

Appendix 20b: Thorne report

The Water Undertakers (Information) Direction 2012

NOTIFICATION OF AN EVENT

FINAL REPORT

Advice Not to Drink Water at Thorne, nr. Doncaster, South Yorkshire **29th July - 4th August, 2016**

Company: Yorkshire Water Services Ltd. **Date of Event:** 29th July 2016
Notified by: Luke Montgomery **Date of Notification:** 29th July 2016
Time of Notification: 15.37 **YWS Reference:** THO16
Company Contact: J A Haley **DWI Reference:** 2016-5660

Summary

On the very late evening of the 27th July a single business property reported the presence of discolouration and taste and odour. An investigation was initiated, and the issues appeared to be quickly resolved. Inspections at this property and at nearby properties on the 28th July were not able to identify a confirmed source of the reported issues. However, discolouration and taste and odour recurred on the 29th of July. Subsequently, results from samples collected the previous day were found to contain high levels of faecal indicator organisms.

The Company instituted an Incident Management Team, and advice not to drink mains tap water was provided to 3648 properties in the areas of Thorne and Moorends, near Doncaster, South Yorkshire. The source of contamination was identified, and disconnected from the YW supply. Further sample results provided evidence that boiling water would be sufficient protection for consumers. Health protection advice remained in place until sufficient confidence was obtained that there was no ongoing risk to consumers. The boil water advice was rescinded on 4th August following consultation with relevant parties.

1 Introduction - Source Water and Supply Network

The supply to Thorne and Moorends consists of moderately hard borehole water derived from the Sherwood sandstone aquifer treated at Nutwell Water Treatment Works (WTW). There are three boreholes on the Nutwell WTW site which provide the raw water to the WTW along with up to five remote borehole sites. Treatment at Nutwell WTW consists of air oxidation cascade to precipitate iron, followed by the addition of sodium hypochlorite to oxidise manganese which are then removed by the rapid gravity sand filtration stage. The water then receives GAC filtration for pesticide removal. Disinfection is carried out with sodium hypochlorite to achieve a free chlorine residual within the contact tanks. Following this the

water is dosed with sodium bisulphite, followed by ammonium sulphate on the inlet to the two clean water tanks (CWT) to provide a chloramine residual for the distribution system. Monosodium, dihydrogen o-phosphate is dosed for plumbosolvency control.

The route of supply from Nutwell WTW to Thorne is via a transfer to Hatfield Service Reservoir (SR) then onto Thorne Water Tower (WTR) via Hatfield No 2 Water pumping Station (WPS). The supply to Thorne and Moorends is from Thorne Water Tower (WTR) via Thorne WPS. A simplified schematic of the supply system is shown in Appendix 2

There are two local Distribution Management areas in Thorne and the nearby Moorends which were directly impacted by this Event. The affected area of Thorne is located within the Thorne 3 DMA (Ref D521), which contains 1298 domestic and 123 commercial properties. The affected area in Moorends is within Thorne Moorends DMA (D458) and contains 2143 domestic and 85 commercial properties. Both DMAs lie within the Hatfield 2004 (WSZ0323) Water Supply Zone (WSZ).

The locations of Thorne and Moorends is shown in figure 1 below.



Figure 1 Location of Thorne and Moorends.

2.0 Summary of Event timeline

Wednesday 27th July 2016

22:37 The Company receives a call from a Food Manufacturing Company(FM) on Coulman Road Industrial Estate, Thorne, reporting discoloured water along with an odour.

23:35 the Duty Network Technician attends the FM site to investigate. No discolouration at inlet to FM at time of visit.

Thursday 28th July

05:30 further call from FM again reporting discoloured water.

06:20 Network Technician from neighbouring team attends site and observes discolouration at the FM so opens a hydrant close by noticing discolouration and warm water at a hydrant close to FM. NT set 2 hydrants flushing on Coulman Road.

06:50 Discolouration on Coulman Road still evident so NT closes a valve to allow a single directional flush around the Industrial estate.

08:10 Water flushing clear at Coulman Road .

08:45 Water Quality Scientist on site to take WQ samples with NT.

09:00 Water Regulations Team (WRT) on site to visit FM and other properties on the Industrial Estate to carry out inspections.

11:00 WRT visit Poultry Processing Factory (PPF) to carry out inspections and find contraventions.

Friday 29th July

04:40 Further contact about discoloured water at the FM Coulman Road, Network Technician sent to attend site.

At 08:53 on 29th July the first domestic customer contact relating to discolouration beyond the Coulman Rd industrial estate, in DMA D521, followed by further customer contacts.

09:30 Presumptive indicator bacteria reported to central control WQS from samples taken on 28th July on Coulman Road.

12:36 Poultry Processing Factory Isolated from mains network.

13:00 Company's Incident Management Team Meet

15:00 Company make first public announcement of advice to do not drink the mains tap water via SMS text, social media, website, and traditional media.

17:00 First Delivery of bottled water to the affected area.

18:00 -21:00 Water Quality Sampling Programme at customer properties.

20:00 Bottled water delivery centres set up in Thorne and Moorends.

22:00 Aesthetic checks at hydrants in DMA D521

23:00 Pressure Step Test Conducted on section of mains around Columan Road Industrial Estate

Saturday 30th July

Delivery of written Do Not Drink (DND) notices commenced.

DND advice replaced with Boil Water Advice (BWA) via SMS text and social media, website and traditional media (except Coulman Road).

Bottled Water to Vulnerable customers

Arlington Bulk water tanks deployed

Further Water Regulations Inspections on Coulman Road and PPF.

Flushing Plans Drawn up.

Further Water Quality Sampling

Review of Nightline Flow suggest backflow has stopped.

Water Quality Sampling

Sunday 31st July

BWA hand delivered to customers

Water Quality Sampling

Manual Chlorination of Thorne WTR

18:00 Flushing programme in DMA D521

Monday 1st August

DMA D458 Flushing programme carried out

WQ Sampling.

Tuesday 2nd August

Steady improvement in water quality results - majority of samples showing absence of coliform bacteria.

Chlorination of 2km leg of main on Moor Edges Road.

Further WQ Sampling.

Wednesday 3rd August

targeted flushing activity to address specific problem areas and further WQ samples were taken.

Thursday 4th August

Lift of the Boil Water Advice to all customers following consultations with Public Health England and EHO.

Water Quality Sampling

Friday 5th August – 9th

Continued water quality sampling takes place in the areas the results support the lifting of the boil water advice.

3 Investigation

This was a complex event and the investigation has been split into a series of themes to provide a clearer picture for each of them.

3.1 Nature of the Event

The initial contact from the Food Manufacturer (FM) and immediate investigation suggested that the discolouration issue was restricted to the Coulman Rd industrial estate. However, the domestic customer contacts from DMAs 521 and 458, which began on 29th July, indicated that the discolouration went beyond Coulman Rd Industrial Estate, even if this was the likely point-source of the issue.

The contact from the FM at 22:31 on 27th July concerning “black water smelling of sewage” from the water supply within the premises resulted in a visit by the on-call Network Technician (NT), who arrived at the site at 23:35. The FM operates a 24 hour production process and the FM Shift Supervisor (FMSS) stated that the water in the factory had earlier appeared black. The FMSS checked the main incoming supply by running it into a white bucket. However, at that time the mains water quality appeared normal, as it had done on each prior occasion it had been checked by staff at the FM. The NT asked to repeat this exercise at the incoming supply, which is situated in a small outbuilding close to the perimeter of the premises. Once again the water at this point was confirmed to appear normal, giving the NT good reason to suspect that this evidence, in association with an absence of other customer contacts in the area, pointed towards the reported discolouration stemming from an issue with the pipework and fittings restricted to the FM premises.

The NT asked the duty maintenance technician from the FM about the onsite pipework layout and installations and whether or not any work had been carried out on the system recently. The maintenance technician did not have any of this information available but did show the NT around the site, although nothing which could have caused the discolouration was apparent during this brief survey.

The FM had retained a white bucket containing water run from one of their site taps. The NT reported that the water had an “aqua green” tinge to it, as is commonly associated with the presence of copper compounds. The NT asked about any activity on site which may have caused scouring of the internal copper pipework and the FMSS agreed that this could be a possibility but didn’t know for certain and neither did the maintenance technician.

