Introduction to Infiltration Reduction Plans (IRPs)

from Southern Water

Contents

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

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 vulnerable to groundwater infiltration, to submit Infiltration Reduction Plans (IRPs) to the EA for approval. The **Introduction to IRPs** document was produced in response to the RPS, and summarises the infiltration reduction strategies that apply across the priority areas.

The purpose and nature of each IRP is that it will be reviewed by Southern Water annually and show the latest information regarding the progress of work in the area to reduce infiltration. It will provide an update on the last year's groundwater situation, what mitigation actions, if any, were taken and a summary of SWS' action plan to prevent flooding due to groundwater infiltration.

There will not be a 'final issue' of the plan as it is a working document, which will be updated as required.

2. GROUNDWATER INFILTRATION

2.1. The significance of groundwater infiltration

Across Southern Water's operating area, there are a number of catchments where, during excessively wet winters, customers have been inconvenienced by the effects of groundwater infiltration into sewers.

Excess groundwater entering the sewers can occupy a high proportion of the sewer system capacity and prevents sewage from customers' properties from being conveyed 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. Where essential, mitigation may include the use of tankers and groundwater treatment to remove excess water from the sewer system.

Such mitigation measures are not sustainable, they have a potentially harmful impact on the aquatic environment and are in breach of environmental legislation. Southern Water has invested in major improvements to the integrity of the sewers and manholes in order to minimise the occasions on which over-pumping is required.

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

Sewers are designed to accommodate wastewater flows, which includes a nominal allowance for groundwater. However, during particularly wet winters the capacity of the sewers can be exceeded, resulting in spills and sewer flooding. To reduce this risk, Southern Water follows a set process each autumn/winter to ensure the sewers are clean and the pumping stations are operating effectively. It is difficult to assess exactly what the effects of groundwater infiltration would be if no action at all were taken as the baseline position is that some mitigation already takes place. It is likely that more customers would suffer loss of sanitation, and more manholes would spill leading to pollution to watercourses and customer flooding 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 would surcharge and flood during storms of differing severity.

Customer issues are reported in three categories:

- **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** – 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 effluent from the local sewers.

The historic flooding issues in each area have been detailed in the individual IRPs for each priority location.

3. INVESTIGATION & REPAIRS

3.1. Investigation of Sources of Infiltration

3.1.1. Infiltration Reduction Process

This section describes the typical process developed by Southern Water for the Infiltration Reduction Programme which is shown in Figure 3.1 below.

