

Misconnection Project Plan

Introduction

Optical Brighteners are chemicals that are added to laundry detergents, their presence in storm water would indicate the presence of laundry effluent which is unique to humans.

Optical Brighteners are good tracers to detect unwanted effluent because they fluoresce when exposed to a UV light. The basis of this detection method is placing untreated pieces of cotton at different points in a surface water system to determine the point or area of misconnection. Due to the nature of laundry, there will not be a permanent discharge of pollution so the cotton must be left in the pipe for 2-3 days, depending on flow rate. If the samples are left in the system for longer than 4 days then the risk of fouling occurs. Fouling is when the sample gets so dirty and covered in solid that it is impossible to see fluorescence when exposed to UV light.

Equipment Needed

- Long wave UV Light.
- Individual, untreated cotton pads or tampons
- Monofilament line
- Clear zip lock bags
- Labels, permanent marker
- Masonry nails

Technician Requirements

A technician is needed to lift the manholes and attach the string to a step iron or if that is not possible, place a masonry nail in the side wall and attach the string to that. One or two technicians will be required. Around 20 pads can be placed in half a day's work, this is generally an entire water system. Wherever possible all samples in system should be placed in a single day. All manholes are pre planned prior to technicians going on site.

Method

Once a outfall has been identified that is potentially polluting the approach taken is to work up gradient of the outfall to identify and isolate the source of the pollution. A map of the surface water system is used to choose manholes that the pads will be placed in. The cotton pads are attached to a piece of string and attached to a step iron or a masonry nail in the manhole then lowered so that they are suspended in the flow below. The pads are left in the pipe for 2-4 days. The manholes will be chosen by looking for the branches in the pipes, putting a pad at each branch allows us to determine the area the misconnection is in.

After 2-4 days they are then removed and put into individual bags and labelled clearly. Pads are then tested under a UV light, if it fluoresces then there has been optical brighteners in the water and therefore a misconnection is potentially present.

There are a number of defined catchments to survey. Survey work will be staggered over a few days

to keep resource requirement to a minimum.

Before any pads are placed in situ the sites need to be assessed to see whether they are on highways or even accessible for a technician. From the assessment it will be decided how much equipment and personnel is needed along with how much time. The amount of flow in the system also needs to be assessed.

Pads should be placed in situ when the flow is low in the surface water system and there is a clear weather window to work, This is to ensure that any contamination present is in sufficient concentration, as sometimes rainwater or high flow can dilute optical brighteners to the point where they cannot be detected.

It will also be beneficial to take water samples whilst we have the manhole raised for bacterial analysis, as this can indicate other forms of cross connection.

For retrieval of the pads;

- First rinse to get rid of sediment as possible
- Squeeze to get rid of as much water as practical
- Place in a plastic zip lock bag labelled with date placed, date retrieved, manhole reference and location

When handling samples always wear plastic or rubber gloves as the samples could have been exposed to waste water., if there is high flow in the pipe then the pads only need to be placed for 2 days, but for pipes with low or intermittent flow the pads should be placed for longer, say 3-4 days.

Analysis

The pads should be placed on a table in a dark room and viewed under a long wave ultra violet light with every measure possible done to ensure the room is dark. The darker the room the easier it is to read the results.

A control pad that hasn't been exposed to sewerage to compare the sample pads should be used with every test.

There are three possible qualitative results; positive, negative and retest. There cannot be a borderline positive or negative.

A pad will very definitely glow (fluoresce) for a positive and for a negative be very similar to the control pad. If not sure retest.

Only a portion of the pad may glow, this could be for many reasons including folding in the pad or uneven submersion in the flow. If this happens and you can explain why part is not glowing then it should be considered a positive.

If there is just specks or spots of glow on the pad this is not indicating a positive result just contamination with a piece of treated cotton or paper.

Data Recording

This method only gives a positive or negative result. On a table the results need to be recorded next to the cotton pad number and the location that pad was placed. Then using a diagram or map the area of the misconnection or connections can be identified.

Action

With the information from the experiment a more exact area where the misconnection is occurring can be identified. Technicians can be sent to this area to carry out CCTV investigation and dye testing to identify the exact point of cross connection and rectify the problem.

Return Check-up

A return visit about 6 weeks after we have corrected the misconnected chosen outfalls would be very interesting to the project. The check-up will look at whether the water course has returned to normal and also look at what has changed directly below the outfall.

Trial

For the initial trial, four outfalls along the tongue gutter water course located in Parsons Cross, Sheffield were chosen. Initial tests at the outfalls had shown there were misconnections somewhere in these systems.

Outfall 1

The first outfall tested was located on Milnrow Road, by No. 38. Initial tests indicated a misconnection in this system, but a visual survey of the outfall wasn't conclusive, so fourteen manholes were identified to place cotton samples in.



The system has two clear, left and right branches which is particularly interesting for this identification method.

The fourteen samples were placed in situ on the morning of 17/09/13 and collected again on the morning of 20/09/2013, a three day sampling period.

The samples were placed in the flow using string attached to either the step iron or a masonry nail placed into the brickwork.

