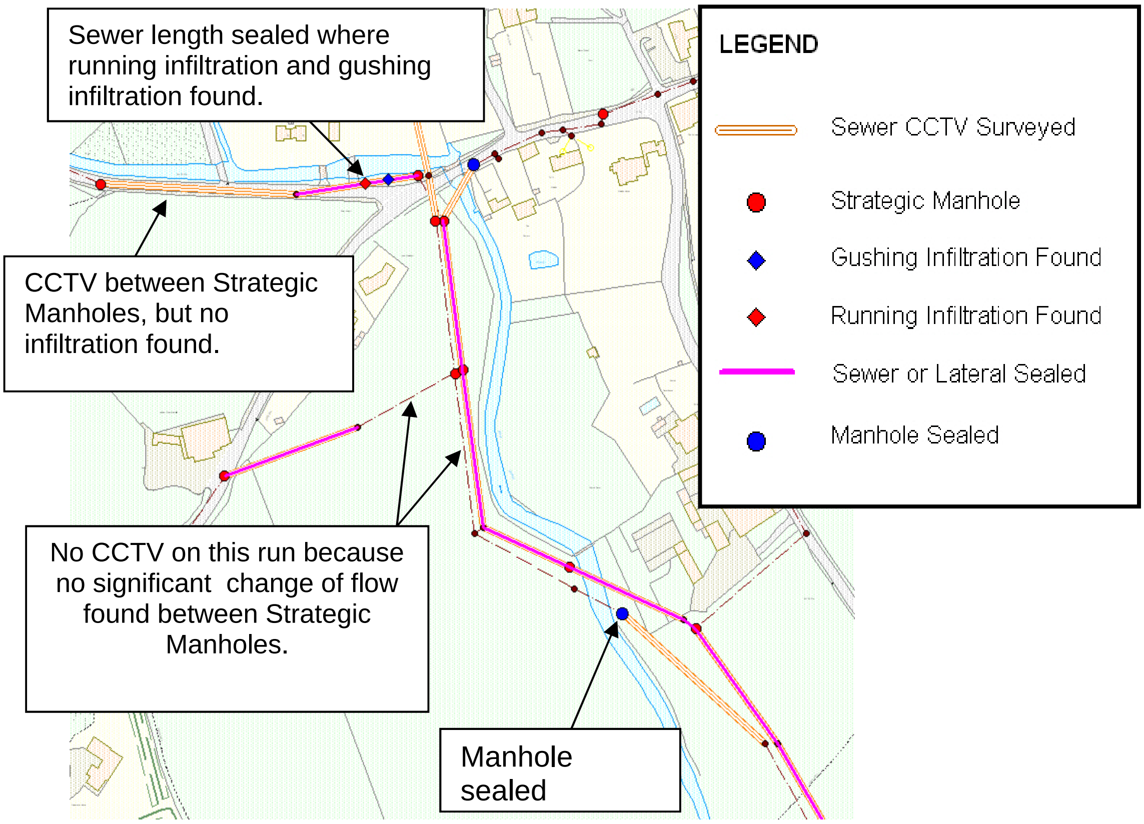

Figure 3.2 - Example of Plans showing Survey and Repairs.

3.1.1. Manhole Inspections and CCTV Surveys

Steps 1 to 4 follow a process of elimination. Initially SW identifies an area where infiltration is either known, or expected, to exist. This is generally based on local knowledge of the area. Then 'strategic manholes' within that area are identified. When the groundwater levels are high but falling and the sewers are no longer surcharged, flow through the strategic manholes is checked. Manholes at the downstream end of the run are inspected first, then the next manhole upstream, until the flow reduces to normal. Where there is a reduction in flow from the downstream manhole to the upstream manhole these are noted. The change in flow indicates infiltration. The manholes are also checked for infiltration. As soon as possible after this inspection, the sewer lengths are inspected using CCTV units which are moved through the sewers working upstream from manhole to manhole, as far as the manhole where the flow is normal. If significant flow is seen from lateral connections, these are also surveyed by CCTV (subject to gaining access from customers' properties – where required).

The CCTV cameras are mounted on a wheeled unit which measures the distance along the pipe from the manhole. A report of the CCTV inspection is prepared noting the location of any defects (e.g. displaced joints) or leakage of groundwater into the pipe. Still photos of these are captured from the video and included in the report.

The report and CCTV recording is reviewed by Southern Water with the most appropriate repair techniques specified for any defects found. An order for the work is placed with SW's framework networks maintenance contractor.

3.1.2. Flow Monitoring Surveys

Flow monitoring is another activity which can be used to aid in the identification of areas of infiltration in addition to CCTV surveys. The activity does not fit sequentially between the other activities, hence it is shown to the side in Figure 3.1. Flows can be monitored in both dry and wet weather conditions. Flows are typically monitored for a period of four weeks. In some cases, comparison between the data from the wet weather and dry weather surveys can be used to assist with identifying areas of high levels of infiltration. Details of the flow monitoring in the Nailbourne catchment are given in Section 3.2 and dates are in Table 3.1.

3.1.3. Repairs

When the repairs are instructed, the contractor will return to the site and prior to starting the repair, will repeat the CCTV inspection to ensure there are no material changes since the initial survey was conducted. This is particularly relevant if the repair is not carried out until a significant period of time after the initial inspection. The repair method would be from the list below. After completing the repairs, a further post repair CCTV survey is carried out to demonstrate the effectiveness of the repairs. This information is retained by SW, which updates its sewer records. The lengths of sewers surveyed by CCTV and the results are also included in the sewer records database.

