# Nailbourne Infiltration Reduction Plan

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APPENDIX A

Technical Report

APPENDIX B

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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 working during 2013 and 2014 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 Littlebourne. Flows from Littlebourne gravitate to Nargate St WPS from where it is pumped to join the flow from School Lane WPS. The resultant flow gravitates in a north-easterly direction to Newnham Valley WTW in Preston.

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 has been communicating with other agencies and in particular during the recent flooding, SW has been working closely with these bodies to minimise the inconvenience to residents.

The repairs being carried out by SW are improving the situation but the success of the infiltration reduction programme will also be dependent on the support of the following agencies, councils and groups:

- Environment Agency,
- Kent County Council,
- Canterbury City Council
- Shepway District Council
- Little Stour & Nailbourne River Management Group

Southern Water has been consulting with representatives of these parties in the meetings of the Little Stour & Nailbourne Multi-Agency Group.
Flow in northeastern direction to Newnham Valley WTW, Preston

Riverside Close WPS, Bridge

Bekesbourne

Patrixbourne

Bishopsbourne

Littlebourne

Nargate St WPS, Littlebourne

School Lane WPS, Bekesbourne

Bridge

Canterbury

Barham

Kingston

Representation of the sewerage system for the Nailbourne in the Newnham Valley WTW catchment
Representation of the sewerage system for the Nailbourne in the Hythe WTW catchment

The Orchards WPS, Elham
Ottinge WPS
Flow to Hythe WTW
EXECUTIVE SUMMARY

In response to the Environment Agency’s publication of their Regulatory Position Statement on discharges made from groundwater surcharged sewers, and the consequence of several very wet winters since the millennium, Southern Water has developed a strategy and action plan to manage the groundwater infiltration (GW infiltration) affecting villages in the Nailbourne catchment from Ottinge in the south to Littlebourne in the north.

In the 2013 versions of the IRP, the extent of the catchment being investigated was from Barham to Bekesbourne. The flooding in the winter of 2013/14 was more severe than the 2012/13 flooding, extending further up the catchment to Elham and Ottinge. In response to this flooding, the scope of this IRP has been extended to cover these areas.

This IRP includes:

1. The background to the current situation. (Appendix A)
2. The process being followed and the actions being taken to investigate and rehabilitate the sewerage system to reduce infiltration to an acceptable level. (Sections 1 & 2)
3. Long-term plans to monitor flows and investigate sources of flow increase beyond completion of the current phase of rehabilitation. (Section 2)
4. Actions being taken by SW to identify sources of infiltration and to reduce the amount of infiltration. (Section 4, Table 1)
5. Multi-Agency actions to mitigate conditions which give rise to the need for tankering and discharges to watercourses (Section 4, Tables 2-5). SW will work with others to encourage infiltration reduction in private drains connected to our sewerage system.
6. Plans to show the areas surveyed indicating areas of infiltration and the rehabilitation carried out. (Appendix B)
7. Reasons why emergency discharges will continue to be required in extreme conditions (Section 3) and other potential solutions.
8. Outline information about the emergency discharges - short-term (Section 3 and Appendix C) and long-term (Appendix D)

Conclusions:

1. A technical report is provided in Appendix A which includes the background to the current situation.
2. The process set out in Section 1 is being followed. In 2013, surveys were carried out on 250 manholes and over 10km of sewer. Rehabilitation work was carried out in Autumn 2013 which included the sealing of 10 manholes and repairs on over 3.6km of sewer. Location plans for survey and rehabilitation work in 2013 are provided in Appendix B.
   In April/May 2014, further surveys were carried out in the village of Elham at the locations shown in the plans provided in Appendix B. Further rehabilitation work arising from these surveys and other work delayed from 2013 is scheduled to be carried out in 2014.
   Historical surveys and rehabilitation work prior to 2013 are summarised in Section 3.4 of the report in Appendix A.
3. ‘Dry weather’ flow monitoring exercises were carried out in the summer of 2013. ‘Wet weather’ flow monitoring was carried out in May/June 2014. The differences between the surveys will be compared to identify areas of remaining high flow. This data will be used to help identify localities with high infiltration.

4. In the winter of 2013/14, following the repairs carried out last year, over-pumping did not commence until the groundwater level reached 81.3m. This is more than 3m higher than the groundwater level in 2013, when over-pumps were switched on.

5. SW is engaging with other agencies through the Little Stour & Nailbourne Multi-Agency Group to keep the stakeholders informed about planned activities and progress and to address multi-agency actions to build on the work being done by SW to reduce infiltration.

6. The IRP has been prepared by SW, but the success of ultimately eliminating the requirement for emergency discharges (other than under exceptional circumstances) is dependent on a multi-agency commitment. [the current set of actions are included in Tables 2 – 5]

7. SW is committed to detecting and repairing sources of infiltration to reduce groundwater infiltration into sewers in accordance with best technical knowledge not entailing excessive cost. (BTKNEEC). Significant repairs were carried out in 2013 and further repairs are scheduled for 2014.

8. Reducing infiltration is a long term activity. The work identified from the CCTV surveys in the summer of 2013 is virtually complete, but due to the extreme heavy rainfall throughout the period December 2013 to February 2014, emergency discharges have been necessary to ensure a minimum level of sewerage service is provided to residents. (Details of emergency discharges and tankering in the winter of 2013-14 are provided in Appendix C).

9. Despite the significant investments being made by SW to reduce infiltration into sewers, and multi-agency actions to be taken, due to circumstances outside SW’s control, there may continue to be occasions when emergency discharges will be required. The circumstances when overpumping and tankering would be expected to be required, locations and expected flow rates are included in Appendix D.

10. It should be noted that manholes in the vicinity of the tankering/pumping may spill during extreme weather events, despite our actions to maintain sewage disposal services for customers by the use of tankers and (where appropriate) pumps.
1. REPORT REQUIREMENTS AND SOUTHERN WATER APPROACH

The scope and structure of this IRP is guided by the requirements in the Environment Agency’s publication of their Regulatory Position Statement on discharges made from groundwater surcharged sewers. In response to the EA’s RPS and flooding that has occurred during several very wet winters since the millennium, Southern Water has developed a strategy and action plan to manage the groundwater infiltration (GW infiltration) affecting the Nailbourne catchment.

In the Nailbourne villages, during periods of very high groundwater level following prolonged rainfall, the consequence of infiltration into the sewers and manholes has been sufficiently disruptive and costly, that inaction is not an option.

In all locations, where infiltration reduction is being tackled, the problem cannot be resolved by SW alone. It requires a collaborative approach with other organisations. We have found from our experience in other locations where we have completed sewer rehabilitation, that repairs need to be reasonably comprehensive to reap benefits.

Despite the significant investments being made by SW to reduce infiltration into sewers, due to circumstances outside SW’s control, there may continue to be occasions when emergency discharges will be required. During the last two winters, it has been necessary for SW to remove excess flow from the sewers using tankers and/or pumps. This action has been required to minimise restricted toilet use, spillages from manholes and internal/external flooding of properties with sewage.

The issues are complex and affect a long linear area over several villages. SW has engaged consultants to complete a technical review and provide the evidence showing the correlation between groundwater and the performance of the sewer network in the Nailbourne catchment. A copy of their report is in Appendix A.

Accepting that the infiltration needed to be reduced, SW adopted a standard process with the objective of reducing emergency discharges. The following steps are being taken:

1. survey
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. limited follow up survey and repairs if required
7. ongoing monitoring.

Planned and completed activities are shown on the programme below. Activities marked in green have been completed whilst activities marked in grey are to be carried out in the future.
2. SURVEY, REHABILITATION AND MONITORING

2.1. Pressures and Consequences of High Groundwater

Southern Water recognises that a number of very wet winters in recent years has resulted in infiltration into the sewer network, which has resulted in restricted toilet use, and a few instances of internal and external sewer flooding.

SW has acknowledged that rehabilitation work is required to improve the situation and has undertaken repairs at specific locations over the last few years. These are detailed in Appendix A. In 2013, SW acknowledged that a more comprehensive approach was required and embarked on the survey and rehabilitation steps of the infiltration reduction process explained in Section 1.