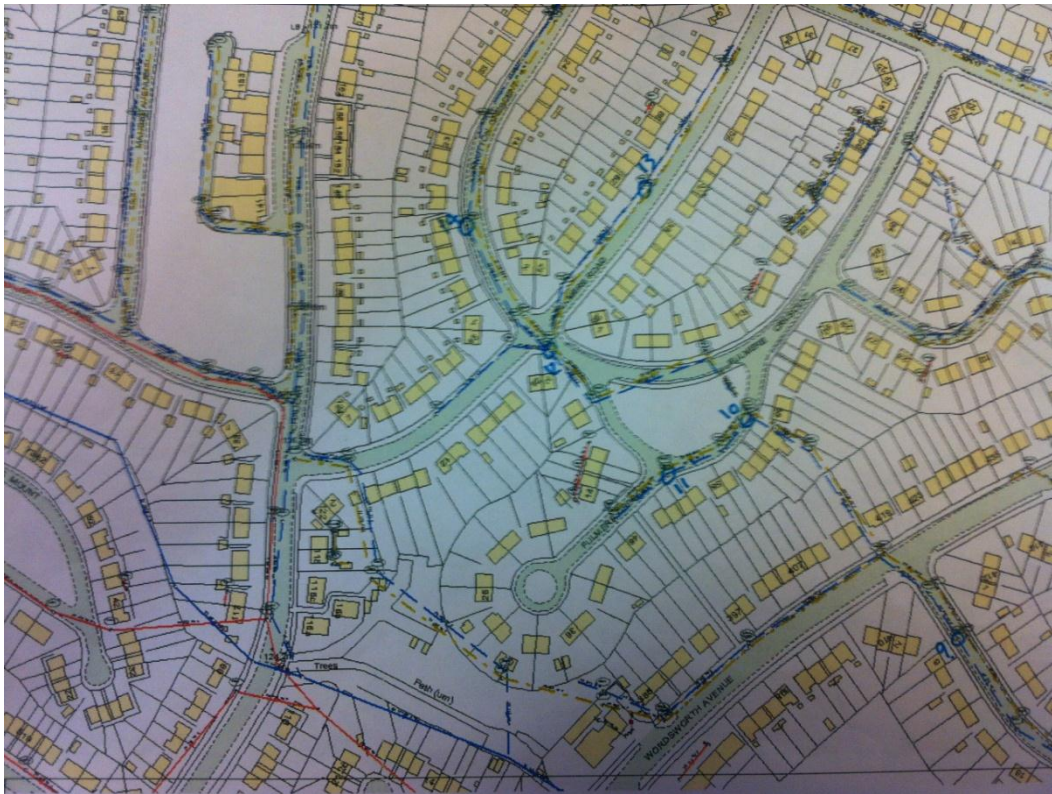
To place all samples in the system it took two Drains Aid technician four hours.

The right hand branch, shown here has eight manholes;



Originally, ten manholes were planned but once on site it was impossible to lift the manholes due to their age.

The left hand branch has 6 manholes;



Results table, Outfall 1;

Drainage Area: Tongue Gutter, Outfall 1						
	Manhole Number	Location	Placed	Retrieved	No. of Days	O.B Pos/Neg
1	SK34926503	Milnrow Road	17/09/2013	20/09/2013	3	Pos
	Right Branch					
2	SK34926612	Milnrow Drive	17/09/2013	20/09/2013	3	Pos
3	SK34925707	Wordsworth Ave	17/09/2013	20/09/2013	3	Pos
4	SK34926820	Margetson Drive	17/09/2013	20/09/2013	3	Neg
5	SK34925712	Margetson Drive	17/09/2013	20/09/2013	3	Neg
6	SK34926804	Knutton Road	17/09/2013	20/09/2013	3	Pos
7	SK34926903	Knutton Road	17/09/2013	20/09/2013	3	Neg
8	SK34936102	Dugale Road	17/09/2013	20/09/2013	3	Neg
	Left Branch					
9	SK34925606	Milnrow Road	17/09/2013	20/09/2013	3	Pos
10	SK34924706	Fulmere Crescent	17/09/2013	20/09/2013	3	Neg
11	SK34923706	Fulmere Crescent	17/09/2013	20/09/2013	3	Neg
12	SK34923701	Fulmere Crescent	17/09/2013	20/09/2013	3	Neg
13	SK34923801	Fulmere Road	17/09/2013	20/09/2013	3	Neg
14	SK34923805	Knutton Crescent	17/09/2013	20/09/2013	3	Neg

Once the samples had been tested under a ultra violet light and the results collected, it was clear that there is a misconnection or multiple misconnections in both branches.

On the right hand branch the method has naturally narrowed it down to a very small area. The misconnection is between manhole 6 and manhole 7 on Knutton road. You can say for certain that there is a misconnection here, but there may also be further misconnections further down the system that cannot be detected until this one is resolved.