Where rehabilitation is required, the appropriate repair technique is selected from the following:

- Sewer lining – fitting a new lining to sewers from one manhole to another or to sections of sewer to repair several leaks, by forming a leak-tight pipe within the existing sewer.
- Excavations to repair damaged pipes where no-dig techniques are not possible.
- Quick-Locks – metal ‘sleeves’ which are inserted remotely into damaged pipe sections and are expanded via compressed air against the inner walls of the pipe to instantly seal leaks.
- Joint Test and Seal – each joint between sewer pipes is air tested and, if it does not hold the pressure, the joint is injected with a gel to seal it. Sealed joints are retested.
- Capping of leaking un-used connections.
- Top Hats – fibreglass inserts which form a leak-tight bond at the point where a lateral sewer connects to the main pipe.
- Ground Stabilisation – an alternative technique which involves the injection of gel into the ground around a leak.
- Manhole chamber sealing – a non-excavation method to repair manholes.

3.1.4. Follow-Up Survey and Repairs

If there is evidence of remaining infiltration following repairs, further targeted investigation and repairs may be carried out if required.

3.2. Investigation and Repairs in the Newnham Valley

Groundwater infiltration into sewers has been a long-running issue for the villages by the Nailbourne. SW has been making significant investments over many years to minimise infiltration and the need for over-pumping. Details are provided in a table at the end of Appendix A. SW recently completed a major programme of survey and repairs to the sewers in the Nailbourne catchment. The investigations and repairs followed the process set out in Section 3.1 above. The timing and status of each step is in Table 3.1 below.

Step.	Description	Approx Date	Status
1.	manhole lifting followed by CCTV Investigation	Spring 2013	Completed
3.	Determination of required repairs	Spring/ Summer 2013	Completed
5a.	Dry Weather Flow Survey	July 2013 – August 2013	Completed
4.	Repairs – [refer to plans in Appendix A]	September 2013 - January 2014	Complete
5b.	Wet Weather Flow Survey	May 2014 – June 2014	Completed
7a.	Property Level Protection	October 2014	Completed
6.	Targeted follow up survey (Bishopsbourne & Elham)	Spring 2014	Complete
7b.	Targeted Repairs (Bishopsbourne & Elham)	Autumn 2014	Complete
6a.	Further Targeted Survey	April 2015	
7c.	Further Targeted Repairs: repair of sewers at Bourne Cottages, Bishopsbourne & relining of sewers at Brewery Lane, Bridge and Elham	December 2015/ April 2016/Autumn 2019	Complete
8.	Ongoing monitoring	Commenced Jan 2015, recommenced Sept 2015 and Sept 2016.	Ongoing

Table 3.1 – Summary of Survey and Repairs at Nailbourne Villages and Environs

Following the CCTV surveys in spring 2013, during which 10.7km of sewers were surveyed and 263 manholes were inspected. Repairs commenced in September 2013 and were completed in January 2014. The extent of these repairs is shown in the plans in Appendix A. Within the Newnham Valley catchment, 3.6km of sewers and 10 manholes were repaired. In the Hythe catchment, CCTV surveys revealed that sewer repair works were not required, with the exception of two manholes. Root cutting also took place to maintain appropriate flow along the sewage network.

SW continues to monitor performance of the sewers each winter. Whilst no further work is scheduled, if infiltration remains an issue, the requirement for further investigation and repairs will be considered in relation to other locations which experience sewer flooding.

In addition to physical investigations on site, SW has instigated a programme of monitoring flows in critical catchments, including the Nailbourne catchment. Further details are given in Section 5.6. Flow monitoring (Step 5 in Figure 3.1) was carried out both in dry weather conditions (18th July to 15th August 2013) to establish baseline flows, and in wet weather conditions (21st May to 18th June 2014). Good data was obtained from these surveys which was subsequently used for validation of a hydraulic model of the Nailbourne catchment.

The sewer in Park Lane, Bishopsbourne which serves a row of cottages was repaired in 2014, but further points of ingress became apparent after winter 2014/15. These were identified as a major contributor of groundwater to the sewer network so, after inspection in April 2015, the sewer has now been repaired.

4. Over-pumping

4.1. Circumstances that lead to overpumping

If sewers flows continue to increase, as groundwater levels rise, mitigation measures at certain locations will be required. Using previous experience, areas likely to be the first affected, are identified. The requirement for tankering or pumping will be driven by levels in the manholes locally.
SW's objective is to maintain wastewater disposal services for customers, avoid internal sewer flooding and to avoid significant spills from manholes. Since 2013, SW has made significant investment to reduce infiltration and to protect specific properties at risk of flooding, with the objective of reducing the frequency of discharges to watercourses. As Figure 4.1 below shows there has been a significant benefit from the investment.

In January 2013, prior to the start of the major reinstatement work, pumps needed to be turned on when the groundwater level measured at Little Bucket reached 78.5m. In January 2014, after completion of major repairs, over-pumps were only required when the groundwater level reached 81.3m. In February 2015, when the level reached 84.7m, tankers needed to be deployed at Bishopsbourne, but over pumps were not required despite the Little Bucket groundwater level being more than 5m higher than when pumps were required in Jan 2013 and over 3m higher than when pumps were required in Jan 2014. This demonstrates the effectiveness of SW's investment to reduce infiltration and thus to reduce the requirement for discharges.

Despite the investment, following prolonged wet weather, to maintain services and avoid significant spills, SW expects that there will continue to be an occasional need to remove excess flow from the network.