2.2. Survey and Rehabilitation

Sewer systems are designed for normal ‘dry weather’ conditions but with an allowance for the effects of rainfall and infiltration. However, where we are aware of significant infiltration which impacts on the ability to provide effective drainage, steps are required to reduce infiltration to an acceptable level.

Southern Water has previously undertaken infiltration reduction measures as detailed in Section 3.4 of the report in Appendix A. However, acknowledging that infiltration needed to be reduced further during 2013, the process described above has been implemented.

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

- Sewer lining – fitting a new lining to entire manhole to manhole sections of sewer to repair several leaks, by forming a leak-tight pipe within the existing sewer.
- Excavations to repair leaking joints where no-dig techniques are not possible.
- Quick-Locks – metal ‘sleeves’ which are inserted remotely into damaged pipe sections and, once located correctly, are expanded via compressed air against the inner walls of the pipe to instantly seal leaks.
- Capping of leaking un-used connections.
- Top Hats – fibre glass 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 thus sealing the sewer.
Manhole chamber sealing – a non excavation method to repair manholes.

Barham to Bekesbourne

To date, the surveys and rehabilitation work carried out in 2013 and 2014 have been on the length of sewer between Barham and Bekesbourne.

In 2013, we used CCTV to extensively survey over 10km of sewers and 250 manholes. Significant sources of groundwater infiltration were identified at the following locations:

- Bridge (near Brewery Lane and Mill Lane)
- Bourne Park (Bishopsbourne)
- Charlton Park
- Barham

Between September 2013 and January 2014, over 3.6km of these sewers were repaired.

Comparison of the flow monitoring results indicated potential infiltration in the vicinity of Kingston. However groundwater levels fell during the flow monitoring so no further CCTV was carried out at the time.

Coloured plans showing the location of survey and rehabilitation work in 2013 are included in Appendix B.

Elham and Ottinge

Elham and Ottinge were not included in the recent survey and rehabilitation work due to the infrequency of the flooding in these areas. However, following the flooding in the winter of 2013-14, further CCTV survey was carried out in Elham in April/May 2014. Location plans showing the extent of the CCTV survey are provided in Appendix B. Rehabilitation work identified from these surveys is scheduled for 2014.

Groundwater Levels

The graph below shows the groundwater level measured at Little Bucket borehole during the winters of 2012-13 and 2013-14, which reached a peak of 87m AOD in February 2014. The graph also shows the groundwater level when overpumping started and stopped in the Nailbourne villages.

In the winter of 2013/14, the last overpump in the Nailbourne was turned off when the groundwater level was 81m AOD. This level was 6m higher than when the overpumps were turned off in 2012/13 and appears to demonstrate that recent repairs on the sewers have restored the structural integrity of the sewers repaired.
On the basis of the information from 2014, the following trigger levels are proposed based on groundwater levels at Little Bucket borehole. It should be noted that the trigger levels at Little Bucket BH are the point at which SW expects to start mobilising equipment and resources for tankering and over-pumping. Depending on the severity of the flooding, with over-pumping in operation it is likely that tankers will also continue to be required to address localised flooding issues.

**Over-pumping ‘Trigger’ and start values in 2014**

| Trigger GW level at Little Bucket | 79.0m |
| Commence at Ottinge | n/a |
| Commence at Elham | TBC |
| Commence at Barham | 0.7m freeboard in manhole |
| Commence at Bishopsbourne | 0.2m freeboard in manhole |
| Commence at Patrixbourne | 0.1m freeboard in manhole |
| Commence at Bekesbourne | 0.5m freeboard in manhole |
| Commence at Littlebourne | 1.0m freeboard in manhole |

The points at which tankers will start operation is based on a number of factors which are assessed at the time; a major factor is the levels in the local sewers. SW’s
approach is to deploy tankers to address localised sewer flooding events, prior to using over-pumps.

The trigger levels will be reviewed following future rehabilitation and other high groundwater events.

2.3. Flow Monitoring Surveys

As noted in Step 5 above, flow monitoring has been carried out in both ‘dry weather’ and ‘wet weather’ conditions to assess whether there remain areas where excessive groundwater is getting into the sewers.

If analysis of the ‘wet weather’ flow survey indicates areas where groundwater infiltration is still significant, then we will carry out further surveying to identify the locations of the main sources of infiltration. This may include CCTV surveys or the use of alternative techniques. If we find any major sources of infiltration, then we will carry out limited sewer repairs and rehabilitation as appropriate.

2.4. Long Term Monitoring

Following the completion of the rehabilitation, SW will set up a regular review programme to monitor and seek correlation between groundwater levels, sewer flows and rainfall. This will be used to detect flow increases. Repairs will then be carried out as appropriate. The monitoring programme is still being developed, but the principle will be to set up a simple monitoring programme that will give advance warning of increases in infiltration.

3. EMERGENCY DISCHARGES

3.1. Requirements

The rehabilitation work being undertaken by SW has improved the integrity of the sewerage system thus reducing groundwater infiltration. However, private drains are also a source of infiltration and SW will work with others to reduce infiltration into these pipes.

SW is committed to detecting and repairing sources of infiltration to reduce groundwater infiltration into sewers in accordance with best technical knowledge not entailing excessive cost. (BTKNEEC). Nevertheless, in extreme conditions emergency discharges may continue to be required. Section 2.3 iii) and iv) of the RPS, Version 2, 2014 (reproduced below) anticipates this possibility. Further analysis will be conducted in 2014 after completion of the current rehabilitation programme, and analysis of the ‘wet weather’ flow monitoring exercise, to assess the circumstances under which an overflow would be required, the location and expected flow rate.

Excerpt from Regulatory Position Statement, Version 2, 2014 - Section 2.3 iii) and iv) (in italics).

iii) Details of anticipated unavoidable discharges (resulting from groundwater infiltration) indicating their location and the circumstances under which they will need to be made.

iv) Details of the proposed discharges such as screening that will be in place and maximum discharge rates etc.
The RPS also places an obligation on Water Companies to limit discharges to when they are unavoidable. The ways in which we would address these requirements are given below in relation to each part of Section 2.4.

Excerpt from Regulatory Position Statement, Version 2, 2014 - Section 2.4

2.4 Discharges will generally include those made to avoid danger to health and those made to maintain sewerage services to customers. It may also include those made to protect critical infrastructure.

SW’s objective is to maintain sewage disposal services for customers, avoid internal sewer flooding and to avoid significant spills from manholes. We have made significant investment to reduce infiltration and to protect specific properties at risk of flooding. However, following prolonged wet weather, to maintain services and avoid significant spills, we expect to need to remove excess flow from the network.

The Environment Agency expects that before controlled discharges are made, the WaSC should:

a) take all reasonable steps to prevent discharges and only make a controlled discharge if there are no reasonable alternatives (that is discharges are unavoidable).
   • In consultation with our contractors, and other professional partners and groups, including the Environment Agency and local council, we will have dynamically assessed, and where possible implemented, other viable alternative options before over-pumping.
   • During the last two years, SW has undertaken extensive survey and repairs of points in the sewerage system where infiltration was found.
   • In previous recent years, we have also undertaken significant repair work (listed at the back of Appendix B)
   • We will ensure that our assets are in working condition and operating at capacity, in anticipation of high groundwater levels. This comprises activities such as cleaning wet wells and checking pumps to confirm they are working at capacity.
   • Properties known to be at risk are protected against flooding by installation of NRVs or isolating valves.
   • where known environmental damage to critical infrastructure (such as water supplies), or rare habitat (e.g. SSSI) has the potential to occur we would seek alternative solutions.

b) if discharges can’t be prevented, take all reasonable steps to minimise the volume and duration of discharges.
   • Where practical, pumps at discharge points will be fitted with level controls to limit pumping to when the capacity of the sewerage system and the permanent pumps cannot handle the flow.

c) use screening and other mitigation measures to reduce impact.
   • a typical over-pumping site consists of a pump located at ground level adjacent to a sewer manhole near the watercourse. The pump lifts flow (through a barrel filter) from the sewer at a level which captures liquid flows rather than solids (which remain in the sewer).
• The flow is pumped into a settlement tank where it passes under settlement weirs, before discharging via a hose with a filtration sack located on the end.
• In-situ river sampling is undertaken regularly to check ammonia levels and bacteria content.
• In 2013-14, portable biological treatment units 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

• Maintenance of the over pumping units is carried out regularly which includes checking the flow, cleaning/replacement of filtration sacks and cleaning the tanks.
• Typical discharge rates for over pumping are between 10 l/s and 50 l/s depending on the pump and the pipework configuration. Power is supplied either by local access point or Silent Pack diesel generators on site.

\[d)\text{ inform the Environment Agency (by logging through the Agency’s National Incident Communication Service and through informing a local contact as detailed in the Infiltration Reduction Plan) and affected public when discharges are starting (through messages agreed and documented in the Infiltration Reduction Plan, such as signage and informing for example the Parish Council).}\]
• We will update stakeholders and customers on progress and level of preparedness for periods of high groundwater. Further information on communications is in Section 3.4 of this document.

\[e)\text{ monitor the quality of the downstream watercourse in consultation with the Environment Agency as agreed in the Infiltration Reduction Plan (for example this could include; daily monitoring of upstream and downstream and of the discharge for ammonia, solids and bacterial quality, as determined by river amenity / use / quality).}\]
• SW undertake regular water quality monitoring as set out in Section 3.5 of this document.