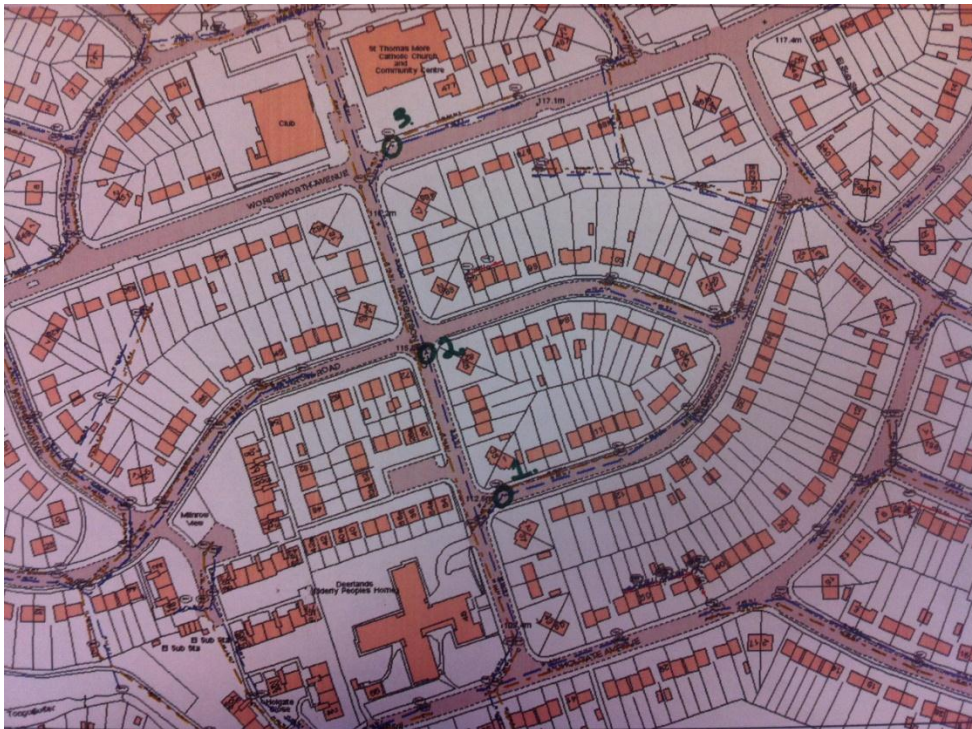
The small length of pipe between manhole 6 and 7 serves a recently built enterprise centre that isn't on our maps called SOAR Works.



The left hand branch also had a positive result for misconnection, this occurred near the start of the system. Manhole 9 gave a positive result but manhole 10 was negative. So the misconnection is either between number 385 and 419 on Wordsworth Avenue or its on Milnrow Road.

Outfall 2

Outfall 2 is located at the bottom of Margetson Road and is quite a small system, only servicing five roads, although only serving a small amount of houses, initial tests at the outfall indicated a misconnection in the system. Five manholes were chosen to place samples in but once on site three of them were impossible to lift so an alternative manhole was chosen alongside the two originals. The samples were placed on the morning of 26/09/2013 and collected again on the morning of 01/10/2013, giving a five day sampling period. This slightly longer sampling period is not ideal as it gives the possibility for fouling of the samples but logistical problems meant this was the shortest period possible. As it is a small system with a low flow there was no fouling.



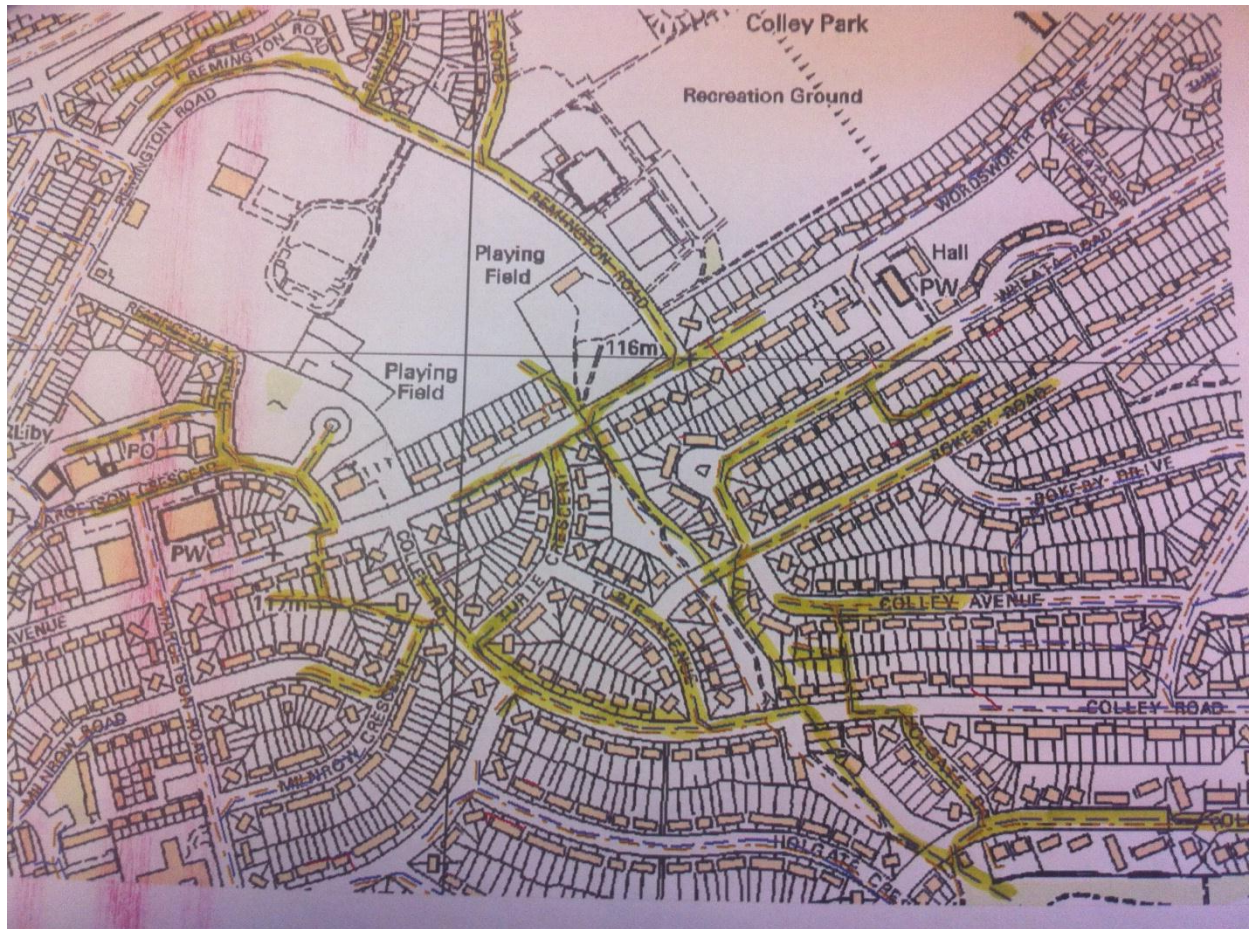
Results table, Outfall 2;