At this point, with any discoloured samples having been obtained from within the FM site itself and the main incoming supply having always run clear, the NT informed the FMSS that the evidence pointed towards an issue within the site, which at this time was a reasonable conclusion to make. There was no indication of black water or an odour of sewage anywhere within the factory at this time. The NT suggested that he take a set of samples for physico-chemical, metals and bacteriological analysis (see Appendix 1.1 and 1.2), which the FMSS agreed would be welcome and requested to be informed as soon as the results were known.

The NT took the samples from the cold tap in the site canteen, informed the Company’s Duty Manager (DM), leaving the FM at approximately 02:20 on 28th July to drive the samples directly to the laboratory, where they were left in the “out of hours” fridge for processing at the start of the working day.

At 05:09 on 28th July, the Company received a further call from the FM stating that the foul-smelling black water had returned and that production had to be suspended. The NT who had attended earlier that night was not able to return due to the total number of hours he had already worked over the preceding 24 hour period. It was therefore necessary for a NT from a different area to visit the FM and carry out a more extensive investigation on the premises and in the local network.

The NT arrived at the FM at 06:00 on 28th July and found the FM maintenance technician had been flushing from the mains inlet. The NT confirmed that this water was highly discoloured.

The mains system around the Coulman Rd industrial estate normally operates on an open system. Coulman Rd is in effect a crescent, connecting to Coulman St at two junctions and the mains network follows this layout, with water flowing in and out of the industrial estate at two points (see Appendix 5.1).

At 06:20 the NT commenced flushing from the closest hydrant to the FM in Coulman Rd (Hydrant H2 see Appendix 5.2) and found water to be discoloured. In order to try and disperse the discoloured water, the hydrant was left flushing at a rate of approximately 3 l/s.

At 06:30 the NT began flushing hydrant H1, outside a Poultry Processing Factory (PPF). The water was found to be discoloured but also unusually warm.. This hydrant was set flushing at 3 l/s.

From approximately 06:40 the NT flushed hydrants 04442001506, 04442001507 and at Moor Edges Rd, which were located upstream and downstream of Coulman Rd but found these to be running clear, indicating that the problem appeared to be localised within the Coulman Rd industrial estate.

Meanwhile, at around 07:00 the Company's Duty Manager contacted the standby Water Quality Scientist (WQS) and requested that they attend site.

The NT returned to the previous two hydrants on Coulman Rd at approximately 06:50 but found no improvement in the observed water quality. The NT reported these findings to the Company's Duty Manager and proposed turning the mains system on Coulman Rd into a single direction flow, thereby allowing a thorough flush of the localised mains system to an end hydrant. With all available evidence suggesting that the source of the discolouration was within the industrial estate and at this time could not be attributed to anything other than the re-suspension of historical mains deposits, it was agreed between the NT and DM that flushing in one direction to a hydrant next to a closed valve would be the most effective way of dispersing the discoloured water.

The NT therefore closed valve (V1) and opened hydrant at (H1) and commenced flushing in one direction on Coulman Rd (see Appendix 5.2)

At 08:10, the NT confirmed that water was running clear at the FM and at hydrants H1 and H2. At around this time the FMSS contacted the NT to ask if they could resume production. The NT advised against this, as the cause of the discolouration had not been established and had proven to be somewhat intermittent throughout the course of the investigation so far. The FMSS agreed and made arrangements to flush the FM internal pipework in readiness for an imminent restart.

At approximately 09:00, the WQS arrived on site at the FM, along with the area Customer Service Manager (CSM) and two Water Regulations Inspectors (WRI). The Managing Director of the FM requested from the CSM that a tanker of water be made available to allow production to resume at the factory whilst further investigations into the cause of the discolouration were ongoing.

Between 09:45 and 11:00, the NT and WQS flushed and sampled at two hydrants on Coulman Rd, as well as one upstream of the industrial estate at Moor Edges Rd and again there was no apparent discolouration. The samples were taken directly to the laboratory services provider for priority analysis.

From approximately 09:00 until 11:00, the two WRI had conducted a water fittings inspection of the FM but did not report any contraventions or conditions which could have resulted in the discolouration observed at the factory and local mains network. Therefore the WRI proceeded to carry out similar inspections at the other businesses on the Coulman Rd industrial estate, along with a farm upstream of this, on Moor Edges Rd.

At 12:00 on 28th July the area CSM discussed the latest findings with the FM managing director and site supervisor. The supply of a tanker to the FM to allow production to resume was also discussed.

Of the other businesses on the Coulman Rd industrial estate, one in particular, a poultry processing factory (PPF) was found to have a large (approximately 16 m³) hot water tank, heated to 58°C which had only recently been installed. It was not possible to confirm if the inlet feed to this tank had an air gap which would prevent back-syphonage, as the tank was completely enclosed and no diagrams of the installation were available at the time of the WRI visit.

The PPF's on site engineer informed the WRI that all water used in production was fed from two large storage tanks. These tanks were inspected by the WRI and found to have compliant AB air gaps, thereby eliminating the risk of water feeding back into the distribution network from this particular location (see section 3.3 for full details of the Water Regulations investigations).

At this point, given the report of warm from the hydrant H1, which was also closest to the hot water tank at PPF, the WRIs suspected that the hot water tank inlet may not in fact have a compliant air gap and that this was the most likely cause of the warm water and discolouration within Coulman Rd. However, the WRIs made the reasonable decision to conduct further investigations at other premises in the immediate area to attempt to rule out contamination from other sources. This information was fed back to the CSM by one of the WRIs at approximately 13:30 on 28th July.

The presence of warm water within the distribution network suggested that water from a hot water system was somehow feeding into the mains network. This could also conceivably introduce discolouration in the form of debris from the hot water storage and pipework but nevertheless suggested that it was likely that the contamination was essentially Water Regulations Advisory Scheme (WRAS) Fluid Category 2 (pertaining only to the aesthetic effects of a change in temperature, rather than pathogenic or toxicological contamination).

The location of the PPF had previously been in use for the manufacture of chicken products, and as a high risk location had last been inspected by Water Regulations Inspectors in 2012, when only the office block was in use; the production machinery and equipment having been removed. At the time of this visit it was stated that the facility had not been in production use for approximately two years. The current site owners have recently installed production equipment but at the time of the Event stated that it was only at the commissioning stage and that full production had not yet commenced. Unfortunately, YW had not been informed of the installation of new process equipment and modification of site pipework related to the return to production operation as is required under the Water Fittings Regulations.

On 29th July at 04:36 the FM rang the Company again to report discoloured water. At approximately 07:15 a NT and WQS began flushing and sampling the hydrants on Moor Edges Rd and hydrant H2 on Coulman Rd (see Appendix 5.2). The water at both hydrants appeared clear at that time.

The area CSM met with the FM managing director at 08:30 to explain that further investigation was required and that the Company was awaiting sample results from the previous day. The FM managing director requested a copy of the results once available.

At approximately 09:30 the CSM met with one of WRIs who had carried out the inspection at the PPF on 28th July. In view of the potential for backflow from that particular factory, the apparent restriction of the issue to the Coulman Rd industrial estate and Water Regulations inspections at the other properties ruling them out as the origin of the observed contamination, it was decided to serve a Section 75 (Water Industry Act 1991) Notice on the PPF. This would initially require the PPF to fit a check valve to the hot water tank inlet pipe, as it was uncertain whether or not an air gap was present. The Section 75 Notice would also allow the Company's WRIs to carry out further investigations at the PPF.

During the morning of 29th July, another WRI was carrying out Water Regulations inspections at other industrial units on Coulman Rd industrial estate and farms upstream of this area, particularly on Moor Edges Rd (see Section 3.2 for details of all investigations carried out during the Event).

The two WRIs met up later that morning to carry out a further inspection of the PPF. They had previously requested schematic drawings of the water supplies on site but were informed that none were available. The WRIs also enquired whether a Regulation 5 notification form, informing the Company of production resuming at the factory, had been submitted. The representative from

the PPF informed the WRIs that this form had not yet been submitted. However, the PPF had previously contacted the Company's trade effluent team.

The WRIs attempted to identify and trace all pipework at the PPF. This proved difficult, as none of the pipework had been labelled. However, engineers from the company which had installed the system were present on site and assisted the WRIs in understanding the complex network of pipes and tanks. It became clear that there were at least four cross-connections of process water streams with the potable water system on this site. The WRIs immediately spoke with the site engineer and arranged to have the water supply to the factory turned off. The PPF was isolated from the mains network at 12.36.