3.2. Proposed Discharges

It is imperative that the sewerage system and wastewater pumping stations in the Nailbourne catchment operate at all times and to maximum design capacity to ensure that residents and customers do not have to suffer from restricted use of their facilities, or that the sewer system becomes overloaded to the point that uncontrolled discharges occur which causes disruption and pollution incidents to the environment. If the hydraulic capacity of the sewers and wastewater pumping stations is exceeded due to additional flows from groundwater, the first response of Southern Water is to deploy tankers at strategic locations to remove some of the flows. These tankers then transfer flows to Canterbury WTW or other suitable locations.

However, tankers have limited capacity, can only draw off liquid at a relatively low rate and cause disturbance by their presence and noise associated with the work.
In cases of exceptional high flows in the sewers, in order to protect residents from imminent public health dangers of sewage flooding in properties or restricted toilet use (RTU), it may be necessary to supplement the tankers with temporary discharges from the sewers to watercourses, should the combination of wastewater pumping stations and tankers capacity still be exceeded.

Discharging the diluted sewage to watercourses is seen as the last resort option, and Southern Water is investing in sewer improvement works to ensure the ingress of groundwater into the sewers is kept to a practicable minimum. However, currently in extreme weather conditions such as was experienced in early 2014, emergency discharges to watercourses at one or more locations will be required.

The Environment Agency, Canterbury CC Environmental Health Department and local public will be kept informed of discharges to watercourses (over-pumping) before and during the operation.

Details of historical tankering sites and discharges to watercourses are included in Section 3.3 of the report in Appendix A. Details of tankering and over pumping sites during the winter of 2013-14 are provided in Appendix C. The proposed arrangements for over-pumping are included in Appendix D.

### 3.3. Potential Discharges

SW has carried out over £1.6m of work in the Newnham Valley to survey the sewerage system and rehabilitate the network. We are also completing the replacement of the pumps at School Lane WPS as part of SW’s Total Care Package, to ensure that they continue to reliably deliver their design flow. However during extreme weather conditions, it is to be expected that there will continue to be occasions when discharges from the sewerage network into the watercourses will be required. As noted above, currently this is addressed by setting up temporary over-pumps with settlement tanks and basic screening. However, we are investigating the possibility of fixed control structures at locations that suffer from hydraulic overload during flood conditions. A hydraulic model of the sewerage network has recently been completed and is being used to determine the optimum location for providing pumped discharges from the network. If such units were to be constructed (following planning and other regulatory approvals), they would only be operated in conditions comparable to when we have to over-pump currently (following the same arrangements with the EA).

We may conclude that such fixed assets are not viable; however, we consider it is appropriate for us to investigate alternatives to improve the quality of diluted effluent reaching watercourses, when discharges become unavoidable. In those situations, we want to work with the community to ensure that we minimise the impact on customers and the built, and natural, environment.

In addition to the work that SW is doing to reduce infiltration and to seek alternative solutions in the event of flooding, we will also continue to work with the other agencies to pursue the actions described in the tables in Section 4.

Currently, we will update the tables quarterly.

### 3.4 Communications

Since the start of the infiltration reduction programme early in 2013, Southern Water has been proactive in communicating with stakeholders and customers about
planned and completed work to improve the integrity of the sewerage system. During the year, we kept customers and stakeholders informed of progress on survey and sealing work via letters or emails.

Despite the work being undertaken, over-pumping may still be required during extreme conditions, in such situations, prior to commencing over pumping, we will notify the EA National Incident Communication Service (Tel. 0800 807 060) and inform the local EA contact and Canterbury CC Environmental Health Department. We will contact other local stakeholders as soon as is practicable.

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 wording on the signs will be as, or similar to, the example in Appendix E, although the reference number may be different.

3.5 Water Quality Monitoring

Southern Water has been carrying out regular monitoring of receiving watercourses at locations where it has been over pumping. At each site we will require 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

The upstream/downstream locations provided above are typical positions and may vary depending on the watercourse depth, width or flow.

If we have to over pump, then a laboratory sample would 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 units with the Environment Agency. If required, the sondes units would be provided at these locations and would record 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)
4. ACTION PLANS

The current rehabilitation work will reduce infiltration into sewers at the locations where repairs have been carried out. However, it is expected that during periods of high groundwater, some infiltration will occur at new locations. The process being followed by SW to reduce infiltration into sewers anticipates this and an allowance has been made for further surveys (CCTV or alternative technique) on a percentage of the sewers if the ‘wet weather’ flow monitoring surveys show higher than expected localised flows.

Activities being carried out by SW that will reduce infiltration into sewers are given in Table 1 below. This table also includes timescales and expected outcomes. The EA notes that it is not seeking the complete elimination of groundwater surcharging, but requires improvements to be made in line with BTKNEEC.

In 2012/13, SW spent £0.3 million on survey work and £1.4 million on rehabilitation work in the Nailbourne area, benefiting a population of 4,000 people. The work currently being carried out by SW will further improve the situation following historical rehabilitation work described in Section 3.4 of the report in Appendix A. Analysis of the ‘wet weather’ flow survey will give an indication of the level of success achieved by the rehabilitation programme. A summary of the information will be added to the IRP.

In addition to the steps being taken by SW set out in Table 1, actions to be taken by other agencies that will further reduce the infiltration into sewers are set out in Tables 2 – 5 below. Proposed actions for other parties are dependent on agreement by the respective organisations.

The actions in the tables below relate to all the villages unless stated otherwise.