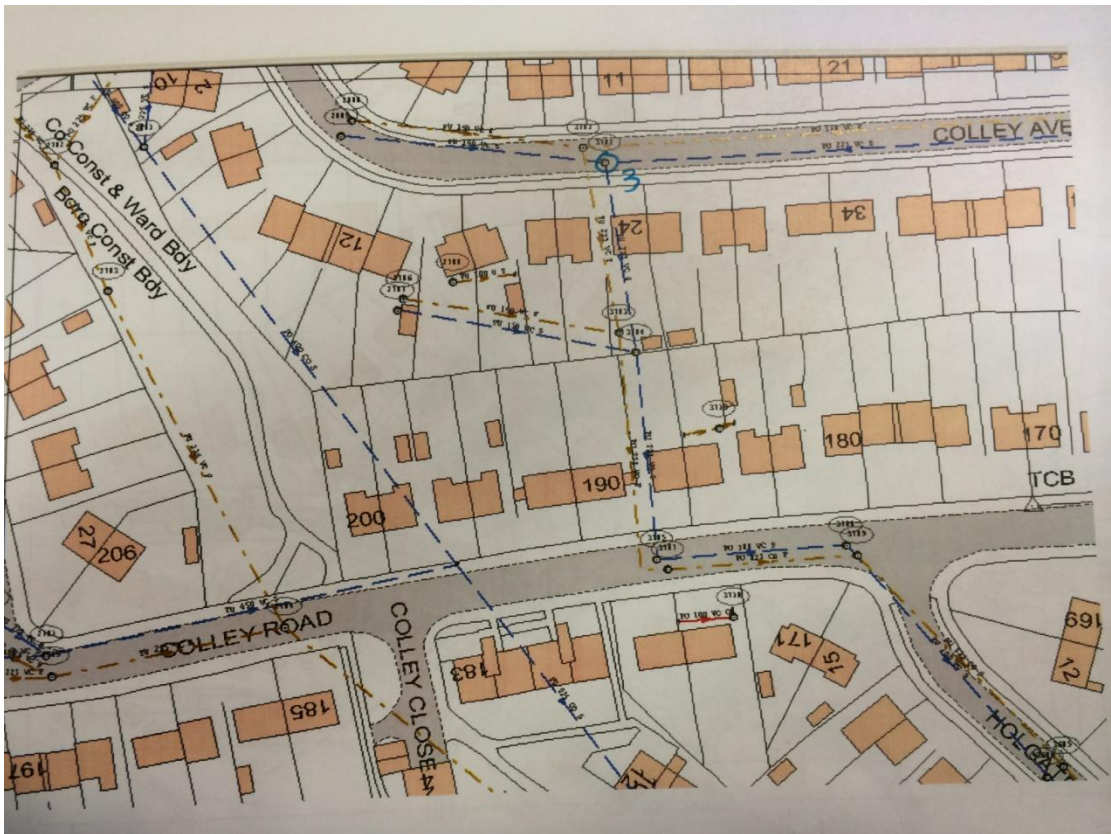
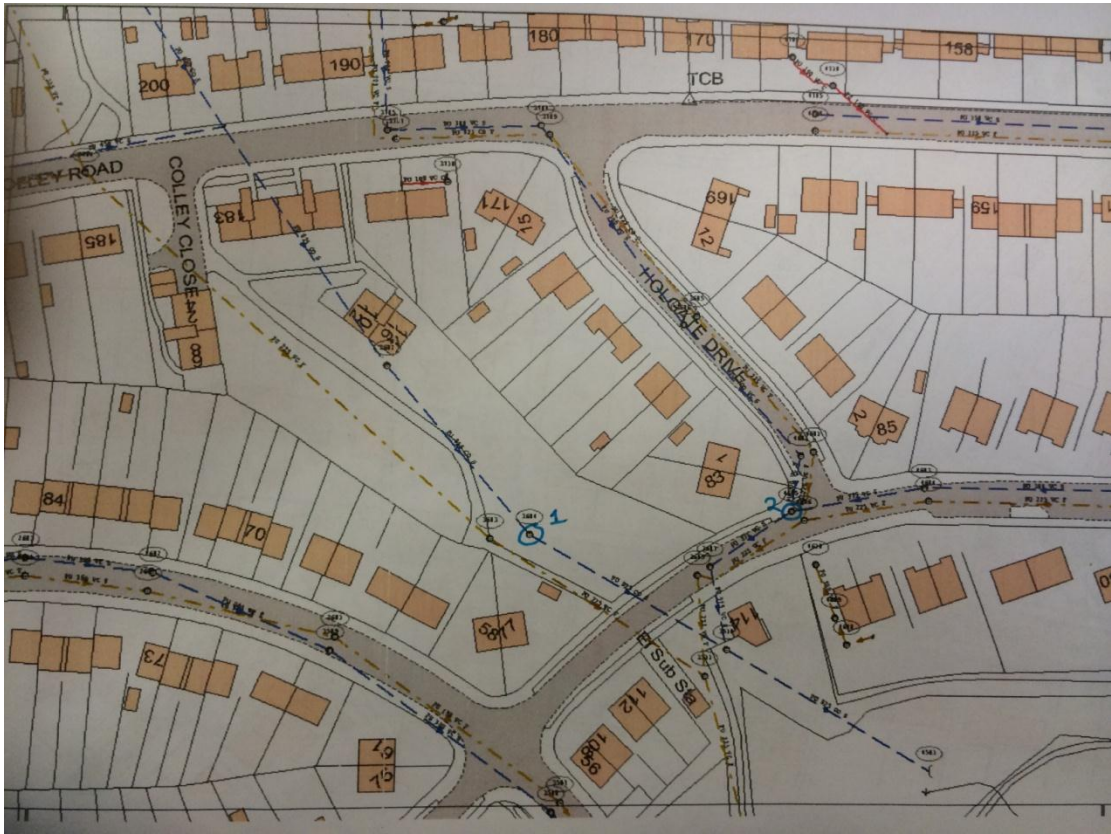
Drainage Area: Tongue Gutter, Outfall 2						
Manhole Number		Location	Placed	Retrieved	No. of Days	O.B Pos/Neg
1	SK34928604	Milnrow Crescent	26/09/2013	01/10/2013	5	Pos
2	SK34927704	Margetson Road	26/09/2013	01/10/2013	5	Neg
3	SK34927812	Wordsworth Avenue	26/09/2013	01/10/2013	5	Neg