Based on experience in 2014 and 2015, currently over-pumping could be expected to be required when the groundwater level at Little Bucket borehole exceeds 85m. (in Feb/ March 2015, groundwater levels peaked at 85.0m and over-pumping was not required). However, to allow time for investigation and preparation, SW has historically retained a 'trigger level' of 78.5m in the winter planning report. Due to the success of the repairs, tankering and/or overpumping is now only required at higher groundwater levels, therefore the trigger level has been raised to 80.0m. Whilst SW would not expect to start physical measures such as tankers or pumps at that level, the purpose of the 'trigger level' is to trigger actions to prepare for an appropriate response. Refer to Section 4.2 below - 'Steps to prevent discharges and prior alternatives to over-pumping'.

Figure 4.1 shows the groundwater levels (recorded at Little Bucket) over the last eight years, as well as when pumping was required in 2012/13 and 2013/14, and tankering in 2014/15. The approximate timing of repair activities is also shown. Tankering was used for one day in February 2016, but only as a precautionary measure.

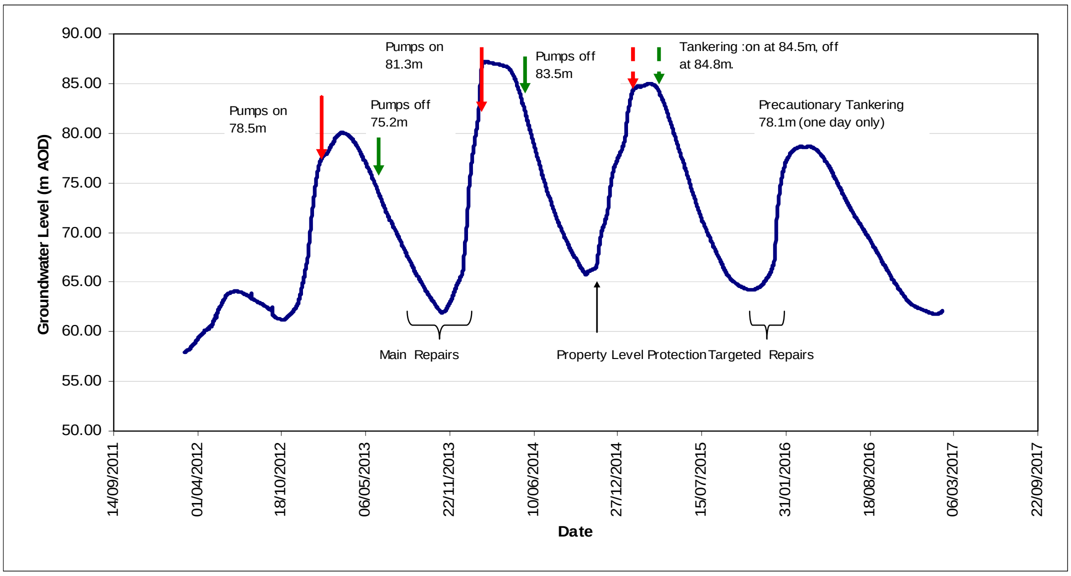

Figure 4.1 - Groundwater levels from 2012 to 2017.

The details of when and where tankering and over-pumping has been necessary in the past are given in Appendix C. The repairs carried out, combined with the winter preparation checks, are expected to minimise the number of locations where over-pumping would be required. However, as a consequence of repairs and potentially other factors outside SW's control (such as the severity of the weather), the hydraulics may dictate that over-pumps are required at other locations either in place of, or in addition to, the sites described in Appendix C. Note that whilst the Hythe catchment drains into a separate sewage system to the Nailbourne catchment, when over-pumping takes place at the Orchards WPS, effluent is discharged into the Nailbourne.

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

As described in Section 3.1, 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, and summarised in Section 3.2). This built on the repairs that had been carried out in previous years (listed at the end of Appendix A). Following the main repairs, property level protection was installed in 2014, and 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 the Winter 2014/15 SW instigated the following steps which are now part of the winter preparation. These activities supplement the rehabilitation programme.

1. Carry out scheduled maintenance visits to key pumping stations prior to winter weather. This covers activities such as cleaning wet wells and checking that pumps are working at capacity.
2. Ensure that sewers prone to silt deposition or fat build-up have been jetted as per SW's Scheduled Maintenance Tasks.
3. Monitor groundwater levels in relevant local boreholes.

4. When groundwater levels start to rise, monitor WPS performance as groundwater level approaches trigger levels based on previous flood events.
5. Determine forecast dates for trigger levels based on previous dry, average and wet winters.
6. Hold weekly calls with the EA and share forecasts for potential over-pumping
7. As each trigger level is approached, check sewer levels at selected manholes in the catchment. Continue to monitor and record sewer levels.
8. If levels continue to rise, carry out manhole lifting and record sewer levels and share data with the EA. [following Step 7. Share data weekly]
9. Monitor customer calls. Seek to establish whether there is a common cause for the lack of capacity to maintain sewage disposal services. [ad-hoc analysis, as and when required during flood events]
10. Respond to customer calls with targeted sewer jetting, tankering or over-pumping as appropriate.
11. Keep EA informed about potential and current tankering and jetting activities. Agree course of action where over-pumping is required. [as required (as for Step 7) through weekly reports and calls]
12. Continue to monitor levels. [weekly through the winter/ spring]
13. Where over-pumping is required, ensure duration and quantity of discharges are minimised (e.g. by use of level control on pumps). Also ensure use of the over-pumping components (settlement tanks etc) as agreed. [refer Appendix B of the IRP]
14. Following the flooding event, as levels in the sewers return to normal, lift manhole covers in catchments where there has been over-pumping to identify sudden increases in flow.
15. Instigate survey and repairs if required.