* It should be noted that the timing for some of the activities in these tables is dependent on the suitability of flow conditions in the sewer.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Actions</th>
<th>Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Develop an approach for reduction of infiltration and maintenance of reduced levels of infiltration.</td>
<td>Refer to Section 1 above and the report in Appendix A.</td>
<td>Summer 2013, Complete</td>
<td>The steps are being followed to deliver results.</td>
</tr>
<tr>
<td>1.2</td>
<td>'Dry weather' flow surveys (to measure background levels of infiltration during low groundwater periods)</td>
<td>Identify suitable measurement points, carry out survey over four week period in Summer, match rainfall records with flow data.</td>
<td>July/ August 2013 - Complete</td>
<td>Groundwater infiltration is greater than would be expected for summer conditions.</td>
</tr>
<tr>
<td>1.3</td>
<td>'Wet weather’ flow surveys (to identify remaining areas of infiltration following initial sewer rehabilitation/repair).</td>
<td>Identify suitable measurement points, carry out survey over four week period, match rainfall records with flow data.</td>
<td>May/ June 2014 – Survey complete Analysis - ongoing</td>
<td>When complete, review comparison between wet and dry weather flow surveys to identify if further survey is required in localised areas.</td>
</tr>
<tr>
<td>Ref.</td>
<td>Item</td>
<td>Actions</td>
<td>Timescale and Status</td>
<td>Outcomes</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.4</td>
<td>CCTV etc survey of sewers</td>
<td>Identify Strategic Manholes, survey MHs to identify clear flow and infiltration. Carry out CCTV survey where clear flow was identified.</td>
<td>Barham to Bekesbourne Summer 2013 – Complete Elham Summer 2014 - Complete</td>
<td>Identify major sources of infiltration to determine scope of rehabilitation work.</td>
</tr>
<tr>
<td>1.5</td>
<td>Carry out sewer rehabilitation work</td>
<td>Use various techniques to seal infiltration points in manholes and sewers</td>
<td>Barham to Bekesbourne Autumn 2013 Elham Scheduled for Summer/Autumn 2014</td>
<td>Structural integrity of sewers restored.</td>
</tr>
<tr>
<td>1.6</td>
<td>Further surveys (CCTV or alternative techniques), if required, where ‘wet weather’ flow surveys show areas of high infiltration remaining</td>
<td>Further surveys in areas where ‘wet weather’ flow surveys show high level of clear flow.</td>
<td>2015 –if required after analysis of the ‘wet weather’ flow surveys.</td>
<td>Determine scope and carry out further rehabilitation if identified as required from the survey results.</td>
</tr>
<tr>
<td>Ref.</td>
<td>Item</td>
<td>Actions</td>
<td>Timescale and Status</td>
<td>Outcomes</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>----------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>1.7</td>
<td>Further sewer rehabilitation work, if required, in areas where surveys carried out.</td>
<td>As above, use various techniques to seal infiltration points in manholes and sewers</td>
<td>Summer/Autumn 2015</td>
<td>Reduced infiltration.</td>
</tr>
<tr>
<td>1.8</td>
<td>Maintain IRP as a live document</td>
<td>Update text of the IRP as appropriate to describe work carried out and/or developments</td>
<td>Annually</td>
<td>Up to date IRP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Update Tables 1 to 5 to show progress on individual activities.</td>
<td>Quarterly</td>
<td>Up to date Tables of Actions</td>
</tr>
<tr>
<td>1.9</td>
<td>Consider alternative solutions that involve some risk</td>
<td>Investigate unconventional options such as vacuum sewers or consider conventional combined sewer overflows</td>
<td>SW, 2014/15, following analysis of the ‘wet weather’ flow survey.</td>
<td>Ongoing. Ensure solutions are cost effective.</td>
</tr>
</tbody>
</table>
### Table 2. Multi-Agency Activities to Reduce Groundwater Infiltration

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Actions</th>
<th>Owner, Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Strategy for infiltration via private drains</td>
<td>Southern Water to propose a strategy for dealing with infiltration via private drains*</td>
<td>SW supported by EA and local Parish Councils, Summer/Autumn 2014.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SW will monitor sewer flow to identify significant increases in inflows.</td>
<td>SW, Autumn 2014 onwards</td>
<td>Early identification of areas where infiltration has increased</td>
</tr>
<tr>
<td>2.2a</td>
<td>Investigate highway ‘mis-connections’</td>
<td>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</td>
<td>Kent County Council with support from SW, 2014</td>
<td>Reduced flow of surface water (if connections are found).</td>
</tr>
<tr>
<td>2.2b</td>
<td>Investigate domestic ‘mis-connections’</td>
<td>Where non-sewage flow is identified from domestic properties, investigate to identify source of flow into SW sewers</td>
<td>SW, with assistance from Canterbury City Council where required, 2014</td>
<td>Reduced flow of surface water (if connections are found).</td>
</tr>
</tbody>
</table>
| 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. | SW | |
| | Sewerage materials for new developments | SW, District Council | |

*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 3. Publicity / Communication Activities to Reduce / Mitigate the Effects of Groundwater Infiltration.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Actions</th>
<th>Owner, Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Public meetings about reducing groundwater infiltration into sewerage system</td>
<td>Attend public meetings with other agencies as appropriate.</td>
<td>SW, as required</td>
<td>Inform local population of progress and planned activities and receive feedback.</td>
</tr>
<tr>
<td>3.2</td>
<td>Letters from SW to stakeholders and residents about reducing groundwater infiltration into the sewerage system</td>
<td>Send letters at regular intervals to communicate progress and planned activities</td>
<td>SW, as required</td>
<td>Inform local population of progress and planned activities</td>
</tr>
<tr>
<td>3.3</td>
<td>Multi-Agency Group meetings</td>
<td>Discuss and agree actions to reduce requirements for tankering and emergency discharges to watercourses.</td>
<td>All Parties, alternate months until further notice.</td>
<td>Improved understanding and appreciation of issues. Agreement to actions to help reduce the need for tankering and emergency discharges to watercourses</td>
</tr>
<tr>
<td>3.4</td>
<td>Implement local campaign to discourage misconnections</td>
<td>Publicise through parish councils. Include article in Parish magazines. **</td>
<td>District and Parish Councils, Summer 2014</td>
<td>Publicise the role that everyone has to play in reducing non-sewage flows in sewers.</td>
</tr>
</tbody>
</table>

** 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 4. Activities to Mitigate the Effects of Groundwater Infiltration/ Other Flood Protection Mechanisms

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Actions</th>
<th>Owner, Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Early Warning system</td>
<td>Joint continuous monitoring of groundwater levels and sewer levels/flows.</td>
<td>SW, EA, 2014</td>
<td>Develop trigger levels by comparing historic customer complaints and tankering with BH levels (or other reference). Note trigger levels should vary as a consequence of rehabilitation. Also they will need to reflect groundwater reaction times.</td>
</tr>
<tr>
<td>4.2</td>
<td>Tankering arrangements</td>
<td>Investigate options for improving location of tankers and over-pump units for future events. e.g. by use of longer hoses/ pumping</td>
<td>SW, Spring 2014, Done</td>
<td>Potentially less disruption to residents when tankering / pumping is essential.</td>
</tr>
</tbody>
</table>
| 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. Trialled if and when the sewers are surcharged | Potential to increase output of pumping stations at:  
  • School Lane, Bekesbourne  
  • Nargate Street, Littlebourne |
<p>| 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 &amp; 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. |</p>
<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Actions</th>
<th>Owner, Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>Maintenance of watercourses</td>
<td>Riparian owners to carry out their responsibilities to maintain adequate flow through watercourses by clearing vegetation, desilting, etc</td>
<td>Riparian owners with input from District and Parish Councils – ongoing responsibility</td>
<td>Maximise the flow along watercourses in order to minimise surface flooding, which results in inundation of manholes to the sewerage system.</td>
</tr>
<tr>
<td>4.6</td>
<td>Review of utilisation of control structures</td>
<td>Investigate the possible use of fixed control structures to relieve hydraulic overloading of sewers.</td>
<td>SW, 2015</td>
<td>Potential approval of concept and locations of control structures.</td>
</tr>
</tbody>
</table>
Table 5. Activities required if Groundwater Infiltration cannot be adequately reduced at reasonable cost (BTKNEEC)/ interim arrangements.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Actions</th>
<th>Owner, Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Over-pumping Sites: improve effluent quality</td>
<td>Investigate potential for improved screening and basic treatment at points of discharge into watercourse.</td>
<td>SW, Summer/Autumn 2014</td>
<td>Improved arrangements for discharges when required.</td>
</tr>
<tr>
<td>5.2</td>
<td>Over-pumping Sites: minimise flow</td>
<td>Add level control to pumps to reduce durations for pumping</td>
<td>SW, 2014, Done</td>
<td>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.</td>
</tr>
<tr>
<td>5.3</td>
<td>Standards for emergency discharges</td>
<td>SW to discuss with EA about best practice set up for over-pumping arrangements.</td>
<td>SW, 2014, to follow 5.2</td>
<td>Agree with EA acceptable treatment for discharges and acceptable flow rates.</td>
</tr>
<tr>
<td>5.4</td>
<td>Flow, location, screening arrangements for emergency discharges</td>
<td>Determine potential flow rates and screening arrangements and most appropriate locations,</td>
<td>SW, concurrent with 5.2</td>
<td>Agree with EA, Canterbury CC, Shepway DC and local Parish Councils acceptable arrangements for future emergency discharges.</td>
</tr>
<tr>
<td>5.5</td>
<td>Action Plans</td>
<td>Develop SW action plans documenting set up of pumps, tankers, etc. for emergency situations.</td>
<td>SW, Summer 2014- Complete</td>
<td>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.</td>
</tr>
</tbody>
</table>
## MWH Project Code: 41520490