At 08:53 on 29th July the first domestic customer contact relating to discolouration beyond the Coulman Rd industrial estate, in DMA D521, was received by the Company. At 09:47 a discolouration customer contact was received from DMA D458. These were followed at 10:53 and 11:01 by the first customer contacts pertaining to taste & odour from DMAs D458 and D521 respectively. This was the beginning of a significant number of customer contacts received by the Company throughout the course of this Event (see section 3.4 for detailed discussion of customer contacts and also Appendices 16 and 17).

On the morning of 29th July The Company's laboratory analytical service provider reported the presence of presumptive indicator bacteria in four of the six samples taken on the 28th July. Two of these samples from hydrants indicated the presence of *E. coli*. The sample from the hydrant H1 had the highest presumptive count. However, samples from hydrants representing supply to domestic customers on the 28th July were clear of indicator bacteria. A Schematic showing these presumptive indicator bacteria counts is shown in Appendix 5.3. A table of the 1 sample results is in Appendices 1.1 and 1.2

At 13:00 on the 29th July the Company's Duty Manager called for the Company Incident Management Team (CIMT) to meet in the Company's Regional Operational Control Centre (ROCC) to manage the rapidly evolving event. On review of the events the CIMT quickly recognised the need to protect public health. Following consultation between the Company and representatives of South Yorkshire Public Health England it was agreed that as the exact nature of contamination was unknown it was appropriate that 'do not drink' advice should be provided to all customers who could be affected, which was considered to be customers in DMAs D458 and D521. A Schematic of the supply system is shown in Appendix 2.

Provision of bottled water to the affected areas was a key aspect of the response and two locations, one in Thorne itself (DMA 521) and the other in Moorends (D458) were identified and agreed with the representatives from those establishments at around 14:00.

The CSM on site at Coulman Rd was informed at 14:17 by the duty WQS about the final coliform count of 6:0 from the FM, as well as the positive results from other locations sampled on 28th July. The CSM and WQS discussed the implications to the FM in particular prior to the CSM contacting the FM managing director at 14:27 with this update.

At 15:00 The Company made the first public announcement of the advice not to use water for drinking or food preparation. Updates were made to the Company's website, on its social media presence, and to local TV and newspapers, as well as local and national radio.

The Company's website was updated with the "do not drink" advice at 15:00 on 29th July. At this time a webpage dedicated to this Event was set up, with a highlighted link on the Company's homepage (see Section 3.5 for discussion of the Company's communications throughout the

Event). The information with regard to the potentially affected properties took the form of partial post codes, these used five digits of the postcode instead of the full six, e.g. DN8 XX_. The decision to present the affected areas in this way was due to the more than 200 streets impacted, which was considered to be too many to list on the website. Whilst this approach did make the information on the website less overwhelming, it soon became apparent that addresses outside of the two affected DMAs were included in the do not drink advice to this list of partial postcodes, due to the fuzzy nature of the post-code defined areas

As part of the investigation into the source of the suspected contamination an assessment of flow into the zones was made. It was observed from telemetry data that the minimum nightline outflow from the upstream Thorne Water Tower on the 28th and 29th July was approximately 4 l/s lower than on previous days. This observation suggested that there was a potential injection of up to 4 l/s into the local DMA from an unknown source. The outflow from Thorne WTR is shown in Appendix 9.

In order to fully investigate this observation a step test of the network in the vicinity of the industrial estate was carried out; this involved isolating the flow to the industrial estate and to Moor Edges Rd.

This test indicated that there was a loss of pressure upon isolation of inlet to the localised area; indicating that there was no longer an unknown import into the network in this area. Later in the morning it was subsequently identified that the minimum nightline outflow from Thorne Water Tower had returned to more normal levels.

With the contamination now having spread beyond the Coulman Rd industrial estate into the DMA (D521) within Thorne itself and a downstream DMA 458 at the neighbouring village of Moorends, the decision was made on the afternoon of 29th July to flush the system at strategic hydrants. A network Technical Support Engineer (TSE) set out a plan to flush DMA D521 at fourteen locations.

However, given the other network investigations, including step-testing, which were on-going, as well as the considerable social unrest once the “Do Not Drink” advice had been given, and the need to control members of the public who were collecting supplies of bottled water, thorough flushing of the network did not commence until 31st July.

The first delivery of fourteen pallets of bottled water arrived at the designated collection point in Thorne at 17:00 on 29th July. A water tanker arrived at the Moorends collection point at 20:06.

It was decided to use the nearby Nutwell WTW, located roughly 12km south of Thorne, as a logistics hub. This was to facilitate the logistics of distributing pallets of water, coordinating other operational activities and to provide a neutral location for staff hand over and welfare facilities.

From approximately 22:00 on 29th July, two NTs carried out aesthetic checks at hydrants in DMA 521. These checks are summarised in Table 1 below:

Hydrant Location	DMA	Time	Comments
Maple Rd	D521	23:20	Ran clear straight away , No smell , Turbidity: 0.33 NTU

Cherry Tree Drive	D521		Tea like in colour, typical iron smell. Flushed for 5 mins with no improvement. Turbidity: 15.26 NTU Flushed again for 30 mins until clear. Turbidity reduced to 1.74 NTU.
Ivy Rd	D521	30 th July 00:50	Ran clear after 30 mins of flushing. Was discoloured at first with typical iron smell. Nephnet deployed ref Turbidity: 0.51 NTU
Bridge St	D521	22:13	Iron discolouration for 2-3 mins, air cleared after 2 mins. No smell
St Nicholas Mews	D521	23:14	Iron discolouration for 2 mins, air cleared almost straight away. No smell.
Palm Grove Ct	D521	23:28	Ran clear instantly. No smell

Table 1 Aesthetic checks at hydrants in D521 on 29th/30th July

On the morning of Saturday 30th July delivery of written 'Do Not Drink' notices was commenced to the 3648 affected properties.

As sample results of physico-chemical, microbiological and organics sample analysis became available during the 30th July, an assessment of the event was carried out by senior water quality and operational managers. These were correlated with our understanding that hydraulic measurements for the zone indicated no further unexpected inlet flows to the main network could be identified.

Early microbiological indications from samples obtained on the 29th July indicated the continued presence of presumptive indicator bacteria, although not faecal indicators, in the at-risk area. Subsequent analytical work indicated that many presumptive isolates did not confirm as coliform or *Clostridium perfringens*.

From all the updated information available at the time the CIMT were able to make a reassessment of the risk to consumers. In the absence of any organic compounds, and with physico-chemical parameters within normal variation it was decided to replace the 'Do not drink' advice with 'Boil Water Advice' (BWA). However, the advice not to use water for drinking or for cooking purposes was retained for the properties located in Coulman Road industrial estate, which impacted the FM in particular due to the use of significant quantities of water in their production process. The decision to change the advice to BWA was discussed with Public Health England. Valve status was maintained to ensure a single inlet into the industrial estate and a non-return valve was installed on this inlet main in order to provide further protection to customers in the wider area (see Appendix 5.5).

The change to BWA was communicated to customers via SMS text updates, social media, the Company's website and traditional media. Coordination was carried out with stakeholders, and Company staff were available to advise customers.

During the 30th July arrangements were made to deliver bottled water to vulnerable customers and further bulk deliveries of bottled water were made. The Company also deployed a number of "Arlington" water units at an agreed location (see photographs in Appendix 20). These units incorporate a disposable sterile water containing bag within a tough plastic container for protection. The units are filled by tanker and can be used to provide a drinking water supply to customers.

The Company's Water Regulation Inspectors carried out visits to four further businesses in the Coulman Rd area. During a further visit to the PPF they were able to identify further fittings contraventions and most significantly, confirmed that, in addition to the identified backflow risks, the site had equipment with the capability of raising pressure in site pipework by 16-bar, which would overcome the pressure in the mains network. Cross connections to the inlet drinking water pipework were also identified. No other properties were found to pose a risk to the supply of drinking water in that area.

Two rounds of water quality sampling were undertaken at customer's taps during the day and then the evening of the 30th July. Samples were also collected from specific customers indicating illness to the Company (see Appendix 16.2).

The Company's Water Regulation Inspectors carried out further visits to the Poultry Processing Factory and were able to identify further fittings contraventions. During the visits on the 30th July it was confirmed that the site contained equipment which had the capability to raise pressure in pipework by 16-bar, and that cross-connections to the inlet drinking water pipework were identified. As a precaution, additional visits were also carried out at farms in the vicinity. No other properties were found to pose a risk to the supply of drinking water.

On Sunday 31st July written BWA was delivered to all customers, with the exception of the customers on the industrial estate. A further a water quality sampling programme was undertaken during the day.