4.3. Over-pumping arrangements (flow rates and minimisation of effect on watercourse)

Depending on local conditions, a typical over-pumping site consists of a pump located at ground level adjacent to a sewer manhole near the watercourse into which it will discharge. The pump lifts dilute effluent from a surcharged manhole. The suction hose is positioned as near as practical to the top of the flow so that it is mostly liquid which is pumped. The solids tend to remain in the sewer. A barrel filter is attached to the end of the suction hose. The barrel filter has 10mm holes in it, so it holds back larger material in the manhole. (Refer Figure B1 in Appendix B.)

The size of pump will be chosen to only remove the necessary flow from the sewer. In fact, to minimise the flow that is pumped out of the sewers, ‘level control’ sensors are used to ensure that a pump only operates when the level in the manhole is high. When the level drops, the pump stops and only starts again when the water level in the manhole rises above the level at which it is necessary to pump to protect properties. As explained above, SW monitors levels in the manholes as the levels rise, so has knowledge of the maximum level in the manhole that can be tolerated before properties experience flooding or restricted toilet use.

Flow rates depend on the size of pump and the length of hoses through which the pump delivers the flow. Historically 150mm (6") pumps have been used for villages along the Nailbourne, because of the flow rates which have needed to be removed. A typical discharge rate for a 150mm (6") pump with a short delivery hose is approximately 80 l/s, however, the longer suction and/or delivery hoses reduce the flow rate significantly. So 50 l/s is a more typical flow rate. Having carried out extensive repairs, smaller pumps may be appropriate when over-pumping is next required. The objective is to remove the minimum flow that is necessary to maintain services to customers.

For a 150mm (6") pump, power is supplied by local diesel generator. For smaller pumps a combined unit is used which contains a Silent Pack generator and a pump.

Maintenance of the over-pumping units is carried out regularly; daily checks include checking the flow and cleaning/replacing filtration sacks and the barrel filter on the suction hose. The settlement tanks are cleaned each week.

The locations where tankering and over-pumping was used in winter 2013/14 are shown in Appendix C. These locations were effective in restoring service to customers and are the default locations should the situation re-present itself. Dates of historic tankering and over-pumping are also provided in Appendix C.

When the pump operates, flow is pumped into a settlement tank. In the tank, the flow passes under settlement weirs, which trap much of the floating material. Finally, at the end of the discharge hose, before the flow is discharged into the receiving watercourse, it passes through a filtration sack located on the end of the hose.

Further details on a typical over-pumping arrangement are provided in Appendix B, and the locations and dates of over-pumping activity in recent years are given in Appendix C.

In addition to the measures described above to remove solid matter, SW invested in ten portable biological treatment units in January 2014 for use at flooded areas throughout its area. Units were used in the Newnham Valley. They were trialled to enhance the quality of the water discharged to the watercourse at the following locations:

- Nargate Street WPS, Littlebourne
- School Lane WPS, Bekesbourne
- The Orchards WPS, Elham
- Valley Road, Barham

The main benefit of the biological treatment units was that the dilute effluent was aerated, thus reducing the biochemical oxygen demand (BOD) on the receiving water.

River quality monitoring to check ammonia levels and bacteria content will be carried out when over-pumping is required. More information on monitoring the quality of the downstream watercourses is given in Section 4.6.

4.4. Steps to minimise the volume and duration of over-pumping

4.4.1. Factors considered prior to over-pumping

As explained in Section 4.2 above, SW follows a set of steps to ensure that its assets operate correctly. The steps identify how they deal with high flows when they still occur. SW endeavours not to use over-pumping into water-courses. However, it is anticipated that there will be occasions when it cannot be avoided. Generally tankering is used prior to over-pumping. Tankering is an appropriate response to small scale sewer flooding. But if the flooding becomes more widespread, over-pumping has to be used to maintain wastewater services to customers.

There is no clear rule for the exact point to change from tankering to over-pumping and it must be considered to be a last resort. Prior to installing and operating over pumps SW will consult with the Environment Agency and local council, and assessed or exhausted the implementation of other viable alternative options. Account is taken of local factors such as water supply intake, or rare habitat (e.g. SSSI) which may restrict or prevent the use of over pumping, where these are factors then SW would seek alternative mitigation measures.

4.4.2. Pros and Cons of Tankers and Pumps

Tankers and over-pumping are both appropriate solutions, each suiting different scenarios. The key benefits and disadvantages are noted below.
Tankering

<u>Benefits</u>:

- Dilute sewage is discharged at a treatment works for treatment.
- Quicker response time.
- No impact to watercourse.
- Convenience – suitable for response to short duration localised flooding.

<u>Disadvantages</u>

- The flow rate is low (approx. 2l/s per tanker over a 24 hour period*).
- There are traffic issues associated with large vehicles using narrow roads.
- Rural roads are not designed to take the load of repeated visits by tankers – potentially resulting in damage to the road, and particularly the verges.
- Tankers are noisy causing disturbance to the local residents, particularly at night.
- High cost and carbon footprint compared to over-pumping.

*Tankers operating at Bishopsbourne discharge at School Lane WPS and Canterbury WTW - round trips of an average of approximately 2 hours including loading and discharging.

Over-pumping

Benefits:

- Typical pump fuel consumption is 20% of the fuel that one tanker would use in a day.
- The discharge rate is significantly greater. A 150mm (6 inch) pump will discharge typically 50 to 80l/s; the equivalent of a fleet of 24 tankers.
- Continuous activity with higher guarantee of success in terms of enabling a sewerage service to customers
- Pumps are quieter than tankers
- The pumps run on level control so only operate when required.
- Located off the highway.
- Lower cost and carbon footprint compared to tankering.