### Version

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<th>Version</th>
<th>Date</th>
<th>Description/Amendment</th>
<th>Prepared by (Author)</th>
<th>Checked by</th>
<th>Reviewed by</th>
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<td>First Draft</td>
<td>Jody Cockcroft</td>
<td>Robert McTaggart</td>
<td>Rob Perrett</td>
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<tr>
<td>02</td>
<td>23rd May 2013</td>
<td>Second Draft</td>
<td>Jody Cockcroft</td>
<td>Kate Harris</td>
<td>Richard Andrews</td>
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<tr>
<td>03</td>
<td>11th September 2013</td>
<td>Third Draft</td>
<td>Jody Cockcroft</td>
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### File Location

S:\41520386 - Southern Water I&I and Sewer Flooding\Technical (T)\T4 Deliverables\Controlled\Priority 1 catchments\Nailbourne\V3

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1. INTRODUCTION 3
2. STATEMENT OF PROBLEMS 3
3. BACKGROUND INFORMATION 3
   3.1. Sewerage System 3
   3.2. Evidence of Groundwater Infiltration 4
   3.3. Unavoidable discharges - location, options and reasons why necessary 5
   3.4. Work To Date 6
   3.5. Consultation and customer liaison 6

Figures

Evidence of Groundwater Infiltration
1. INTRODUCTION

This Infiltration Reduction Plan covers the series of villages within the Newnham Valley Wastewater Treatment Works (WWTW) catchment that lie adjacent to the Nailbourne watercourse in Kent. The WWTW catchment is made up of ten main villages starting in the south with Woolage, Barham, Kingston, Bishopsbourne and Bridge. The valley and sewerage system then turn west to Patrixbourne, Bekesbourne, Littlebourne, Wickhambreaux and Stodmarsh.

Figures A1 and A2 show the location and extents of the WWTW catchment.

The Nailbourne Valley runs from the south of Canterbury and flanks the city on its east side continuing north east. Between Bekesbourne and Littlebourne, the Nailbourne is then known as the Little Stour which then joins the Great Stour and drains to sea near Ramsgate.

2. STATEMENT OF PROBLEMS

The villages have suffered from flooding in the past due to ingress to the sewer system from the Nailbourne. Properties regularly suffer from flooding and restricted toilet use during period of high groundwater.

The last significant event was in 2010 where four properties where affected by internal sewer flooding and nine properties with external sewer flooding.

These issues were overcome with temporary over-pumping of excess flows at Bridge, Patrixbourne, Bekesbourne and Bishopsbourne. This was also assisted by tankers drawing down sewer flows in Bridge, Patrixbourne and Bishopsbourne. Canterbury County Council issued sandbags to properties to help assist as flood defences.

There are two properties and one other external area currently on Southern Water’s 1 in 20 year DG5 database at risk of flooding. These are located in Patrixbourne and Littlebourne.

3. BACKGROUND INFORMATION

3.1. Sewerage System

Table 1 below summarises the basic information on the sewerage system and catchment upstream of Newnham Valley WWTW.

<table>
<thead>
<tr>
<th>Catchment area (ha)</th>
<th>1133</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of properties</td>
<td>3037</td>
</tr>
<tr>
<td>Catchment population</td>
<td>6784</td>
</tr>
<tr>
<td>Catchment elevations (metres AOD)</td>
<td>2m to 116m</td>
</tr>
<tr>
<td>No. of pumping stations</td>
<td>18</td>
</tr>
<tr>
<td>No. of permitted overflows</td>
<td>0</td>
</tr>
<tr>
<td>Length of foul/combined sewers (km)</td>
<td>81.8</td>
</tr>
<tr>
<td>Diameters of foul/combined sewers (mm)</td>
<td>100mm to 450mm</td>
</tr>
<tr>
<td>No. of foul/combined manholes</td>
<td>1968</td>
</tr>
<tr>
<td>Length of surface water sewers (km)</td>
<td>0.5</td>
</tr>
<tr>
<td>Diameters of surface water sewers (mm)</td>
<td>100mm to 300mm</td>
</tr>
<tr>
<td>No. of surface water manholes</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 1: Summary of Newnham Valley sewerage network
The sewerage system for the Newnham Valley catchment consists of both a pumped and gravity foul system. The catchment population is approximately 6800.

Pipe sizes range in diameter from 100 mm to 450 mm as the system progresses through the catchment. Newnham Valley WWTW is located off Grove Road between Stodmarsh and Grove.

A total of 18 wastewater pumping stations (WPS) lift flows at various locations to reach Newnham Valley Preston Wastewater Treatment Works. The majority of these pumping stations lift relatively small low-lying areas into the main gravity network. However, the largest pumping station is School Lane WPS, Bekesbourne which pumps all sewer flows from Woolage, Barham, Kingston, Bishopsbourne, Bridge, Patrixbourne and Bekesbourne approximately 3 km towards Littlebourne.

There are no permitted Combined Sewer Overflows (CSOs) or Emergency Overflows (EOs) in the catchment.

There are two small surface water systems operated by Southern Water in the catchment that outfall to the environment, one serving Riverside Close in Bridge and the second serving The Elders and Court Meadows in Littlebourne. The total length of surface water sewer is 463 m.

There is currently no Impermeable Area Survey for the catchment.

Southern Water does not currently hold any details of the highway drainage for Woolage, Barham, Kingston, Bishopsbourne, Bekesbourne, Wickhambreaux and Stodmarsh. This can be explored with Kent County Council Highways Department.

The catchment topography and the Nailbourne watercourse are shown in Figure A3. The Newnham Valley catchment follows the Nailbourne valley closely from Barham to the WWTW.

The geology of the catchment is mainly chalk upstream of Littlebourne, Thanet Sands near Wickhambreaux and Stodmarsh, and Lambeth Group clays, silts and sands.

3.2. Evidence of Groundwater Infiltration

Historical level information has been obtained from Southern Water’s telemetry system for four sewer level monitors placed in the network at:

- Black Robin Lane, Kingston,
- The Street, Bishopsbourne
- Patrixbourne Road, Bridge
- Nargate Street, Littlebourne

Telemetry data has also been obtained for School Lane WPS, Bekesbourne and Newnham Valley WWTW.

Measured total daily flow data from the WWTW has been plotted in Figure A11 below for the period Jan 2008 to Mar 2013 with Environment Agency (EA) groundwater data recorded at Railway Embankment borehole (NGR TR1732254311), located 1 km west of Bridge.
Flows to the WWTW show a very strong correlation with local groundwater levels suggesting that groundwater has a significant influence on sewer flows.

The groundwater level of 30.58 m AOD recorded on 24th September 2012 is some 7 m higher than in August and October 2012 and therefore appears to be erroneous. When this data point is removed and a correlation analysis is undertaken, a correlation coefficient of 0.81 is obtained.

A correlation coefficient is a number between -1 and 1 that indicates the strength of the linear relationship between two variables. A positive correlation coefficient indicates a positive relationship. A correlation coefficient between 0.1 and 0.3 is considered weakly related, those between 0.3 and 0.5 are moderately related and those greater than 0.5 are considered strongly related.

The correlation coefficient of 0.81 between groundwater level data and sewer flows therefore indicates a very strong relationship between the two variables.

Figure A12 shows the calculated percentile daily flows and permitted DWF for the Newnham Valley WWTW for the period January 2008 to March 2013.

The percentile curve for a typical wastewater catchment with minimal infiltration is normally relatively flat up to around the 97th percentile indicating only small changes in sewer flow for the majority of the time. Above the 97th percentile there is often a sharp rise in the curve indicating much higher flows caused by rainfall and storm response in the sewer for a small percentage of the time.

Figure A12 however shows a steadily rising percentile line with a sharp increase at around the 90th percentile and again at the 97th percentile. This indicates the progressively increasing influence of inflows into the sewerage system, which in this case is caused by groundwater ingress.

A permanent sewer level monitor is installed in the foul sewer at Nargate Street, Littlebourne. This installation measures sewer flow depths and records data on Southern Water’s telemetry system. Figure A13 shows sewer level data obtained for the period from March 2009 to March 2013 with groundwater level data from Railway Embankment borehole.