The Company's CIMT continued to the meet during the 31st July in order to assess the on-going situation. Sample results from analysis collected on the 30th July continued to indicate an improvement in water quality. The chlorine residual for the area was enhanced by carrying out a manual chlorination of the upstream Thorne WTR. However, the continued presence of presumptive *C. perfringens* was also noted.

Bottled water deliveries to vulnerable customers were continued and a delivery of bottled water to properties on Coulman Road Industrial Estate was made in preparation for the return of workers to these business premises at the beginning of the working week.

The Company designed a flushing programme to be undertaken in D521 and D458. In an attempt to avoid possibly misrepresentative results, sampling was ceased and flushing was commenced at approximately 18:00 on the 31st July. The flushing scheme was designed to be "passive" in order to reduce the risk of disturbing significant amounts of historical sediment that might cause discolouration and result in further concern for customers. Unfortunately, this design did result in a relatively extended programme, and it was only possible to complete the flushing of D521 on the evening of the 31st July.

On Monday 1st August a further assessment of the water quality sample results was undertaken by CIMT. Early indications were that flushing activity was acting to effectively improve water

quality. Arrangements were made to collect further samples. However, it was also decided not to further delay flushing in D458. The hydraulic arrangement of D458 is relatively complex, and was expected to require a significant amount of time.

On the basis of samples collected from the industrial estate on the 31st August, and following consultation with Public Health England, the CIMT were able to make the decision to convert advice to customers in this area to 'Boil Water Advice' in line with the other affected areas. Written advice was hand delivered to these fourteen properties in afternoon of the 1st August.

By Tuesday 2nd August CIMT was able to identify a steady improvement in the quality of water supplied. The majority of samples were indicating the absence of coliform bacteria. However, low levels of *C.perfringens* were observed. In particular, it was noted that there were persistent coliform detections from customer properties on Moor Edges Road, Thorne. This location is to the south east of Coulman Road Industrial Estate in D521. The distribution main in this location terminates in a dead end beyond the final customer properties. In an attempt, to resolve the presence of recurrent coliform bacteria new fittings were installed on this main and chlorination was carried out on an approximately 2km length of 4" diameter main. The chlorine residual was raised to up to 2 mg/l for more than one hour before being fully flushed out.

A further visit to the site Poultry Processing Factory confirmed that there was progress being made to resolve the fittings contraventions. However, the required boundary protection was found not to be located in the appropriate location and the Company provided further advice on necessary improvements.

Further water quality sampling was carried out in the area in two rounds during the day and during the evening of the 2nd August.

There was continued coordination of on-site activity by the Company, Doncaster MBC, and other stakeholders on Wednesday 3rd August. The Company carried out targeted flushing activity to address specific problem areas and further samples were taken.

The advice to boil water before drinking remained in place for all residents in the two affected DMAs. The Company was focussed on returning normal water quality to all customers. However, the Company also ensured it gathered evidence sufficient to allow options for pursuing the contraventions of the Water Supply (Water Fittings) Regulations.

On the morning of Thursday 4th August following the receipt of clear bacteriological results from the previous days samples the agreement was made with PHE and EHO to lift the Boil Water Advice to all customers.

Friday 5th August – 9th August continued water quality sampling took place in the areas and the results support the lifting of the boil water advice.

3.2 Water Regulations Activity

The Company responded to the discolouration Contacts from the Food Manufacturer (FM) by sending two Water Regulations Inspectors (WRI) on 28th July at approximately 09:00. Whilst several contraventions were identified none of these were considered to have contributed to the discolouration observed at the factory and local mains network. A report of the contraventions is included in the Appendix.

The WRI identified the Poultry Processing Factory (PPF) as a possible source of the discolouration due to the close proximity of the factory to the hydrant (H1) where the Network Technician (NT) reported warm water.

At around 11:00am a water regsWater Regulations inspection was undertaken at the PPF. The factory was found to be broadly split into two parts, the original factory site and a new build section. A sketch of the PPF layout is shown below in Figure 1.

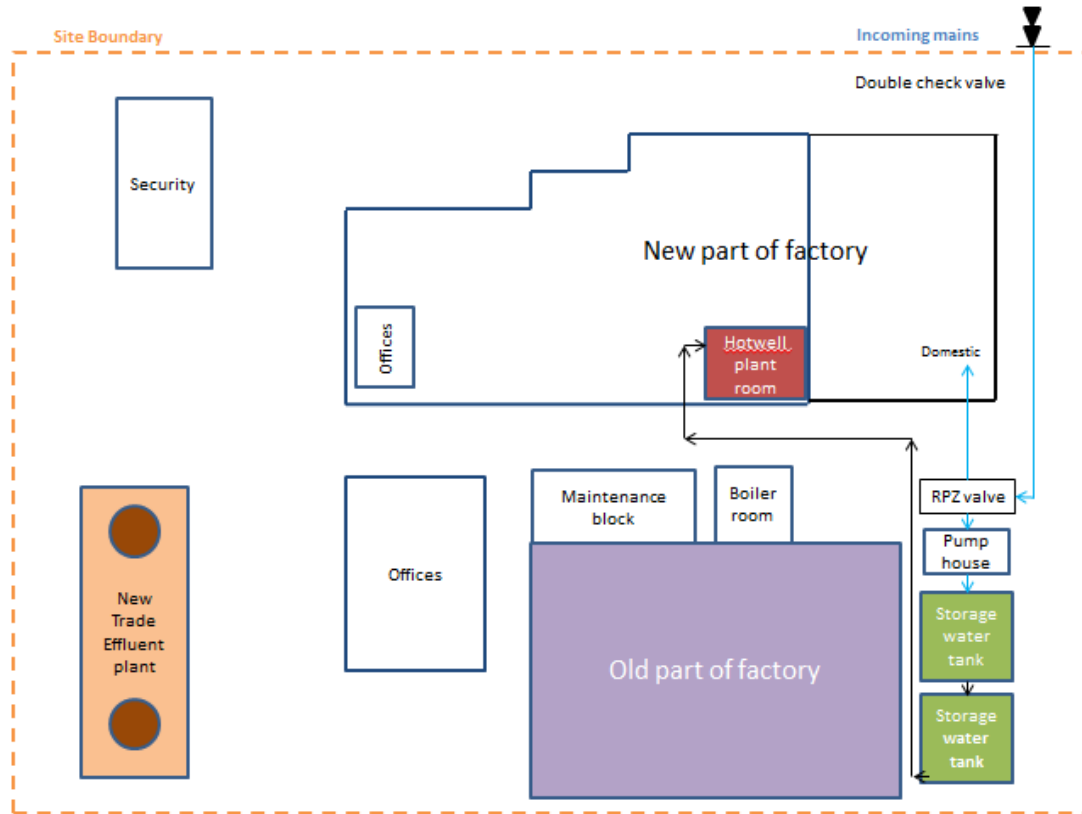


Figure 2 PPF layout

The WRI was accompanied by the PPF's on-site engineer and the contractor who was responsible for installing and commissioning the new works.

The WRI was told that all of the water used in production was fed directly from two large storage tanks. The tanks were inspected and found to have compliant AB air gaps as seen in Figure 2.



Figure 3: PPF storage tanks with incoming mains feed.

This implied that backflow into the mains from the PPF storage tanks should not be possible. The WRI requested schematic drawings in order to confirm the pipework layout but was told that no drawings had yet been created by the contractor.

Given the reports of warm water at a nearby hydrant (H1) the WRI asked how the hot water was produced and was told a new hot water system had been recently installed. The hotwell plant room was inspected and when questioned further, the contractor clarified that the hot water inlet pipe did indeed have a mains fed connection. The contractor stated the incoming mains was above the overflow thus creating an AF air gap. As seen in Figure 3, it was not possible to confirm the existence of an AF airgap as the storage cylinder is a sealed system.