Disadvantages

- Temporary environmental impact of over-pumping dilute effluent to the watercourse, including loss of amenity value to the local community.
- Increased hydraulic load in the watercourse with potential for associated flooding.
- Pumps are less noisy than tankers but may cause disturbance to neighbouring residents, particularly at night.
- Visual impact of over-pumping equipment (in the Kent Downs Area of Natural Beauty)

The graph in Figure 4.2 shows the estimated carbon emission per m^3 of dilute effluent removed by tanker and by pump. In this example, data has been used for tankers and the 6 inch pump at Bishopsbourne in 2014. Data for the tankers is taken as an average of the 2,000 gallon and 3,000 gallon tankers used.

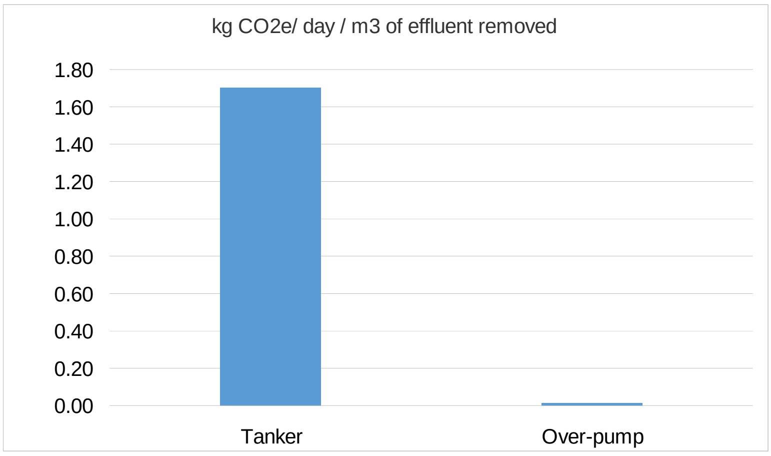

Figure 4.2 – Carbon Footprint figures for Tankers and Over-pumps per m^3 of effluent removed.

Irrespective of the method of removing excess infiltration flow, it is clearly preferable to prevent it entering the system in the first place, which is why SW has been investing in finding and repairing points of infiltration and in installing targeted property level protection.

4.5. 3rd Party Communications about over-pumping

Since the start of the Infiltration Reduction Programme in 2013, Southern Water has been proactive in communicating with stakeholders and customers in the Newnham Valley 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 Multi-Agency Group was influential in helping to shape the IRP. During the flooding of 2013/14 SW had representatives on site who visited affected customers to help them. The latest version of the IRP approved by the EA, will be published on SW's website.
Despite the work being undertaken, if over-pumping is required, prior to commencing over-pumping, SW will liaise with the local EA team in order to agree the requirement and to discuss proposed locations for the emergency discharges to watercourses. Immediately prior to commencing over-pumping, SW will notify the EA National Incident Communication Service (Tel. 0800 807 060).

The local public, local authorities and Environment Agency would also be kept informed of discharges to watercourses (over-pumping) before and during the operation.

Immediately prior to over-pumping being operated, Southern Water will put up advisory signs at the over-pumping discharge location(s) and at appropriate locations downstream along the receiving watercourse, advising the public that over-pumping is in operation. The signs will be removed promptly when the over-pumping has finished. The wording on the signs will be as, or similar to, the example in Appendix D. The location of advisory signs near the over-pumps is also provided in Appendix C.

Prior to the cessation of over-pumping, SW will also liaise with the local EA team and also inform the EA National Incident Communication Service following cessation.

During the winter of 2014/15, 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 pumping.

From time to time, SW updates stakeholders about completed and planned work. The most recent meeting was held in December 2016.

4.6. Monitoring quality of the downstream watercourse

If over-pumping is required, Southern Water will undertake regular water quality monitoring, as it has on the occasions when over-pumping has had to be carried out in the past. For each site, SW will conduct sampling/ measurement at each of the following points:

1. 15m upstream of the effluent discharge
2. The effluent discharge
3. Downstream of the effluent discharge

These upstream/downstream sites are typical positions and may vary depending on the watercourse depth, width or flow.

When over-pumping is in operation a laboratory sample will be taken at each of the above points once a week for:

- E. coli
- Enterococci
- Total coliforms
- COD
- BOD
- Suspended solids

In addition, Southern Water will discuss the requirement for sondes with the Environment Agency and if required, the locations for them. Sondes are instrument probes which are immersed in the receiving watercourses upstream and downstream of the discharge point. They automatically transmit information about the surrounding water. Where sondes are deployed, they provide half-hourly measurements of:

- Ammonium (NH4+)/ ammonia(NH3)
- Dissolved oxygen
- Turbidity
- Oxidation reduction potential
- Additional standard parameters that come with sondes (pH, temperature, conductivity, total dissolved solids etc)

5. OPTIONS TO REDUCE INFILTRATION

5.1. Sewer Rehabilitation Programme

SW acknowledges that infiltration reduction is on-going process. Since 2013, SW has invested £1.65 million in surveys and repairs at Nailbourne. The major repair work was completed in 2013, property level protection and pump replacement at School Lane WPS and Ottinge were completed in 2014 and in December 2015 to April 2016 further targeted repairs were completed. However, on a company-wide basis, to ensure that benefit continues to be gained from the work that has been done, SW is continuing the programme of infiltration reduction investment across its region for AMP6 (2015 – 2020).