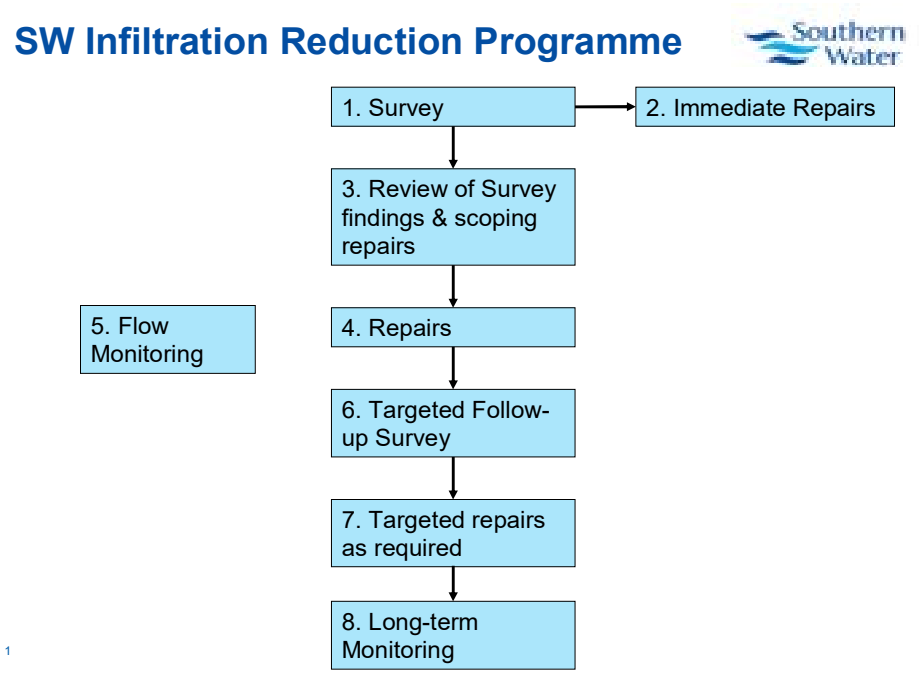

Figure 3.1 – Infiltration Reduction Process

Steps 1 to 7 which have a status of 'Complete', are described in sections 3.1.2 – 3.1.5 below while Step 8 which has a status of 'Ongoing' is covered in Section 5.6. Long term monitoring may result in further passes through the process by triggering surveys and in this respect the process is circular rather than linear.

Plans in each IRP 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.

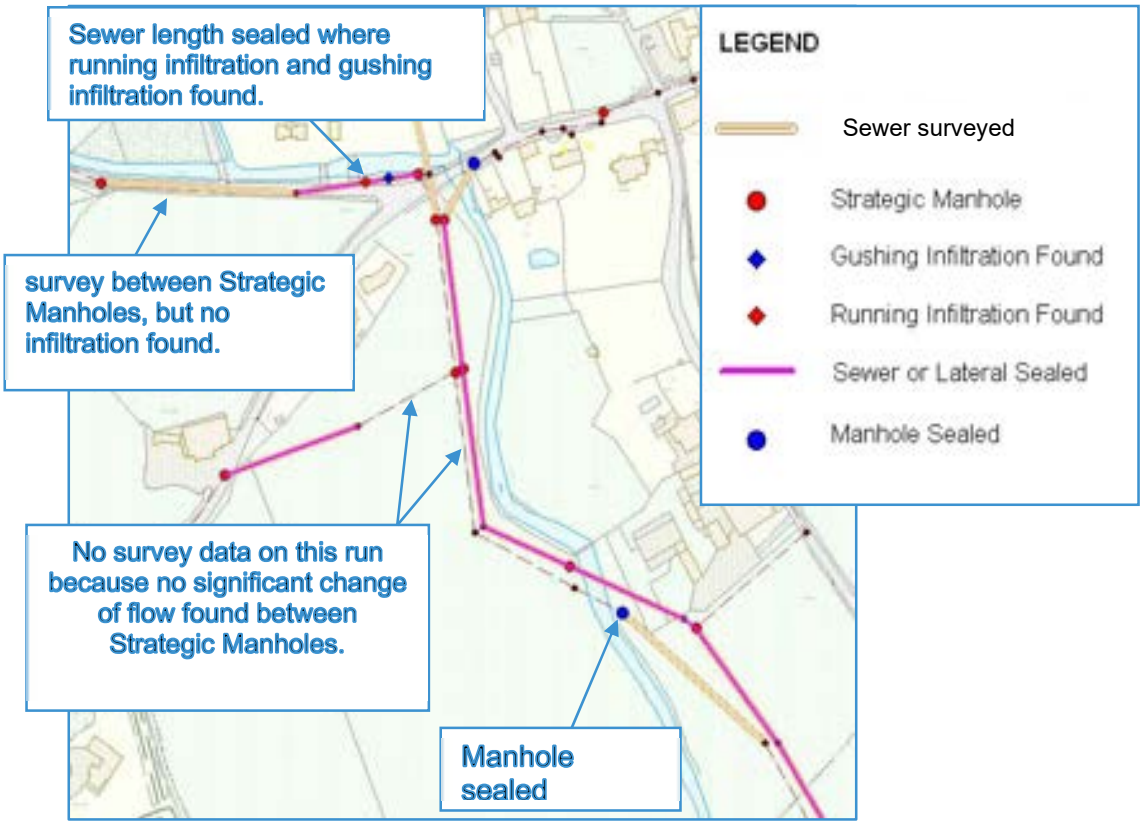

Figure 3.2 - Example of Plans showing Survey and Repairs.

3.1.2. Manhole Inspections and sewer 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 either CCTV units or by electroscanning techniques. These surveys 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 subject to gaining access from customers' properties – where required.

The resulting survey report 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.

3.1.3. Flow Monitoring Surveys

Flow monitoring is another activity which can be used to aid in the identification of areas of infiltration in addition to physical pipe condition 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.