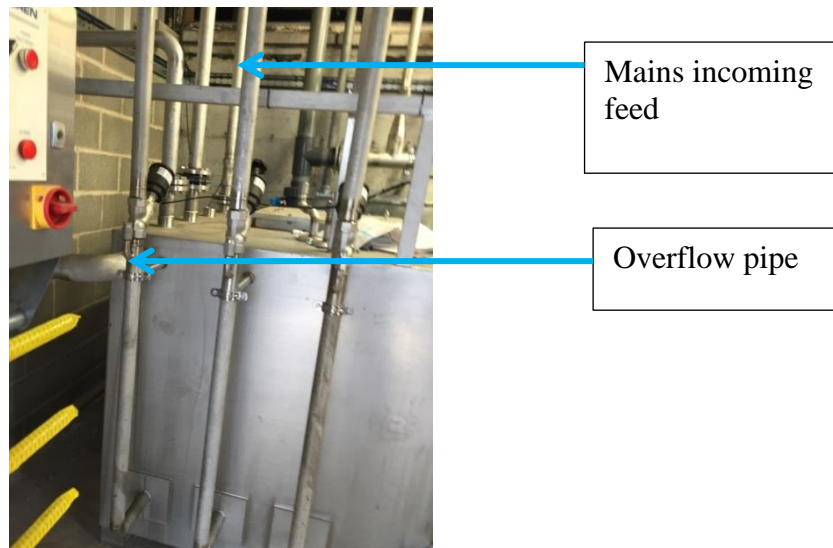


Figure 4: feed in to hotwell with possible mains incoming feed below overflow pipe

The WRI inferred that the incoming mains pipe could instead be a “dip pipe” that reached below the overflow pipe to the bottom of the hotwell tank. This would compromise the AF airgap and could have led to backflow from the hotwell.

The WRI attributed the likely cause of the warm, discoloured water to the hotwell and risk assessed the fluid risk to be under Category 2 of the Water Supply (Water Fittings) Regulations 1999. Since a fluid Category 2 risk is not defined as health impacting an on the spot report was issued for installation of a single check valve. As a precaution, boundary protection was also requested by way of the installation of a double check valve on the incoming main to the PPF.

The WRI informed the PPF owner and contractor of the works required and their attitude was taken into consideration when agreeing timescales for completion. The PPF were amenable to any works required and had engineers available on site that would complete the works over the weekend shutdown period. The PPF were informed of the WRI process and told that a formal written report would be sent in the post and a revisit would take place the following week to confirm that works had been completed.

The WRI team took the decision to continue investigations on the Coulman Road industrial estate to ensure we could rule out a potential second source of contamination from other sources. The WRI investigations did not identify any other contraventions on the Coulman Road industrial estate that linked to the observation of warm, discoloured water.

In light of a further report of discoloured water from the FM on 29th July, and in the absence of finding any further contraventions linked to this, the Company took the decision to issue a Section 75 (Water industry Act 1991) notice on the PPF for the required works (the Section 75 notice is shown in the Appendix 22).

The WRI again sought to clarify the pipework layout and was told that all production areas in the PPF were fed from the storage tanks. The WRI took the decision to conduct a full “source to tap” investigation of the PPF to confirm the pipework layout and eliminate the presence of other potential sources of contamination.

The WRI ability to identify contraventions in the PPF was severely restricted due to a complete lack of pipework identification, as required under BS1710-2014 and the absence of any schematic drawings. All pipework was fabricated in stainless steel and multiple types of water supplies were not labelled including; mains potable water, recirculated hot water, recycled water, high pressure hot water, steam, central heating pipework, and stored process water.

The WRI identified four separate cross connections between mains potable water and various other water sources within the PPF that were under high pressure. These are shown in Figures 4, 5, 6, and 7 below. The WRI immediately spoke with the PPF site engineer and arranged for the water supply to the PPF to be isolated from the mains network.

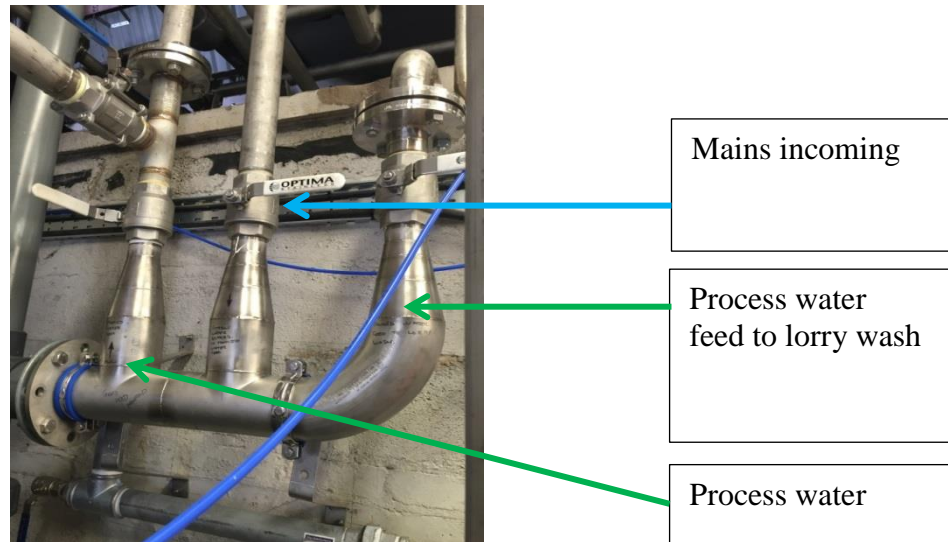


Figure 5: cross connection from mains to process water feeding hotwell (defect number 5 on water regs report in the Appendix 24)

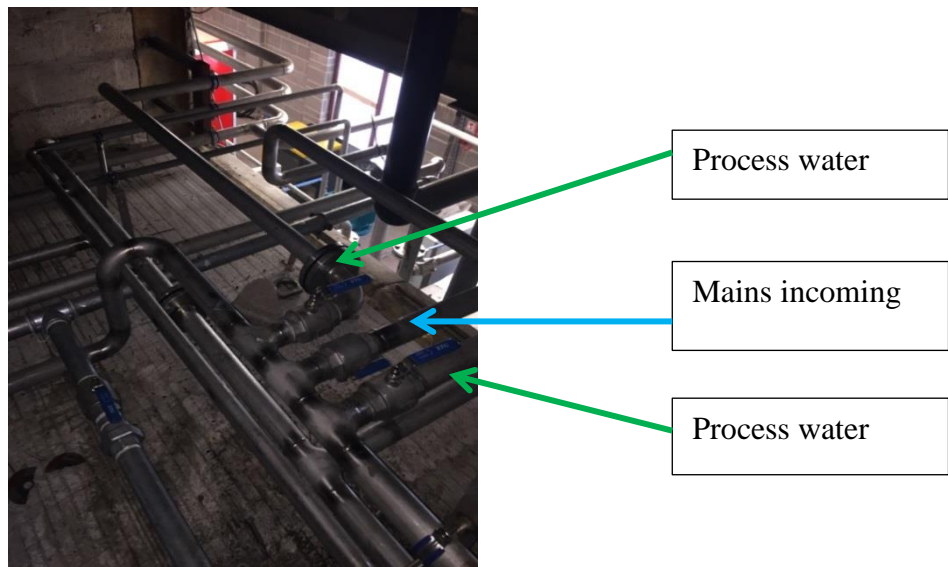


Figure 6: cross connection from mains to process water in roof space before hotwell (defect number 6 in water regs report in the Appendix 24²³)

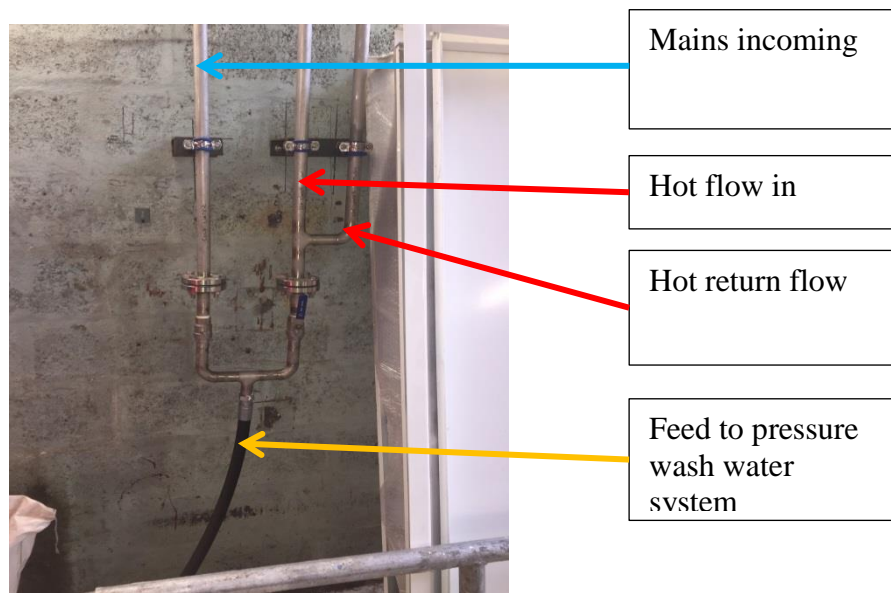


Figure 7: cross connection in boiler room feeding pressure wash water system (defect number 9 in water regs report in the Appendix 24)