5.2. Property Level Protection

Non-return valves (NRVs) 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. During 2014, SW installed six NRVs protecting seven properties. There are no plans currently to install any more NRVs, but the potential benefit of further property level protection will be considered if it is considered to be required for any further vulnerable properties.

5.3. Local Flow Control

As noted in Section 4.1 despite groundwater levels having risen higher in early 2015, than they had in early 2013, overpumping was not required. Localised tankering was required in February and March 2015 to remove the groundwater from the sewer at Bishopsbourne to protect services for a few customers. SW has identified that whilst the sewers in Bishopsbourne were significantly surcharged, levels in manholes further upstream were not. Consequently SW fabricated, and fitted, a throttle upstream of Bishopsbourne village. This was fitted during March 2016; levels in the sewer in Bishopsbourne fell sufficiently that within a few days tankering could be stopped. As expected, upstream of the throttle, sewer levels rose, but did not cause any problems. The throttle was removed when levels returned to normal.

5.4. Pumping Stations

In order to minimise infiltration, SW is continuing to ensure that design discharges are maintained at pumping stations. Pump refurbishments were completed in October 2014 at

School Lane WPS in Bekesbourne, the largest pumping station in the Newnham Valley catchment. This will help to ensure that the design discharge continues to be reliably delivered. Also during 2014, the pumps at Ottinge WPS were replaced.

5.5. Control Structure

SW is committed to reducing the frequency with which over-pumping will be required. As noted in Section 5.6 below, the work carried out in the last four years has improved the resilience of the sewerage system, making it less susceptible to the effects of high groundwater levels. SW is minimising the flow into the sewers through its rehabilitation programme, ensuring that the pumping stations deliver the design flows and that vulnerable properties are protected. Despite these measures, there will still be occasions during severe weather when the flow into the sewerage system exceeds its capacity. On those occasions, the surplus has to be disposed of.
If tankers are not adequate to remove the excess flow, discharges to the watercourse will be required. SW accepts the need to reduce the frequency of over-pumping, so is investigating other options such as a 'Control Structure'. The objective would be to remove dilute effluent at a critical location if flow in the sewer exceeds a set 'pass forward' rate. A study for potential Control Structures was completed in 2014. A further study is currently in progress to develop the proposals for a control structure at Bishopsbourne. The outline design of the Control Structure is still being developed but would include some screening combined with potentially UV disinfection before discharge into a bio-retention pond.

The objective would be to ensure that during times of unusually levels of high groundwater infiltration, customers would be able to retain use of their sewerage facilities, whilst also ensuring that the effluent did not cause detriment to the watercourse. SW is actively engaged with the EA and other stakeholders to seek agreement to a design which would potentially be acceptable. Further updates will be provided in subsequent revisions of the IRP.

.

5.6. Monitoring

SW has set up a monitoring programme using current electronic data. (e.g. EA borehole level data via telemetry links). In January 2015, SW commenced a weekly review of the ten locations in its region which are most prone to sewer flooding. The Nailbourne catchment was one of those locations. The monitoring used ‘real time’ groundwater levels from local boreholes to predict when it might be necessary to respond to mitigate the effects of sewer flooding. The trigger levels are not the levels at which tankering or over-pumping started historically. When a trigger level is breached SW increases activity to ensure that the sewers are running clearly. Levels in the manholes are also checked, as it is this, not groundwater levels, which determine when surplus flow needs to be removed from the sewers.

The graph below, in Figure 5.1, 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.

SW is repeating this monitoring each winter. The reporting commences mid-September, running reports at monthly intervals initially, increasing to fortnightly, then weekly (as appropriate) to suit the rise of groundwater levels. The forecast dates for reaching trigger levels is shared with the EA when they are produced.

The above approach can only be used during periods of rising groundwater. However it is important for SW to continue to monitor the integrity of the sewers through the drier months of the year.