3.1.4. Repairs

When the repairs are instructed, the contractor will return to the site and prior to starting the repair, will repeat the 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 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 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. This is a technique used historically though is no longer preferred due to the development of other techniques such as lining and is included for completeness.
- 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.
- Tubogel – to seal joints in sewers by a flood grouting technique

3.1.5. 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.

3.1.6. Private Laterals

Since 2013 a large part of public sewer network has been investigated and sealed in a number of sewerage catchments. It is evident from more extensive surveys that a significant contribution is from private lateral drain and sewers. Southern Water does not have powers to intervene in repairing these systems and will work closely with external stakeholders and customers to discuss and agree how this issue can be addressed.

3.2. Investigation and Repairs

The Individual IRPs detail the investigation and repair works undertaken in each of the identified areas.

4. GROUNDWATER TREATMENT

4.1. Circumstances that lead to groundwater treatment

If sewer flows continue to increase, as groundwater levels rise then mitigation measures may be required at locations likely to be worst affected. 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.

4.2. Steps to prevent discharges and alternatives to groundwater treatment

SW has 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 groundwater treatment options
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 groundwater treatment as appropriate.
11. Keep EA informed about potential and current tankering and jetting activities. Agree course of action where groundwater treatment 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 groundwater treatment is required, ensure duration and quantity of discharges are minimised (e.g. by use of level control on pumps). Also ensure use of the agreed and approved components (screens, filters etc). [refer Appendix A 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 groundwater treatment to identify sudden increases in flow.
15. Instigate survey and repairs if required.
16. It is recognised that infiltration flows in the sewerage system may remain high for prolonged periods and that towards the end of a high groundwater season the flow in the watercourse may reduce. This would lead to a lower dilution of flows over pumped from the sewerage system which may have an increasingly negative impact on the aquatic environment. These scenarios need to be closely monitored and reviewed in conjunction with the Environment Agency teams.

4.3. Groundwater treatment arrangements

Depending on local conditions, a typical groundwater treatment site consists of a pump located at ground level adjacent to a sewer manhole located near to the watercourse into which water will be discharged. The pump lifts dilute effluent from the surcharged manhole, passing it into the treatment process unit. 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 A1 in Appendix A.)

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.

Maintenance of the treatment units is carried out regularly; daily checks include checking the flow and cleaning/replacing filtration sacks and the barrel filter on the suction hose..

When the pump operates, flow is pumped into a settlement tank. In the tank, the flow passes through a fine screen which traps much of the floating material. Flow is then passed through a cloth filter to remove remaining solids and finally the flow is passed through ultra-violet light to

kill bacteria such as E.Coli and Enterococci. The treated flow is then discharged into the receiving watercourse,

Further details on a typical groundwater treatment arrangement are provided in Appendix A.

River quality monitoring to check ammonia levels and bacteria content will be carried out when groundwater treatment 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 groundwater treatment

4.4.1. Factors considered prior to groundwater treatment

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 groundwater treatment and discharging flow into water-courses. However, it is anticipated that there will be occasions when it cannot be avoided. Generally tankering is used prior to groundwater treatment and is an appropriate response for short term issues. However, if the groundwater inflow becomes prolonged then the treatment option has to be used to maintain wastewater services to customers.

There is no clear rule for the exact point to change from tankering to treatment and it must be considered to be a last resort. Prior to installing and operating treatment units SW will consult with the Environment Agency and local council, and SW will have 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 groundwater treatment, where these are factors then SW would seek alternative mitigation measures.

4.4.2. Pros and Cons of Tankers and Pumps

Tankers and treatment are both appropriate solutions, each suiting different scenarios. The typical key benefits and disadvantages are noted below.

Tankering

Benefits

- 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 drainage issues.

Disadvantages

- The flow rate is low (typically 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 treatment

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. For example, 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 dilute treated 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 groundwater treatment equipment.

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. Stakeholder Communications

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

Despite the work being undertaken, if groundwater treatment is required, SW will liaise with the local EA team in order to agree the requirement and propose locations for the emergency discharges to watercourses. Immediately prior to commencing installing the treatment units, SW will notify the EA National Incident Communication Service (Tel. 0800 807 060).