Again, Figure A13 shows a relationship between high groundwater levels and high sewer levels. Statistically, there is a correlation coefficient of 0.63 between sewer level data and groundwater level data indicating a strong positive relationship between the two variables.

3.3. Unavoidable discharges - location, options and reasons why necessary

In order to prevent restricted toilet and facility use to the residents of the villages within Nailbourne valley, it is imperative that the public sewer system is kept functional. Sewage tankering is currently in operation 24 hours a day, 7 days a week at The Ford, Patrixbourne and Riverside Close, Bridge. Visits to properties on the Patrixbourne Road have also been made. This assistance has not provided the additional capacity and uncontrolled overflowing of manholes has occurred.

Therefore it was necessary to supplement this with additional pumping capacity on the sewer network. These were located in three separate locations shown in Figure A4 to A6:

- Manhole TR19550104 at Keepers Hill, Patrixbourne,
- School Lane WPS, Bekesbourne,
- Manhole TR19520401, The Street, Bishopsbourne.
Over-pumping equipment was also established at Nargate Street WPS, Littlebourne (see Figure A7), although this was not commissioned.

This over-pump unit pumps sewage into a tank where the flows pass through a Copa Sac solid screen bag, passing under settlement weirs before discharging via a hose with an additional Copa Sac located on the end. The discharge from the tank is in the range of 30 to 40 litres per second.

Bacteriological sampling is being carried out weekly from January 1st 2013 and laboratory results are awaited. Daily in-situ ammonia sampling is also being undertaken at and below the discharge.

3.4. Work To Date

A series of investigations and rehabilitation works have been carried out over the years including:

- 2001 – limited sewer inspection/cleaning,
- 2001 – limited local manhole sealing,
- 2003 – survey of main sewer (95% of total length, 70% of joints tested, 9% of joints failed pressure test),
- 2004 – relining of 500 m of 450mm sewer close to WWTW,
- 2006 – remedial works to seal 470 joints over a 2.9 km length of sewer.
- 2006 to 2010 – CCTV inspections (3.2 km) and root removal.

Main sewer CCTV surveys of parts of the catchment were completed in 1999, 2002, 2003, 2006, 2009, 2011 and 2012. Plans showing the extents of CCTV carried out are provided in Figures A8 and A9.

In the early months of 2012 a joint sealing survey had been arranged but due to the drought, groundwater levels were significantly below normal levels.

3.5. Consultation and customer liaison

Customer consultation has been through a letter drop to advise residents that over-pumping will potentially be carried out in the local area. This has been followed up with signage along the Nailbourne to advise of over-pumping.

Southern Water has also kept close links with the Little Stour and Nailbourne River Management Group.

The Little Stour and Nailbourne River Management Group is a liaison committee between the eleven parish councils representing the villages along the length of the Little Stour and Nailbourne rivers in East Kent. The group was set up following the severe flooding in the winter of 2000/2001.
Figures
Figure A1: Catchment Location – Woolage to Bekesbourne
Figure A3: Catchment topography and watercourses
Figure A4: Over-pumping from Manhole TR19550104 Keepers Hill, Patrixbourne into the Nailbourne
Figure A5: Over-pumping from Manhole TR19555603 into the Nailbourne
Figure A6: Over-pumping from node 0401 into the Nailbourne
Figure A7: Over-pumping established from Nargate Street WPS into the Little Stour
Figure A9: Extents of Historical CCTV investigations – Bridge to Stodmarsh
Figure A10: Locations of Strategic Manholes for upstream surveys
Evidence of Groundwater Infiltration
Figure A11: Newnham Valley WWTW - Daily flows and groundwater levels (Jan 2008 – Mar 2013)
Figure A12: WWTW daily flow percentiles (Jan 2008 – Mar 2013) and permitted DWF
Figure A13: Nargate Street sewer levels and groundwater levels (Mar 2009 to Mar 2013)
APPENDIX B

Survey Findings and Rehabilitation Scope Plans
Bridge to Bekesbourne – Plan Showing Location of CCTV Survey in 2013

Manhole
Inspected

CCTV
Survey
Completed

Nailbourne - Infiltration Reduction Plan

Southern Water
Page B2
December 2014
Nailbourne - Infiltration Reduction Plan

Bekesbourne – Plan Showing Location of Proposed Rehabilitation in 2013

School Lane

LEGEND
▼ Dig Repair
♦ Patch Repair or Quick Lock
● Manhole Sealing
--- CIPP
--- Joint Test & Seal

Project Title
AMP5 Yr4 Sewer Rehabilitation

Drawing Title
NEWNHAM VALLEY
Infiltration Reduction Scheme
Additional Works Bekesbourne

Based upon the Ordnance Survey map by Southern Water Services Limited by permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. Crown copyright Southern Water Services Limited W/0038850.
Patrixbourne – Plan Showing Location of Proposed Rehabilitation in 2013

LEGEND

- Dig Repair
- Patch Repair or Quick Lock
- Manhole Sealing
- CIPP
- Joint Test & Seal

Patrixbourne Road

Southern Water

December 2014
Bishopsbourne to Bridge – Plan Showing Location of CCTV Survey in 2013

LEGEND
• Manhole inspected
--- CCTV survey completed

Southern Water
Page B5
December 2014
Bridge – Plan Showing Location of Proposed Rehabilitation in 2013

- Dig Repair
- No Dig Patch
- Manhole Sealing
- Sewer Joint
- Test & Seal
- Sewer Lining

High Street

Bridge
Bourne Park, Bridge – Plan Showing Location of Proposed Rehabilitation in 2013
Nailbourne - Infiltration Reduction Plan

Bishopsbourne – Plan Showing Location of Proposed Rehabilitation in 2013

- Dig Repair
- No Dig Patch
- Manhole Sealing
- Sewer Joint Test & Seal
- Sewer Lining

The Street

Bishopsbourne

Southern Water Page B8 December 2014
Barham and Kingston – Plan Showing Location of CCTV Survey in 2013

LEGEN

Manhole inspected
CCTV survey completed

Manhole Inspected
CCTV Survey Completed
Kingston – Plan Showing Location of Proposed Rehabilitation in 2013

The Street

LEGEND
- Proposed Joint Test & Seal
- Proposed Leak Tight Liner
- Proposed Quick Lock Repair or similar

Project Title
AMP5 Yr4 Sewer Rehabilitation
Proposed Works
Newnham Valley Infiltration Reduction
Kingston CT4 6HZ

Based upon the Ordnance Survey map by Southern Water Services Limited. (C) Crown copyright Southern Water Services Limited 2009/10

Southern Water
Page B10
December 2014
Barham – Plan Showing Location of Proposed Rehabilitation in 2013

- Dig Repair
- No Dig Patch
- Manhole Sealing
- Sewer Joint
- Test & Seal
- Sewer Lining