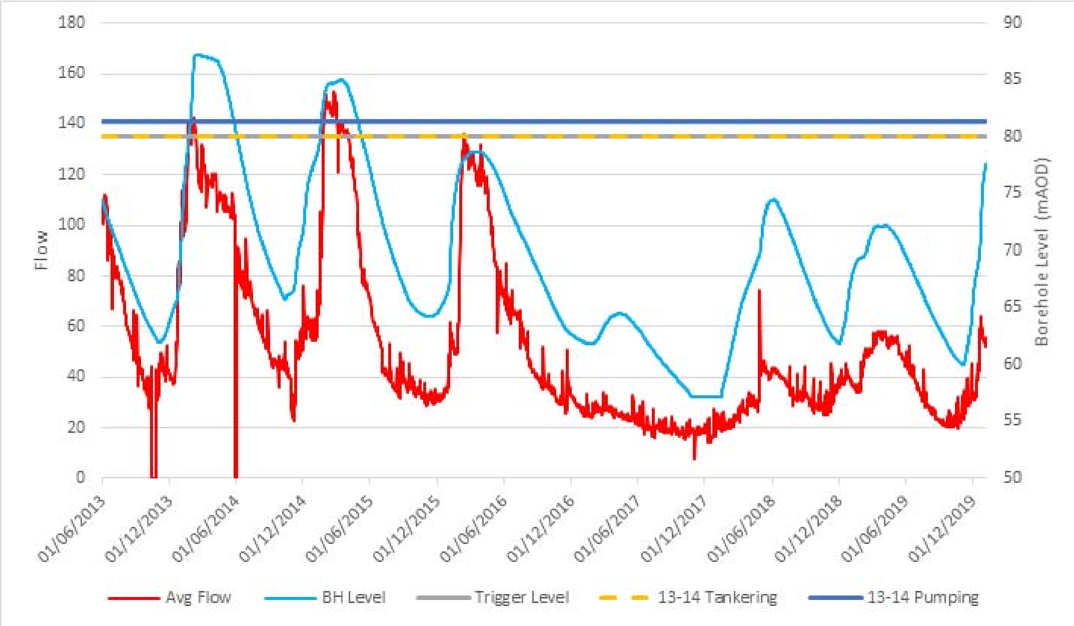

Figure 5.1 – Forecasting of Trigger Dates

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 5.2 shows the groundwater levels at Little Bucket Farm borehole plotted against flows to Newnham Valley WTW. Note that Newnham Valley WTW is located in the Nailbourne catchment, downstream of the major repair works. However, it also processes sewage discharged from two adjacent sub-catchments. (Refer to the Background Section for a description of the catchments feeding Newnham Valley WTW). Thus the flows from the Nailbourne sub-catchment, form a part of the total flows to Newnham Valley WTW.

Figure 5.2 quantitatively illustrates how flow varies with groundwater levels. It is reasonable that as groundwater levels increase, the rate of infiltration increases. Data points prior to the major repairs are plotted in blue: (Dec 2009 – Aug 2013). The data points for the period after major repairs (Jan 2014 – Feb 2017) are plotted in orange. Linear regression lines are also included for each set of data. These give an indication of the difference between average conditions for 'before' and 'after' repairs.

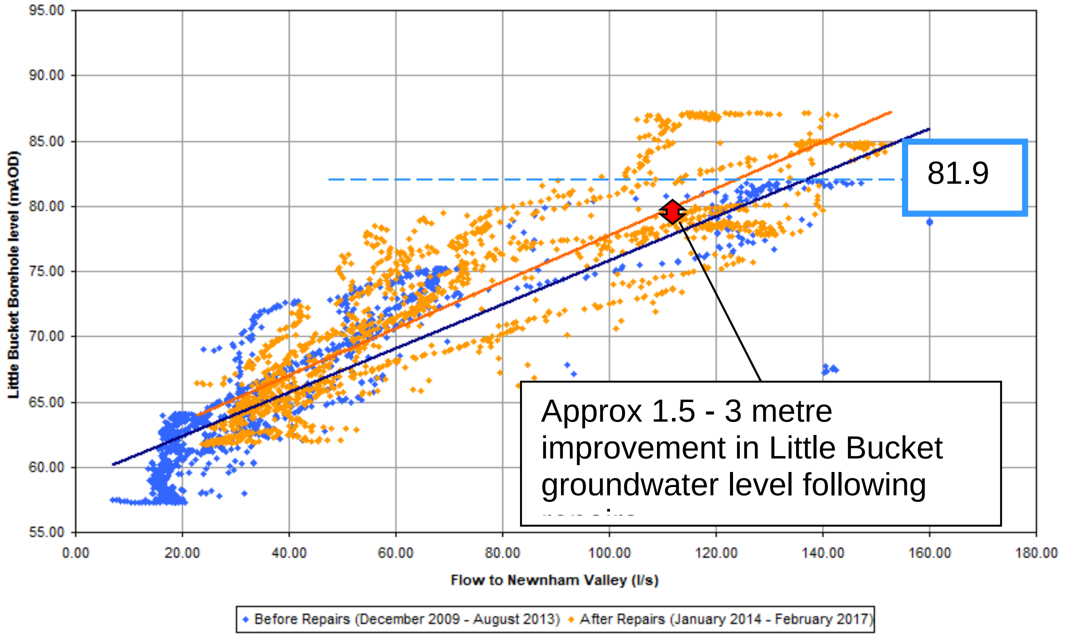

Figure 5.2 – Long Term Monitoring (Dec 2009 to Feb 2017)

The difference in groundwater level between the lines is approximately 1.5 - 3m. In other words, for a given groundwater level, the corresponding flow is lower after the repairs. This confirms that the repair work has been effective.

For the period Dec 2009 to Feb 2017, the graph shows that groundwater levels rose higher after the repairs than they had before. This was due to natural variations in the weather. The maximum groundwater level before the repairs was 81.9 mAOD. After the repairs, groundwater levels at Little Bucket reached 87m. Despite these higher groundwater levels, flows to Newnham Valley WTW generally did not increase. Indeed, for the period of time after the repair works, the groundwater levels have been higher than 81.9 mAOD for approximately 18% of the time, yet flows have remained in a similar range to that which existed before.

The analyses outlined above is supported by the information displayed in Figure 4.1. During the winter of 2013/14, over-pumping only had to commence at a groundwater level of 81.3 mAOD. In the winter of 2014/15 over-pumping was not required, and tankering only had to start when the groundwater level reached 84.5 mAOD. In February 2016 tankering was used at Bishopsbourne when the groundwater level reached a level of 78m, but this was only for one day and only as a precautionary measure.

6. CONCLUSIONS / ACTION PLANS

6.1. Conclusions

SW has carried out significant survey and repair work in the Nailbourne catchment since September 2013. After major repair works were completed in January 2014, the need for over-pumping and tankering has been minimised. Indeed, in the winter of 2014/15, over-pumping was not required at all. Analysis of long-term data supports the view that infiltration to the sewage network has decreased since the repair work was carried out. It was found that in the Nailbourne sewerage catchment, for a given groundwater level, flows within the sewage network are lower than they were before the repairs. Indeed, the repairs appear to provide resilience against an additional 1.5m -3m of groundwater (as measured at Little Bucket borehole).