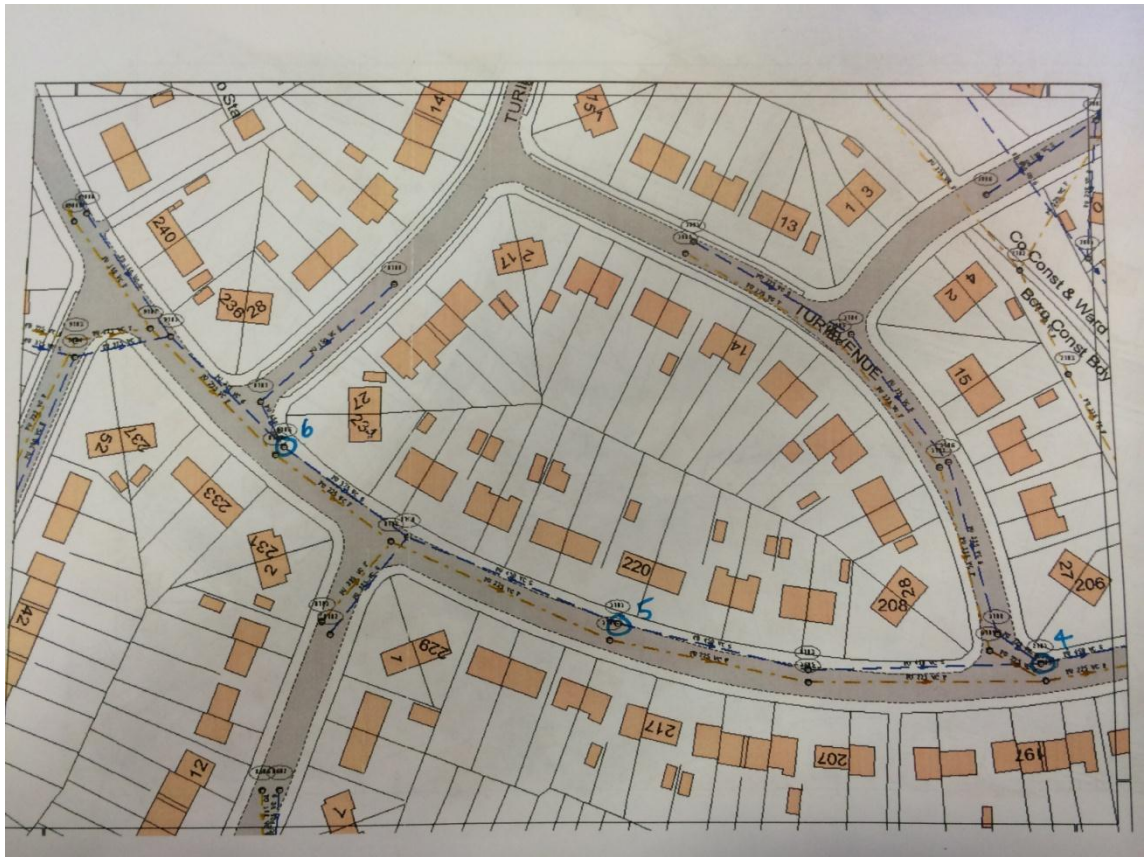
As there was only a small amount of samples in this system, the only place there is a misconnection for sure is on Milnrow Crescent as manhole 1 tested positive for optical brighteners. There could potentially be a misconnection at the bottom of Margetson Road but at the top of Margetson Road and onto Wordsworth Avenue there are no misconnections.