Valley Road

Barham
Elham – Location of CCTV in 2014 (Plan 1 of 2)
Elham – Location of CCTV in 2014 (Plan 2 of 2)
<table>
<thead>
<tr>
<th>Village</th>
<th>Location</th>
<th>Issue</th>
<th>Action/Result</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ottinge</td>
<td>Manholes off Canterbury Road</td>
<td>Surface water ingress through leaking manhole covers</td>
<td>Existing 2x covers replaced with sealed covers</td>
<td>Jun-14</td>
</tr>
<tr>
<td>Hog Green</td>
<td>Root ingress in sewer</td>
<td>Root removal and sewer sealing</td>
<td></td>
<td>2014 (tba)</td>
</tr>
<tr>
<td>Between Canterbury Road and Hog Green</td>
<td>Root ingress in sewer</td>
<td>Root removal and sewer sealing</td>
<td></td>
<td>2014 (tba)</td>
</tr>
<tr>
<td>Elham</td>
<td>Previous repair failed</td>
<td>Replace sewer liner</td>
<td>Monitor/ Further CCTV when conditions allow</td>
<td>2014 (tba)</td>
</tr>
<tr>
<td>Hog Green</td>
<td>Circumferential cracks</td>
<td>Seal manholes</td>
<td></td>
<td>2014 (tba)</td>
</tr>
<tr>
<td>The Orchards</td>
<td>Leaking manholes</td>
<td>Repair Sewer</td>
<td></td>
<td>2014 (tba)</td>
</tr>
<tr>
<td>Between Frog Lane and The Orchards</td>
<td>Circumferential cracks</td>
<td>Monitor/ Further CCTV when conditions allow</td>
<td></td>
<td>2014 (tba)</td>
</tr>
<tr>
<td>Barham</td>
<td>Valley Road</td>
<td>Infiltration (leaking joints)</td>
<td>Gel sealing of sewer</td>
<td>2005/06</td>
</tr>
<tr>
<td>The Causeway/Derringstone Street</td>
<td>Infiltration</td>
<td>Sewer sealing</td>
<td></td>
<td>2013</td>
</tr>
<tr>
<td>Kingston</td>
<td>North west of village</td>
<td>Infiltration (leaking joints)</td>
<td>Gel sealing of sewer</td>
<td>2005/06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infiltration</td>
<td>Sewer sealing</td>
<td>2013</td>
</tr>
<tr>
<td>Charlton Park and The Street</td>
<td>Infiltration (leaking joints)</td>
<td>Gel sealing of sewer</td>
<td></td>
<td>2005/06</td>
</tr>
<tr>
<td>Bourne Park</td>
<td>Infiltration (leaking joints)</td>
<td>Gel sealing of sewer</td>
<td></td>
<td>2005/06</td>
</tr>
<tr>
<td>Significant Infiltration</td>
<td>Gel sealing and lining of sewer</td>
<td></td>
<td></td>
<td>Oct-11</td>
</tr>
<tr>
<td>Significant infiltration</td>
<td>Sealing, lining and Q-lock installation</td>
<td></td>
<td></td>
<td>2013</td>
</tr>
<tr>
<td>Bishopsbourne</td>
<td>Charlton Park (vicinity of cricket pitch)</td>
<td>Significant infiltration</td>
<td>Gel sealing of sewer and spray coating of manholes</td>
<td>Mar-11</td>
</tr>
<tr>
<td>Charlton Park (vicinity of Dower House)</td>
<td>Significant infiltration</td>
<td>Relay sewer</td>
<td></td>
<td>Sep-12</td>
</tr>
<tr>
<td>Trunk sewer through the village</td>
<td>Significant infiltration</td>
<td>Sewer lining</td>
<td></td>
<td>2013</td>
</tr>
<tr>
<td>Park Lane</td>
<td>Significant infiltration</td>
<td>Line sewer at rear of Old Post Office</td>
<td></td>
<td>Jul-14</td>
</tr>
<tr>
<td>Village</td>
<td>Location</td>
<td>Issue</td>
<td>Action/Result</td>
<td>Date</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Bourne Park Road</td>
<td>Infiltration (leaking joints)</td>
<td>Gel sealing of sewer</td>
<td>2005/06</td>
<td>Aug-11</td>
</tr>
<tr>
<td>Patrixbourne Road</td>
<td>Infiltration (leaking joints)</td>
<td>Gel sealing of sewer</td>
<td>2005/06</td>
<td></td>
</tr>
<tr>
<td>Private drain (vicinity of</td>
<td>Infiltration</td>
<td>Sewer lining</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>Patrixbourne Road</td>
<td></td>
<td></td>
<td></td>
<td>2013</td>
</tr>
<tr>
<td>Field to south of Brewery</td>
<td>Sewer manholes in the field floods to 1m depth</td>
<td>Replace 3x covers with sealed covers</td>
<td>Sep-12</td>
<td></td>
</tr>
<tr>
<td>Lane/Brewery Lane/Bridgeford Way</td>
<td>Infiltration</td>
<td>Sewer sealing</td>
<td>Jun-14</td>
<td></td>
</tr>
<tr>
<td>Old Palace Road and</td>
<td>Infiltration</td>
<td>Q-Lock installation and manhole sealing</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>Patrixbourne Road</td>
<td>Manholes in the vicinity of Court House and</td>
<td>Existing 3x covers replaced with sealed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverside Cottage</td>
<td>Ingress directly from the Nailbourne</td>
<td>covers</td>
<td></td>
<td>Jun-14</td>
</tr>
<tr>
<td>Properties to south east of</td>
<td>Property protection</td>
<td>Installation of non-return valves</td>
<td>2014 (tba)</td>
<td></td>
</tr>
<tr>
<td>village</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old Palace Road</td>
<td>Infiltration (leaking joints)</td>
<td>Gel sealing of sewer</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>School Lane</td>
<td>Infiltration</td>
<td>Sewer sealing, manhole sealing</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>School Lane Pumping Station</td>
<td>Refurbish mechanical and electrical equipment</td>
<td>Pumps and control panels replaced</td>
<td>2014 (ongoing)</td>
<td></td>
</tr>
<tr>
<td>Ottinge</td>
<td>Can the output from the station be increased?</td>
<td>Review capacity of rising main</td>
<td>Completed, 2014</td>
<td></td>
</tr>
<tr>
<td>The Orchards Pumping Station</td>
<td>Can the output from the station be increased?</td>
<td>Limited by capacity of Ottinge PS</td>
<td>Mar-14</td>
<td></td>
</tr>
<tr>
<td>School Lane Pumping Station</td>
<td>Can the output from the station be increased?</td>
<td>Refurbishment will increase flows to 125 l/s,</td>
<td>See Note 1. below</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>suggested that downstream sewer capacity is 200 l/s. Also need to consider impact on Newnham Valley WTW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nargate Street Pumping</td>
<td>Can the output from the station be increased?</td>
<td>Currently 34 l/s, maximum incoming capacity 48 l/s, potential to increase to 40 l/s but need to consider use of capacity of downstream sewer</td>
<td>See Note 1. below</td>
<td>Mar-14</td>
</tr>
</tbody>
</table>
Note 1.
During next period of high flow, SW propose to increase the pump rate at School Lane for a short duration, to check the capacity of the system downstream to receive additional flow from School lane WPS.
APPENDIX C

Emergency Discharges in the Winter of 2013-14
Ickham, Nailbourne, Kent - Tankering Sites in the Winter of 2013-14 (Plan 1 of 1)

Tanker Point – flow collected from manholes at junction of Wickham Lane and The Street

Wickham Lane

Drill Lane

The Street

Southern Water Page C2 December 2014
**Overpumping and Tankering Sites in the Winter of 2013-14 (Plan 1 of 2)**

- **Overpump (1x50l/s)** from Nargate St WPS to 2 No. biological treatment units to filtration sacks before discharge to water course (bypass channel)

- **Manholes particularly vulnerable to spillages**

- **Tanker Point – flow collected at MH2801**

- **Church Rd**

- **Nargate St**

- **Bypass channel**

- **Advisory signs to be placed downstream of discharge point**
Bekesbourne, Nailbourne, Kent - Overpumping and Tankering Sites in the Winter of 2013-14 (Plan 1 of 1)

Advisory signs to be placed downstream of discharge point

Overpump (1x90l/s) from School Lane WPS to 4 No. settlement tanks to 3 No. biological treatment units to filtration sacks before discharge to water course

MH4601 and MH4602 are particularly vulnerable to spillages

Tanker Point – temporarily at School Lane WPS until overpump set up.