As noted previously, reducing infiltration is an ongoing journey. In 2013, SW prioritised 17 areas – including Nailbourne – which were identified as priority sites for reducing infiltration. Having reduced infiltration in those priority catchments – including the Nailbourne - SW is now focusing on improving other catchments that have significant infiltration. However, the Nailbourne catchment is not being ignored. SW is currently monitoring the flows (see Figure 5.2), and continuing with 'winter preparation' work. If further work is identified as being required, this will be scheduled into the infiltration reduction programme, taking account of the needs of other catchments.

6.2. Action Plans

A significant amount has been achieved in the Nailbourne catchment in the last seven 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).
SW is committed to continuing to pursue infiltration to reduce the frequency of over-pumping. 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.

6.3. IRP Updates

The IRP records SW's commitment to continuously strive for the long-term objective of eliminating the need to over-pump. As required by the RPS, SW will report progress quarterly to the EA and will review the IRP annually (RPS Section 2.3 vi). The approved IRP will be published on SW's website.

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 1 above and the report in Appendix 1.	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.	July/ August 2013 - Complete	Groundwater infiltration is greater than would be expected for summer conditions.
1.3	'Wet weather' flow surveys (to identify remaining areas of infiltration following initial sewer rehabilitation/repair).	Identify suitable measurement points, carry out survey over four week period, match rainfall records with flow data.	May/ June 2014 – Survey complete Analysis - complete	Wet Weather and Dry Weather flow monitoring data used in hydraulic model completed in December 2014.
1.4	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.	<u>Barham to Bekesbourne</u> Summer 2013 – Complete <u>Elham</u> Summer 2014 - Complete	Identify major sources of infiltration to determine scope of rehabilitation work.

Ref.	Item	Actions	Timescale and Status	Outcomes
1.5	Carry out sewer rehabilitation work	Use various techniques to seal infiltration points in manholes and sewers	Barham to Bekesbourne Autumn 2013 – Complete Bishopsbourne Spring 2017 - Complete Elham Summer/Autumn 2014 – Complete	Structural integrity of sewers restored.
1.6	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.	2015 – Completed Spring 2015 after Tankering at Bishopsbourne	Determine scope and carry out further rehabilitation if identified as required from the survey results.
1.7	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	Summer/Autumn 2015 - Completed work in Bishopsbourne. and Bridge. - [Refer Section 3.2]	Reduced infiltration, leading to reduced requirement for tankers.
1.8	Maintain IRP as a live document	Review text of the IRP and update if appropriate to describe work carried out and/or developments	Annually	Reviewed/Updated IRP. Last issued for review 2017.
1.8a	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

Ref.	Item	Actions	Timescale and Status	Outcomes
1.9	Consider alternative solutions that involve some risk	Investigate unconventional options such as vacuum sewers or consider conventional combined sewer overflows	2020	Ongoing.
1.10	Install Property Level Protection to Vulnerable properties.	Survey and install NRVs at vulnerable properties.	Autumn 2014 - Complete	The aim is that protection to vulnerable properties restricts tankering to those properties only as opposed to more significant sewer pumping.
1.11	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.
1.12	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.
1.12	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.
1.13	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, Canterbury CC, Shepway DC and local Parish Councils acceptable arrangements for future emergency discharges.

Ref.	Item	Actions	Timescale and Status	Outcomes
1.14	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.

Table 6.2. Multi-Agency Activities to Reduce Groundwater Infiltration

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
2.1	Strategy for infiltration via private drains	Southern Water to propose a strategy for dealing with infiltration via private drains*	SW supported by EA and local Parish Councils, Summer/ Autumn 2014. Completed 2014.	Southern Water objective is to improve awareness of the significance of infiltration into private drains and the importance for customers to ensure infiltration is repaired when it is discovered.
2.1a	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	Kent County Council with support from SW, 2014 onwards. To be pursued as and when required.	Reduced flow of surface water (if connections are found).
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 Canterbury City Council where required, 2014 onwards. To be pursued as and when required.	Reduced flow of surface water (if connections are found).
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.
		SW to determine threshold above which they require to be consulted.	District Council, Ongoing. SW wish to be consulted on all proposed development.	

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
		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.
3.2	Letters from SW to stakeholders about reducing groundwater infiltration into the sewerage system	Send letters at regular intervals to communicate progress and planned activities	SW, as required	Inform stakeholders of progress and planned activities

3.3	Multi-Agency Group meetings	Discuss and agree actions to reduce requirements for tankering and emergency discharges to watercourses.	All Parties, Discussed and actions agreed in 2013 and 2014. To be discussed in future as required.	Improved understanding and appreciation of issues. Agreement to actions to help reduce the need for tankering and emergency discharges to watercourses
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 Canterbury City 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). Note: due to the success of the rehabilitation work, the trigger level has been raised from 78.5m to 80.0m at Little Bucket borehole.
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.
4.3	Maximise the capacity of the sewerage system and pumping stations	Investigate the carrying capacity of the sewerage system north of Littlebourne	SW, July 2014 for capacity determination. Trial - if and when - the sewers are surcharged	Potential to increase output from the pumping station at School Lane, Bekesbourne.
4.4	Flooding Management Plan	Develop plan to address the flooding issues caused by high groundwater. Implement recommendations. This is being addressed by the Little Stour, Nailbourne and Petham Bourne Flood Management Group Action Plan.	Kent County Council & Canterbury City Council, Shepway District Council with inputs from SW, EA, and Parish Councils	Plan including actions for participating authorities, that 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.
4.6	Review of utilisation of a control structure	Investigate the possible use of a fixed control structure to relieve hydraulic overloading of sewers.	SW	No current plans to progress this option.

Appendix