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

Immediately prior to groundwater treatment being implemented, Southern Water will put up advisory signs at the discharge location(s) and at appropriate locations downstream along the receiving watercourse, advising the public that groundwater treatment 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, that shown in fig 4.1 below.

Fig 4.1: Typical Advisory Sign - Reference Number and Village Name to be amended

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

4.6. Monitoring quality of the downstream watercourse

If groundwater treatment is required, Southern Water will undertake regular water quality monitoring, as it has on the occasions when discharge 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 groundwater treatment 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)

If readings are above those specified in Appendix A the groundwater treatment process will be discontinued and flow will be managed by tankering until the treatment process is able to meet the required standard.

5. OPTIONS TO REDUCE INFILTRATION

5.1. Sewer Rehabilitation Programme

Refer to the specific IRP for details of the sewer rehabilitation undertaken in each catchment.

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. Refer to the specific IRP for details of the property level protection undertaken in each catchment.

5.3. Local Flow Control

Refer to the specific IRP for details of the local flow control typically undertaken in each catchment.

5.4. Pumping Stations

In order to minimise the impact of ground water infiltration, SW continues to ensure design capacity at pumping stations is maintained. Refer to the specific IRP for details of the pumping station refurbishments undertaken in each catchment.

5.5. Monitoring

SW has set up a monitoring programme using current electronic data. (e.g. EA borehole level data via telemetry links). Since January 2015, SW has undertaken a weekly review of the ten locations in its region which are most prone to sewer flooding. The monitoring uses 'real time' groundwater levels from local boreholes to predict when mitigation may be required to prevent sewer flooding. When the borehole trigger levels are reached, this promotes increased site activity by SW to ensure the sewers are running freely and to observe the level of flow in manholes. It is the observed level of flow in the sewers which determines when surplus flow needs to be removed.

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.

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.

6. NEXT STEPS

As noted previously, reducing infiltration is an ongoing journey and is not an issue that can be easily addressed due to the scale, complexity and ownership of different aspects of a holistic drainage system. Good progress has been made since 2013 in sealing public sewers that have been found to be leaking and is observed in the groundwater table reaching a higher level prior to significant infiltration occurring.

6.1. Action Plans

The hyperlinks below connect to individual Action Plans for the locations subject to a formal Infiltration Reduction Plan. These individual plans provide an update on the last year's groundwater situation, what mitigation action were taken and a summary of SWS' action plan to prevent flooding due to groundwater infiltration.

- St Mary Bourne
- Hambledon
- Lower Nailbourne
- Upper Nailbourne and Elham Valley
- Alkham Valley
- Lancing
- Winchelsea Beach
- Lavant Valley
- Goodworth Clatford
- Appleshaw
- Barnham
- Hursley
- Chilbolton
- Kings Somborne
- Longparish
- Fyfield

SW is committed to continuing to pursue infiltration to reduce impact upon communities and the need for over-pumping. In addition to describing the work that has been done by SW, the Infiltration Reduction Plans also describe 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.

6.2. 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 IRPs will be published on SW's website.

APPENDIX A – GROUNDWATER TREATMENT

At our groundwater treatment sites excess flow is extracted from the sewer by pumping. This flow is passed through screens to remove rags and solids. The screened flow is then passed through a cloth filter to remove fine deposits from the liquid flow.
After the finer solids have been removed the liquid flow is passed through ultra-violet lamps which kill harmful bacteria such as e.coli and enterococci. The resultant treated flow is then discharged to the watercourse.

Monitoring
We will monitor at all times 24/7 the performance of the groundwater treatment process
We will use sondes in watercourse upstream and downstream of the discharge to ensure no impact on the environment
We will spot sample and take daily bottled samples to determine the quality of flow discharged from the treatment process
The quality of the treated flow will meet the standard set out in the table below.

Determinand	NH3-N (mg/l)	BOD (mg/l)	COD (mg/l)	pH (pH Units)	P (mg/l)	SS (mg/l)	E.Coli (no./100ml)	Enterococci (no./100ml)
Crude influent	5.6	18.8	44	7.62	3.19	53.77	230000	41500
Treated effluent	2.5	9.4	22	7.71	2	11	100	100
Removal Efficiency	55%	50%	50%	n/a	37%	80%	>99%	>99%

Photo of a typical groundwater treatment unit.