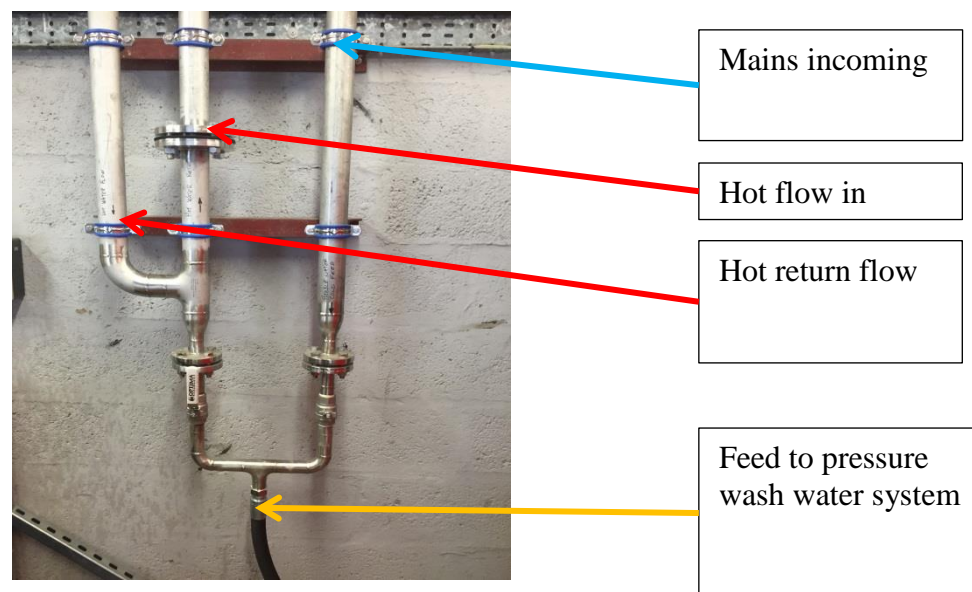


Figure 8: cross connection in hotwell plant room feeding pressure wash water system (defect number 7 in water regs report in the Appendix 24)

A basic pipework diagram highlighting the cross connection and the corresponding Figures used in this report is shown below.

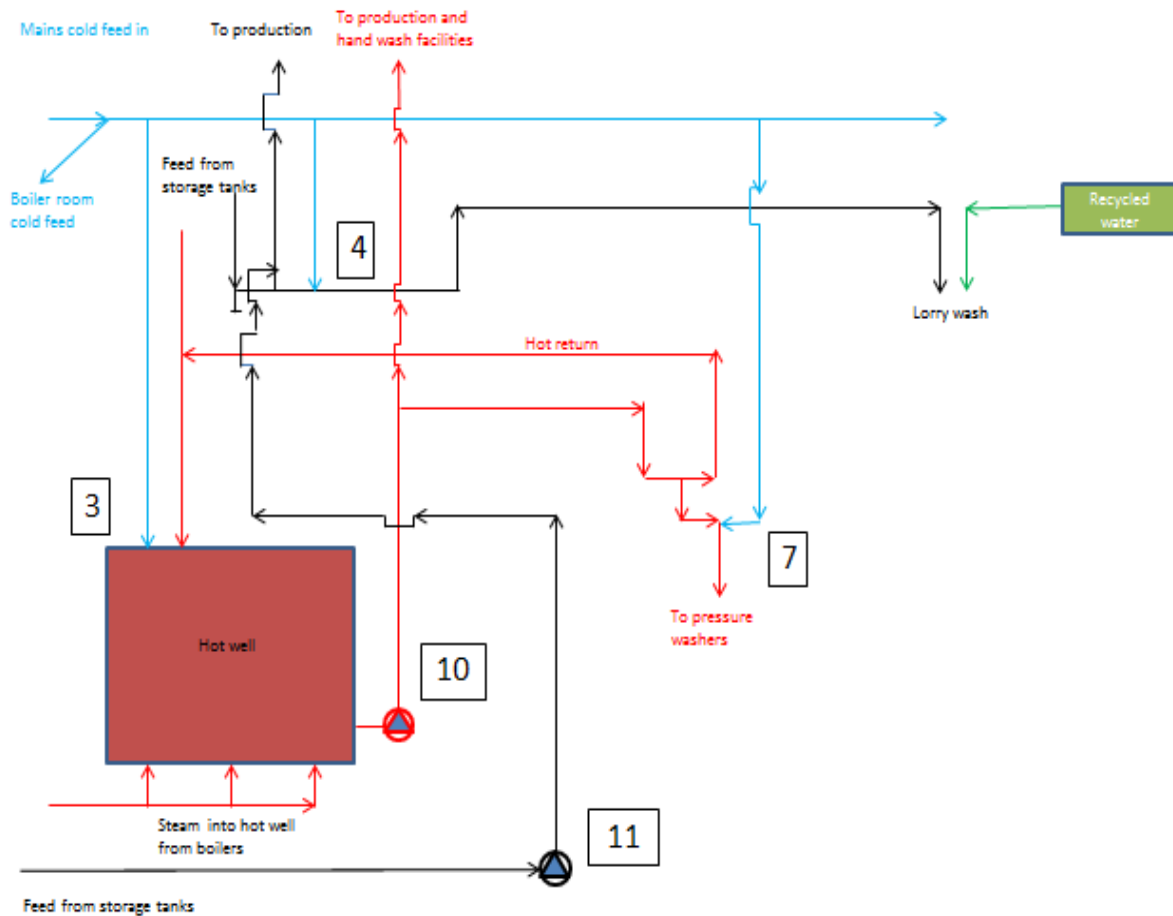


Figure 9: diagram showing cross connections in hotwell plant room with corresponding Figure numbers referenced in this report.

The WRI did not believe that the PPF owner and contractor had intentionally misled the initial investigation but surmised that there was a genuine lack of understanding of the plumbing system layout. The WRI identified the four cross-connections within the PPF as the most likely source of backflow and continued to conduct a full investigation. The PPF were informed that a full written report would be issued upon completion of the inspection. Parallel to this, two WRI carried out investigations in the surrounding area to rule out any further potential sources of contamination. No other premises were found to pose a risk to the supply of drinking water in that area. A list of premises in the area that have been inspected historically is shown in Appendix 23

The WRI inspection of the PPF continued on Saturday 30th and further contraventions were identified. It was confirmed that the PPF had the capability to raise pressure by 16-bar as seen in Figure 10, 11 and 12 below.



Figure 10: pump house



Figure 11: pumped outlet hotwell



Figure 12: pumped outlet storage tank

The PPF had already commenced work on contraventions that had been identified and were advised on site by the WRI. The pipework feeding the storage cistern was modified so that there was a single incoming mains pipe and an AA airgap was created as seen in the before and after images in Figure 13 below.

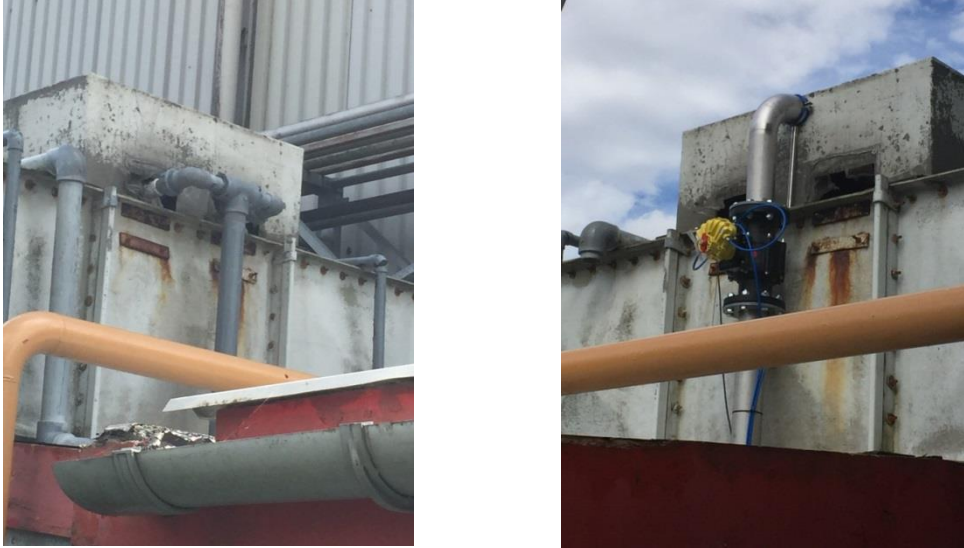


Figure 13: storage tank incoming mains supply before and after modification

The WRI inspection of the PPF resumed on Monday 1st Aug. A site meeting was arranged with the PPF owner and contractor and timescales and a programme of works to ensure compliance was agreed. The work was split into two phases.