Outfall 3

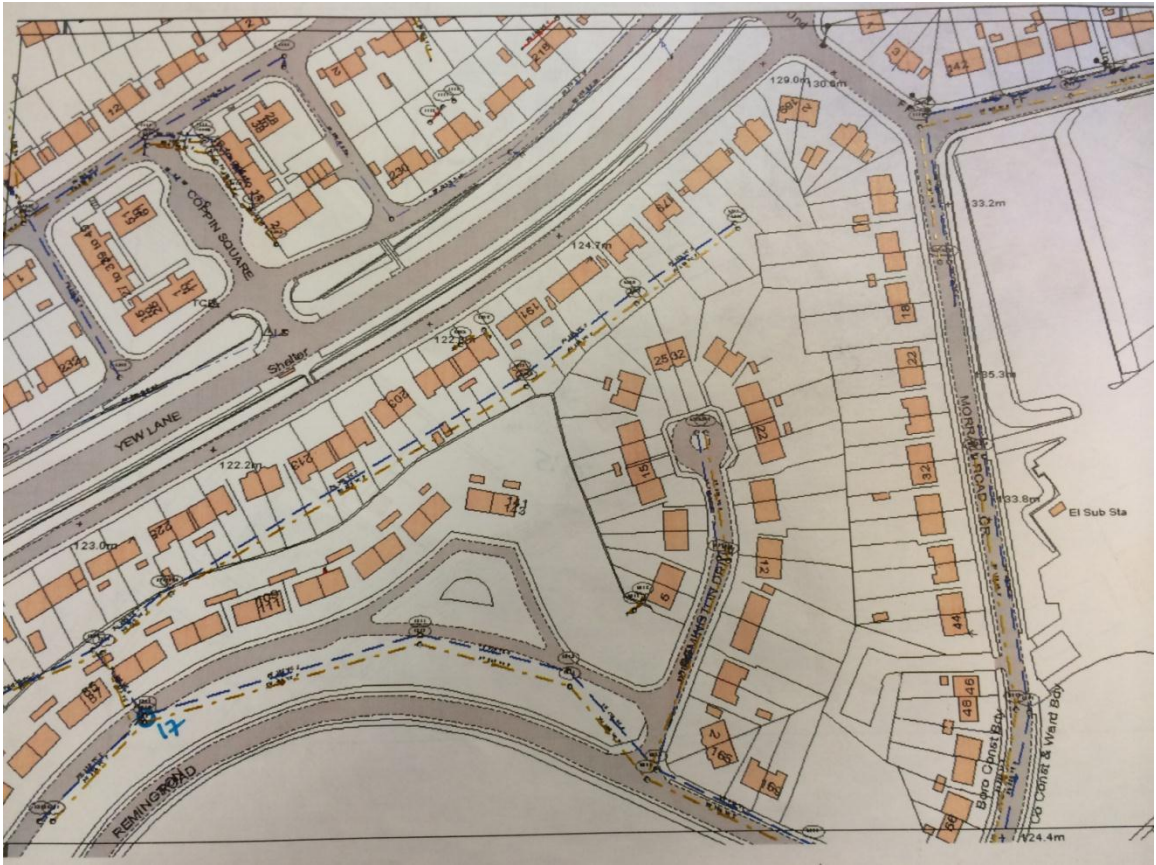
Outfall 3 is a very big system, servicing a large part of the Parsons Cross estate. The outfall itself is situated just off Colgate Road. Again initial tests indicated a misconnection in this system and after a visual survey of the outfall it was clear that there was more than one misconnection in this system.