Overpump (1x50l/s) from MH0205 (see Patrixbourne Plan) to School Lane WPS for treatment

Old Palace Road

Watercourse

School Lane
Overpump (1x50l/s) from MH0205 to School Lane WPS (see Bekesbourne Plan) for treatment

Tankering from properties on The Street
Tankering from various manholes at rear of properties on Patrixbourne Road. These manholes are also particularly vulnerable to spillages.
Bridge, Nailbourne, Kent - Overpumping and Tankering Sites in the Winter of 2013-14 (Plan 1 of 2)

MH2301 and MH4201 are particularly vulnerable to spillages

Tankering from MH2301 in Riverside Close

Tankering from MH2205 in garden of property in the High St

Tankering from MH4201 in Riverside Close

High St

Riverside Close

ZVADAY003

ZVADAY006
Overpump set up but only operational for one week in 2013-14

Overpump (1x50l/s) from MH7601 to 1 No. settlement tank to filtration sacks before discharge to water

Advisory signs to be placed downstream of the discharge point

Pipe crosses road

Watercourse

A2

Patrixbourne Rd
Bishopsbourne, Nailbourne, Kent - Overpumping and Tankering Sites in the Winter of 2013-14 (Plan 1 of 1)

Overpump (1x50l/s) from MH0501 to 2 No. settlement tanks to filtration sacks before discharge to water course

Tanker Point – flow collected at MH0403

A number of manholes are particularly vulnerable to spillages in Park Lane and Charlton Park

Advisory signs to be placed downstream of the discharge point

The Mermaid Inn

The Street

Watercourse

Park Lane

Charlton Park
Kingston, Nailbourne, Kent

MH9501 is particularly vulnerable to spillages

MH9402 is particularly vulnerable to spillages

The Street

Bonny Bush Hill
Barham, Nailbourne, Kent - Overpumping and Tankering Sites in the Winter of 2013-14 (Plan 1 of 1)

Advisory signs to be placed downstream of the discharge point

Overpump (1x50l/s) from MH6003 to 2 No. biological treatment units to filtration sacks before discharge to water course

Tanker Point – flow collected from manhole in narrow access track off Valley Road

Valley Road

The Street

Watercourse
Elham, Nailbourne, Kent - Overpumping and Tankering Sites in the Winter of 2013-14 (Plan 1 of 1)

Tanker Point – flow collected from MH8801 in Water Farm prior to installation of the overpump

Duck Street

Water Farm

Advisory signs to be placed downstream of the discharge point

Manholes particularly vulnerable to spillages

Overpump (1x50l/s) from The Orchards WPS to 2 No. settlement tanks to 2 No. biological treatment units to filtration sacks before discharge to water course
Ottinge, Nailbourne, Kent - Overpumping and Tankering Sites in the Winter of 2013-14 (Plan 1 of 1)

- Advisory signs to be placed downstream of the discharge point
- Sandbags provided around the edge of the wet well to prevent inundation by groundwater on the surface
- Shuttlesfield Lane
- Tanker Point
- Watercourse
- Manholes particularly vulnerable to spillages
- Overpump set up at Ottinge WPS but NOT OPERATIONAL in 2013-14
## Approximate Timing for Deployment of Tankers and Overpumps in the Winter of 2013-14

<table>
<thead>
<tr>
<th>Location</th>
<th>Tankering at Various Locations</th>
<th>Overpumping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start Date</td>
<td>Stop Date</td>
</tr>
<tr>
<td>Ickham</td>
<td>12/02/14</td>
<td>15/03/14</td>
</tr>
<tr>
<td>Littlebourne</td>
<td>06/02/14</td>
<td>02/04/14</td>
</tr>
<tr>
<td>Bekesbourne</td>
<td>23/01/14</td>
<td>03/02/14</td>
</tr>
<tr>
<td>Patrixbourne</td>
<td>24/01/14</td>
<td>02/04/14</td>
</tr>
<tr>
<td>Bridge</td>
<td>26/02/14</td>
<td>02/04/14</td>
</tr>
<tr>
<td>Bishopsbourne</td>
<td>29/01/14</td>
<td>13/05/14</td>
</tr>
<tr>
<td>Barham</td>
<td>13/02/14</td>
<td>06/03/14</td>
</tr>
<tr>
<td>Elham</td>
<td>28/02/14</td>
<td>03/04/14</td>
</tr>
<tr>
<td>Ottinge</td>
<td>Jan 2014</td>
<td>Mar 2014</td>
</tr>
</tbody>
</table>
Internal Flooding in the Winter of 2013-14

In Littlebourne, there were reports of internal and external flooding and restricted toilet use.
In Bekesbourne, there were reports of external flooding and restricted toilet use.
In Patrixbourne, there were reports of internal and external flooding and restricted toilet use.
In Bridge, there were reports of internal and external flooding and restricted toilet use.
In Bishopsbourne, there were reports of internal and external flooding and restricted toilet use.
In Barham, there were reports of internal flooding and restricted toilet use.
In Elham, there were reports of internal and external flooding and restricted toilet use.
In Ottinge, there were reports of external flooding and restricted toilet use.
APPENDIX D

Emergency Discharge Proposal
Emergency Discharge Proposal

Despite the significant investments being made by SW to reduce infiltration into sewers, and multi-agency actions to be taken, due to circumstances outside SW’s control, there may continue to be occasions when emergency discharges will be required. Further analysis will be conducted in Autumn 2014 after completion of the current rehabilitation programme to access the circumstances when overpumping and tankering would be expected to be required, optimum locations and expected flow rates.

Based on our experience in 2014, our proposal for emergency discharges will be as follows:

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Action</th>
<th>When Required</th>
<th>Locations</th>
<th>Expected Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Tankering</td>
<td>Deploy tankers to reduce flows at strategic locations in the sewerage system.</td>
<td>When hydraulic capacity of the sewers and pumping stations are exceeded due to additional flows from groundwater. Monitor rising groundwater level in cellars and sewers.</td>
<td>Collect flow from the same manholes used in the winter of 2013-14 as identified in the plans in Appendix C. Discharge flow to Canterbury WTW or other suitable locations.</td>
<td>Low</td>
</tr>
<tr>
<td>2a</td>
<td>Overpumping: Pumps</td>
<td>Install pumps to reduce flows at strategic locations in the sewerage system.</td>
<td>In cases of exceptional high flows in the sewers, and when tankering is insufficient, in order to protect residents from imminent public health dangers of sewage flooding in properties or restricted toilet use (RTU). Monitor levels in manholes.</td>
<td>Overpump at the same locations used in the winter of 2013-14, as identified in the plans in Appendix C.</td>
<td>Flow rate depends on head/pipe material/distance etc. 4 inch dia. pump = 15-20 l/s (typical rate) 6 inch dia. pump = 30-35 l/s (typical rate)</td>
</tr>
</tbody>
</table>
In addition to the overpumping and tankering, there may on occasions be some spillage from manholes in the vicinity of the operations. By timely set up of equipment and appropriate maintenance, SW will endeavour to minimise, and ideally to completely avoid such spillages. However, we consider that on occasions, some spillages will be inevitable.

During times of high infiltration, it is possible that there could be a spillage from any manhole in the Nailbourne catchment. Manholes that are known to be particularly vulnerable to spillages are highlighted in Appendix C and include:

- Littlebourne – Manholes in Nargate St
- Bekesbourne – MH4601 and MH4602 in horse field on south side of School Lane close to WPS
- Patrixbourne – Manholes at rear of properties on Patrixbourne Road
- Bridge – MH2301 and MH4201 in Riverside Close
- Bishopsbourne – Manholes in Park Lane and Charlton Park
- Kingston – MH9402 and MH9501 near The Street
- Elham – Manholes in Water Farm
- Ottinge - Manholes to the north and south of Shuttlesfield Lane in the vicinity of Ottinge WPS

<table>
<thead>
<tr>
<th>Ref:</th>
<th>Item</th>
<th>Action</th>
<th>When Required</th>
<th>Locations</th>
<th>Expected Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2b</td>
<td>Overpumping: Removal of Suspended Solids</td>
<td>Provide settlement tanks and filtration sacks to remove suspended solids prior to discharge of treated flow into a watercourse</td>
<td>When discharging flow from the sewer into a watercourse</td>
<td>The same locations used in the winter of 2013-14, as identified in the plans in Appendix C.</td>
<td>N/A</td>
</tr>
<tr>
<td>2c</td>
<td>Overpumping: Improvement of water quality</td>
<td>Investigate options including basic treatment to improve the quality of treated water discharged to watercourses.</td>
<td>When discharging flow from the sewer into a watercourse</td>
<td>Investigate options for improved treatment where required.</td>
<td>N/A</td>
</tr>
</tbody>
</table>
APPENDIX E

Communications
**Typical Advisory Sign - Reference Number and Village Name to be Amended**

**VILLAGE NAME**

**EMERGENCY OVERPUMPING**

Please note over-pumping of dilute screened sewage to the **TBC** is being undertaken to protect customers from flooding and lack of drainage.

It is advised to keep children & pets from the watercourse in the vicinity of this discharge. If you have contact with the water please ensure you wash your hands before eating or drinking.

If you have any concerns please contact:

**Southern Water 0845 278 0845 Quoting Ref: TBC**