The first phase involved modifying the incoming mains pipework to the storage tanks, installing boundary protection by way of a double check valve, and installing zonal protection by way of an RPZ valve. This had a timescale of seven working days.

Phase two involved rectifying all of the remaining contraventions within the boundary of the premises and was given a 28 day timescale.

On the 2nd Aug a full written report for all the contraventions was issued to the PPF owner. This is attached in Appendix 2423. In total 47 breaches of the the Water Supply (Water fittings) Regulations 1999 were identified.

On the 4th Aug the WRI attended site to oversee installation of the RPZ valve. The RPZ valve required the water supply to be temporarily turned back on to test it was operational. However, the incoming mains pipework proved to be arranged in a manner that would not supply the valve. This presented an unacceptable risk that there could be a further cross connection buried underground between the new part of the factory and the pump house.

The WRI instructed that the supply was turned off and presented options before a re-connection would be considered. The PPF chose to abandon the existing supply and install an overland supply.

On the 6th Aug the WRI inspected the new pipework arrangement seen in Figure 14 and 15. Satisfied that phase one of the rectification work had been completed the WRI permitted the water supply to the factory to be re-connected. The installation of the double check valve at the boundary and the RPZ valve to act as zonal protection is shown in Figure 16 and 17.



Figure 14: incoming mains before



Figure 15: incoming mains after



Figure 16: Double check valve installation



Figure 17: RPZ valve installation

The site of the PPF has previously been inspected on two occasions by the Company's Water Regulations team. In September 2007 the site operated under Grampian Country Foods. A WRI identified several high risk contraventions (see Appendix 2524) and following satisfactory resolution the site was subsequently placed in the 5 year re- inspection programme.

In Jan 2012 another WRI was undertaken and at this time the site was under Vion Foods Ltd. The WRI identified that the production part of the factory had closed down in Nov 2012 and only the office block was in use. All machinery had been removed from production areas, canteen, and engineering workshops etc. Due to the low risk contraventions noted on the WRI report (see Appendix 23))? cant find a report NFthe site was placed on the 10 year re-inspection cycle - subject to any new notifications.

It is unclear precisely when the new owners of the PPF moved into the site. Anecdotal evidence from the contractor used by the PPF suggests that installation and pipework layout for the new owners began in August 2015. The managing director of the PPF has stated on several occasions that the site has only been operational since July 2016 and is only at commissioning phase not full production.

The PPF have another factory in Wilsden, Bradford that has been inspected in March 2011. A number of high risk contraventions were identified (see Appendix 26). All contraventions were resolved and the site was placed on a 5 year re-inspection cycle. It is understood that this factory is closing and the production relocating to the site in Doncaster.

YW Approach to Enforcement of Water Regulations

The Company have a targeted inspection programme which is a key part of it's enforcement approach to the Water Regulations and consistent with the hazards recognised in drinking water safety plans. A risk based methodology is used to prioritise all properties for Water Regulation Inspections. The approach considers the likelihood that contamination via backflow into the water distribution network will occur and the potential consequence that an incident may have.

The methodology utilises Standard Industrial Classification codes (SIC codes) to target non-domestic premises for inspection. These are used to classify business establishments and other standard units by the type of economic activity in which they are engaged. The methodology was refined following a two year inspection programme to audit premises representing a broad range of the SIC codes. Each SIC code was then filtered into four inspection profiles to help build a targeted inspection programme. The priority given to each SIC code was then based on direct feedback from the inspections undertaken. A range of factors were used including, number and type of contraventions, environmental factors, site management processes, and types of activity/processes used on site.

The methodology has been shared widely within the water industry at both the Northern and Southern technical steering Technical Steering Groups (TSG's) and has been included as a case study by the WRAS Consistency Working Group.

In 2016, the Company have to date completed 1681 inspections against a target of 1750. As a result 1473 high risk (fluid category 4 & 5) contraventions have been identified in this period with 1446 now resolved.

All slaughterhouses and food processing premises are already classified in the highest priority profile in the Company's existing inspection programme. Given the lack of notification from the PPF, similar sites within the high risk inspection programme are being cross-referenced against the Food Standards Agency (FSA) website of approved food establishments, in accordance with Article 3 of Regulation (EC) No 854/2004. Sites on this register that have not been inspected in the past 2 years will then be prioritised as part of the ongoing inspection programme.

A paper highlighting specific equipment which contravened the Water Regs has been created and will be circulated at the Water Regulations technical steering group (TSG's) meeting in September to raise awareness (a copy of this paper is attached in the Appendix 27).

A wider industry paper, highlighting the need to promote notification and the consequences of a lack of notification, will be circulated through WRAS to support the Reg 5 working group – of which the Company is an active participant.

Notification will continue to be a key message delivered as part of the Company's WR education and engagement programme. The educational seminar has recently been accredited by the Chartered Institute of Building Service Engineers (CIBSE) and a programme of seminars is planned for architects, designers, and facility management firms. Those more directly involved in the plumbing trade continue to be targeted via the training course accredited by the British Plumbing Employers Council (BPEC) and also through the local college education programme for NVQ level 2 & 3 students.

Aspects of Water Regulations under consideration in relation to this Event

The Water Supply (Water fittings) Regulations 1999 set legal requirements for the design, installation, operation and maintenance of plumbing systems, water fittings and water-using appliances. They have a specific purpose to prevent misuse, waste, undue consumption or erroneous measurement of water and, most importantly, to prevent contamination of drinking water.

Part 2 Paragraph 3 (2i) covers specific requirements for 3rd parties relating to the restriction on installation etc. of water fittings. An excerpt is shown below:

3.—(1) No person shall—

(a) instal a water fitting to convey or receive water supplied by a water undertaker, or alter, disconnect or use such a water fitting; or

(b) cause or permit such a water fitting to be installed, altered, disconnected or used, in contravention of the following provisions of this Part.

(2) No water fitting shall be installed, connected, arranged or used in such a manner that it causes or is likely to cause—

(i) waste, misuse, undue consumption or contamination of water supplied by a water undertaker; or

(ii) the erroneous measurement of water supplied by a water undertaker.

3rd parties are also required to notify the water undertaker under Part 2 Paragraph 5 (Table 2 & 3). An excerpt is shown below:

5.—(1) *Subject to paragraph (2), any person who proposes to install a water fitting in connection with any of the operations listed in the Table below—*

- (a) shall give notice to the water undertaker that he proposes to begin work;*
- (b) shall not begin that work without the consent of that undertaker which shall not be withheld unreasonably; and*
- (c) shall comply with any conditions to which the undertaker's consent is subject.*

Table

2. The extension or alteration of a water system on any premises other than a house.

3. A material change of use of any premises.

3.3 Network Investigations.

3.3.1 Network Management

The Company responded to all three of the discolouration contacts from the Food Manufacturer (FM) on each occasion by immediately sending a Network Technician to site to carry out on site investigations to determine the cause of the reported discolouration. Following the initial call late on 27th July the NT who attended did not find any discolouration at the inlet point within the FM premises but following the second call, in the early hours of 28th July the NT observed discolouration at the inlet point at the FM. The NT investigations of the localised network identified warm discoloured water at a hydrant in the localised mains network on Coulman Road Industrial Estate. Following consultation with the Company's Duty Manager, the NT took the action to close a valve on Coulman Road to enable unidirectional flushing of the mains on Coulman Road to be undertaken, enabling discoloured water to be flushed out. Schematics showing the mains system and the valve closed by the NT are shown in Appendices 5.1 and 5.2.

During the morning of the 28th July the NT met the Water Quality Scientist to take samples of the networks around the industrial estate and also in the wider network. The Company's area Customer Services Manager (CSM) was on site at Coulman Road to keep the FM updated of the Company's actions and investigations. The CSM was also in contact with the Company's Water Regulations Inspectors who were carrying out their investigations at the FM and other industrial units on Coulman Road including the Poultry Processing Factory.

Following the contact in the early hours of 29th July the NT who attended and carried out localised flushing on Coulman Road and the area CSM again attended the FM site to meet up with the FM representatives. During the course of the morning the area CSM maintained communications with the Water Regulations Inspectors who again visited the Poultry Processing factory on Coulman Road.