Drainage Area: Tongue Gutter, Outfall 3					
Manhole Number	Location	Placed	Retrieved	No. of Days	O.B Pos/Neg
SK35923604	Off Colgate Road	03/10/2013	07/10/2013	4	Fouled
Branch 1					
SK35924605	Colgate Road	03/10/2013	07/10/2013	4	Fouled
SK35923702	Colley Avenue	03/10/2013	07/10/2013	4	Fouled
Branch 2					
SK35922701	Colley Road	03/10/2013	07/10/2013	4	Fouled
SK35921701	Colley Road	03/10/2013	07/10/2013	4	Fouled
SK35920706	Colley Road	03/10/2013	07/10/2013	4	Fouled
Branch 3					
SK35921804	Off Rokeby Road	03/10/2013	07/10/2013	4	Pos
SK35922802	Rokeby Road	03/10/2013	07/10/2013	4	Fouled
SK35923801	Rokeby Road	03/10/2013	07/10/2013	4	Pos
SK35922904	Wheata Road	03/10/2013	07/10/2013	4	Fouled
SK35923906	Wheata Road	03/10/2013	07/10/2013	4	Neg
Branch 4					
SK35920901	Wordsworth Avenue	03/10/2013	07/10/2013	4	Neg
SK35921906	Wordsworth Avenue	03/10/2013	07/10/2013	4	Fouled
SK35921905	Wordsworth Avenue	03/10/2013	07/10/2013	4	Fouled
SK35930107	Morrall Road	03/10/2013	07/10/2013	4	Fouled
SK34939203	Remington Road	03/10/2013	07/10/2013	4	Fouled
SK34937204	Behind Remington Road	03/10/2013	07/10/2013	4	Fouled

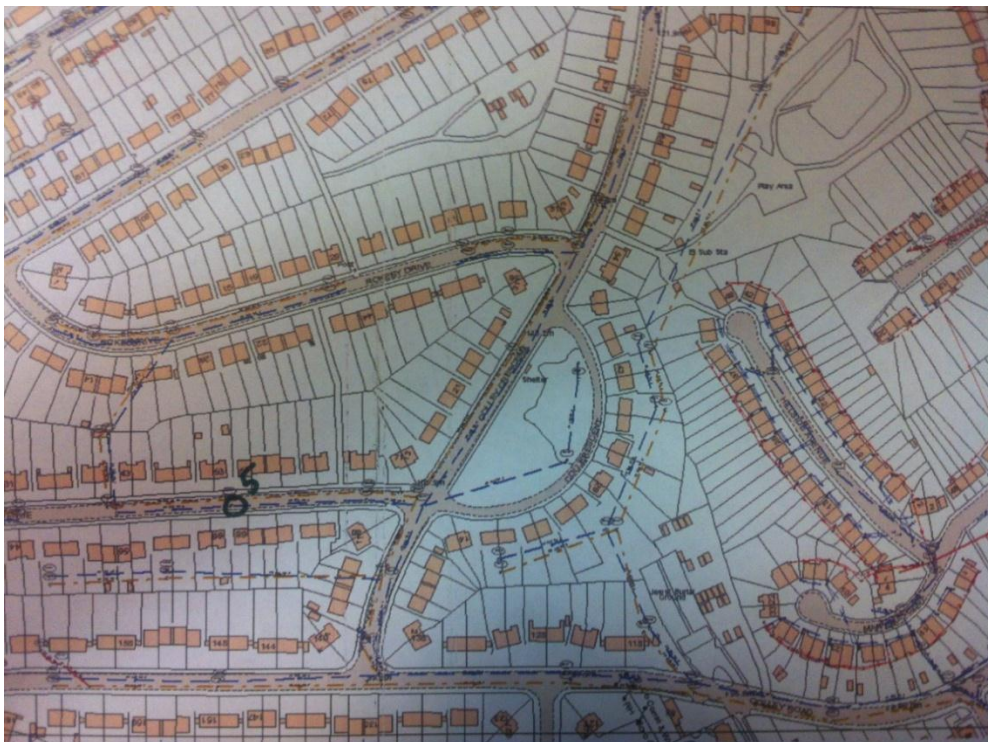
Drainage Area: Tongue Gutter, Outfall 3						
	Manhole Number	Location	Placed	Retrieved	No. of Days	O.B Pos/Neg
1	SK35923604	Off Holgate Road	27/11/2013	28/11/2013	1	Pos
	Branch 1					
2	SK35924605	Holgate Road	27/11/2013	28/11/2013	1	Pos
3	SK35923702	Colley Avenue	27/11/2013	28/11/2013	1	Neg
	Branch 2					
4	SK35922701	Colley Road	27/11/2013	28/11/2013	1	Pos
5	SK35921701	Colley Road	27/11/2013	28/11/2013	1	Pos
6	SK35920706	Colley Road	27/11/2013	28/11/2013	1	Pos
	Branch 3					
7	SK35921804	Off Rokeby Road	27/11/2013	28/11/2013	1	Pos
8	SK35922802	Rokeby Road	27/11/2013	28/11/2013	1	Pos
9	SK35923801	Rokeby Road	27/11/2013	28/11/2013	1	Pos
10	SK35922904	Wheata Road	27/11/2013	28/11/2013	1	Neg
11	SK35923906	Wheata Road	27/11/2013	28/11/2013	1	Neg
	Branch 4					
12	SK35920901	Wordsworth Avenue	27/11/2013	28/11/2013	1	Neg
13	SK35921906	Wordsworth Avenue	27/11/2013	28/11/2013	1	Neg
14	SK35921905	Wordsworth Avenue	27/11/2013	28/11/2013	1	Neg
15	SK35930107	Morrall Road	27/11/2013	28/11/2013	1	Neg
16	SK34939203	Remington Road	27/11/2013	28/11/2013	1	Neg
17	SK34937204	Behind Remington Road	27/11/2013	28/11/2013	1	Neg

Originally a sampling period of days was carried out for this system. This outfall services a very large amount of house and therefore in most parts of the system has a high flow. This coupled with the four day sampling period meant that the majority of the samples were fouled making it impossible to get a positive or negative reading from them. There were four samples in lower flow parts of the system that it was possible to get a reading from. Sample No. 9 showed that there is a misconnection on Rokeby Road.

A retest was carried out, this time only using a one day sampling period. This time no fouling occurred and conclusive results were obtained. The results show a lot of positive tests, so in some areas it is hard to narrow down to a small location. The branch 3 results show that there is definitely a misconnection on Rokeby Road. Branch 2 results show that there is a misconnection on either Holgate Drive, between number 83 and number 111 on Holgate Road or between 190 and 180 on Colley Road.

Outfall 4

Outfall 4 is located just off Colley Drive, and is quite a large system. Again initial tests indicated that there was a misconnection in this system. Initially fifteen manhole sites were chosen to place samples in. Unfortunately once on site Colley Road had recently been resurfaced and the manholes had been covered over so it was not possible to place samples. There were then a further few manholes that couldn't be lifted because of their age. On the day it was only possible to place five samples which makes it very difficult to identify the area of the misconnection.



Drainage Area: Tongue Gutter, Outfall 4						
	Manhole Number	Location	Placed	Retrieved	No. of Days	O.B Pos/Neg
1	SK35929605	Off Colley Drive	26/09/2013	01/10/2013	5	Pos
2	SK35928715	Colley Road	26/09/2013	01/10/2013	5	Neg
3	SK35928707	Martin Crescent	26/09/2013	01/10/2013	5	Neg
4	SK35928702	Hillside Avenue	26/09/2013	01/10/2013	5	Neg
5	SK35924812	Colley Avenue	26/09/2013	01/10/2013	5	Pos

The results we got from this sampling group do narrow down the area the misconnection is in slightly. It can be said for certain the misconnection is not in Hillside Avenue or Martin Crescent. The results show that there is a misconnection either on Colley Avenue or the road behind; Rokeby Drive. Along with this misconnection it is possible that there is an additional misconnection somewhere along Colley Road.

Overview

The areas of the systems that need further investigation to find the misconnections are;

- Knutton Road, by the SOAR Works Enterprise Centre, most likely is the Enterprise Centre that is misconnected.
- Between number 385 and 419 on Wordsworth Avenue and Milnrow Road.
- Milnrow Crescent
- Colley Avenue and Rokeby Drive
- Rokeby Road
- Either; Holgate Drive, between number 83 and number 111 Holgate Road or between 190 and 180 Colley Road.

Review

Overall this trial of the method was a successful one. The start-up costs are low and it was possible to place all samples for a single system in less than half a day. The collection of the samples later on was a shorter task again as the manholes had been loosened and already located.

The most important part of this method is planning before site work to place samples. This includes maps with the locations of the manholes clearly marked on and secondary options in case the manholes are impossible to lift. In the planning stages it is preferable to choose manholes that are not on the highway as this means no roads need to be closed.

Advantages and Disadvantages of Method

The most important benefit of this method is the very low start-up cost and the small amount of time it takes to place all samples in an area. Once the samples have been collected, the testing and results gathering is very quick. With proper labelling and mapping the results make it very easy to determine the location of the misconnection.

This technique can be used as a proactive method of finding misconnections rather than reacting to a member of the public reporting one.

The two main problems that have arisen with this method is not being able to lift some of the manholes due to age or being tarmacked over and the samples getting fouled due to leaving them in the flow for too long. There is almost nothing that can be done about the manholes apart from having secondary manholes to choose from to place samples in. The fouling problem mostly arises in systems with a high flow rate. For these systems a one day sampling period can be used, this is not ideal as it is possible to miss a pollution. Optical brighteners have quite a long lifetime in a system so it is possible to get conclusive results with a one day sample.

In the event of a fouling of the samples and it is not possible to do a retest then you can wring out the sample into a container and shine the UV light on the water to see any fluorescence.

Ideal Conditions

The ideal conditions for this method are a three day sampling period with preferably a clear weather window. Heavy rainfall can increase the chances of fouling the sample and can also dilute the concentration of optical brighteners in flow. If on inspection the flow is very high in a system choose a shorter sampling period of one or two days. It is preferable to get all samples placed in the system on the same day.

Time and Costing

One or two technicians with a van or a buddy team with a van cost between £250.00 and £300.00 for half a day. For a medium to large system it takes half a day to place samples and half a day to collect. So the labour cost for an investigation on one system is £500.00 - £600.00.

The material costs are very low, for each system you need about twenty tampons, twenty masonry nails, clear zip lock bags and some monofilament string. For one investigation all the materials can be bought for around £6.00.

For the analysis of the samples a UV light is needed. These can be picked up for around £10.00.

The time taken to investigate one system is two half days plus the time taken to analyse the samples which tends to take about one hour.

Inspection

Using the locations obtained from this detection method several inspections were carried out at the chosen areas. From outfall 3, two misconnections were found, both on Turie Avenue. One misconnection was a soil stack and the other was a sink connection to the storm water gulley. A note was left at both properties with details of what the problems are. From outfall 2, two misconnections were also found, both on Milnrow Crescent. Both misconnections were sink and washing machines connected to surface water gulleys. The customers at these properties were both informed and stated they would get these rectified as it was a very job to resolve.