During the Morning of the 29th July, the Company started to receive customer contacts for discolouration and taste and odour from the DMA D521 and DMA D458. It was evident that the issue had now become widespread in the network. At this point the Duty Customer Services Manager in the Regional Control Centre requested for additional NT's to assist in the area and for flushing plans to be drawn up.

The Company's Water Regulations Team confirmed that the PPF had been disconnected from the mains networks at 12:36 due to the contraventions found.

A Schematic Showing the connection of the PPF and the FM to the 6" main in Coulman Road is shown in Appendix 5.4.

At 13:00 The Company Incident Management team met in the Company's regional control room.

Aesthetic checks of the water quality at six different locations on hydrants in DMA 521 was carried out in the late evening on 29th July and the hydrants were found to flush clear and no odour was detected at any hydrant.

The flushing programme for the two affected DMAs was delayed until 31st July for DMA 521 and 1st and 2nd of August for DMA D458 until the Company was satisfied that the probable backflow into the networks had been isolated so that any flushing activity did not run the risk of further backflow into the networks. It was also likely that flushing activity could cause further

discolouration due to unlined mains in the networks which could mask any further discolouration caused by backflow into the network.

In the late evening of the 29th July, and early hours of 30th July, a step test was carried out which indicated that there was no backflow into the system in the isolated area at this time.

On the 30th July, valving carried out on Coulman road the previous day was maintained to ensure a single inlet into the industrial estate. A non-return valve was installed on the inlet main in order to provide further protection to customers.

A Schematic of the position of the installed NRV on the 6" main is shown in Appendix 5.5.

Following further water quality sampling on the 31st July DMA521 was systematically flushed during the evening following the flushing plans provided by the area Network Technical Support Engineer. The flushing was carried out passively to avoid discolouration from disturbance of historic sediment causing any further concern for customers. As the flushing programme was extensive, this only allowed for only DMA 521 to be flushed during the evening.

On the morning of 1st August, DMA 458 which has an extended network was flushed and this flushing programme continued into the 2nd August.

The flushing programmes carried out 31st July – 2nd August within the two affected DMAs were carried out using flushing times calculated by the Network Technical Support Engineer based on achieving two turnovers of water in the mains. Both digital and mechanical flow meters were used to determine accurate flow rates. The flushing was monitored so that the peak flow rates for the DMAs were not exceeded and customer contacts were monitored alongside the flushing activities by the Network Controllers in the Regional Control Centre.

A schematic of the layout of mains networks for DMAs D521 and D458 are shown in Appendix 13

Schematics indicating the flushing points in the DMAs of 521 and 458 between 31st July and 3rd August are shown in Appendix 14

Water quality sampling results were reviewed on a daily basis along with the activities being carried out in the networks. The results indicated that the flushing activities carried out on 31st July and 1st 2nd of August were being effective to improve water quality however it was noted that there were persistent coliform detections from customer properties on Moor Edges Road. Chlorination of this 2 Km length of 3 and 4 - inch main was carried out during the early evening of 2nd August following the fitting of a hydrant at the end of the end of main to allow the main to be flushed out.

On 3rd August an area within DMA D458 was flushed again following the area being targeted based on a review of the water quality sample results. The flushing of this area involved some valving and installation of new a new hydrant.

3.3.2 Hydraulic Assessment.

During the afternoon of the 29th July an assessment of flow into the affected zones was made by one of the Company's Leakage and Compliance Managers. It was observed that the minimum night flow from the upstream Thorne Water Tower and the inlet meter to DMA D521, on both the 28th and 29th July, was approximately 4 l/s lower than on previous days. This observation suggested that either a significant burst had been repaired or there was a potential of an import of up to 4 l/s into the local DMA 521 from an unknown source. The DMA areas of D521 and D458 were checked for burst repairs but none were noted. This information supported the view of the earlier Company's incident management team that backflow may have occurred. It was also noted that the night flows had not deviated by this level in the previous twelve month period.

A trend of the Thorne Water Tower flow and the DMA D521 inlet meter flow are shown in Appendix 9.1 -9.2.

It had already been established that the pressure in the affected mains system is lower during the night flow period as Thorne WPS does not operate in this period and the Water Tower supplies directly to the area.

A trend of Pressure and flow in DMA 521 is shown in Appendix 9.3. Unfortunately flow data is not available as the inlet flow meter for the downstream DMA458 was out of order at the time of the event. The pressure trend confirms there had been no depressurisation leading up to or during the event.

A pressure step test was carried out on the late evening of the 29th July. This was a single step isolation which included Coulman Road and Moor Edges Road and the Poultry Processing Factory, the pressure was observed to drop to zero, indicating that there was no backflow into the system in the isolated area at this time.

Examination of the flow data at Thorne WTR WPS outlet and DMA 521 inlet data from the 30th July onwards, showed that the night flow at both Thorne Water Tower and the DMA D521 inlet meter returned to normal levels. This suggested that the isolation of the Poultry Processing Factory on 29th July had eliminated the issue.

The flow through the inlet meter to DMA D521 remained positive throughout the incident and with the initial discolouration contacts being on the industrial estate in Coulman Road this pointed to the likely source of the problem being between the inlet meter to the DMA 521 and the Food Manufacturer's premises.

A network model was run by the Company to evaluate the likely pressure required to change the night flow of the system by 3 to 4 l/s and to trace how contaminated water might be distributed through the network. It was demonstrated that for a flow of 3 to 4 l/s to be generated into the network on Coulman Road at the location of the Poultry Processing Factory, a pressure of approximately 30 meters head during the night time period would be required. However, at this pressure there would be no inflow to the DMA from this source between approximately 06:00 hrs and 02:00hrs due to the increased pressure from Thorne WPS which would be running to meet demand.



Figure 18 snapshot from hydraulic model of scenario

The mains system around Coulman Road industrial estate is such that it normally operates as an open system. On the 27th and 28th of July (before the mains configuration was changed by the closing of a valve (V1), the network model showed that contaminated water could be distributed into the mains networks around the industrial estate towards the Food Manufacturer as well as to the rest of the DMA. However it seems likely that the majority of any contaminated water from a backflow on Coulman Road on the 28th July would have been preferentially drawn down the 6" main towards the Food Manufacturer as it was drawing water in the early hours for its process.

When the configuration of the mains system around Coulman Road was changed in the early morning of 28th July by the closing of a valve (V1) it was then more likely that any further backflow into the network could take a different route on the 6" main and be transmitted both locally on Coulman Road and also could more readily impact the downstream networks. This could explain why (apart from the FM) there had been no customer contacts for discolouration or taste and odour until the morning of 29th July.

It is likely that the flushing carried out by the Network Technician in the early morning of 28th July on Coulman Road removed a significant amount of the backflow from the mains networks.

Schematics of the mains around the Industrial Estate are shown in Appendix 5.1 - 5.4.

A Screen shot of a point in time on the networks model is shown in Appendix 15.

3.4 Customer contacts

Advice to boil the water was issued to 3440 domestic customers and 208 commercial properties. See Table 1 below

DMA	No. of Domestic Properties	No. of Domestic Properties	Total
D521 Thorne 3	1298	123	1421
D458 Thornmoorends	2142	85	2227
		total	3648

Table 1 – populations of affected areas.

During the Event the Company received contacts from customers in connection with discolouration and or taste as shown in Table 2 below.

	D521		D458		Total	
	Discoloured	Taste and Odour	Discoloured	Taste and Odour	Discoloured	Taste and Odour
27/07/2016	1	0	0	0	1	0
28/07/2016	0	0	0	0	0	0
29/07/2016	8	4	9	6	17	10
30/07/2016	0	0	0	1	0	1
31/07/2016	0	0	0	0	0	0
01/08/2016	1	0	1	0	2	0
02/08/2016	1	0	0	0	1	0
Total	11	4	10	7	21	11

Table 2 - Discolouration and Taste and Odour Contacts per affected DMA.

As one might expect there was a significant increase in customer contacts during the event. From 29th July until 24th August the total number of contacts from the DN8 area was 3502, made up predominately of the following;

Discolouration	68
Taste and Odour	132
Illness	90
Boil notice	2593
General info	466

A detailed breakdown of the contacts is available in Appendices 16-17

3.5 Customer Management

The Company reviewed its strategy with regard to issuing written advice to customers in Autumn 2015. The contingency service (The Service) has been put in place by the Company's Emergency Planning team (YWEP) for any future water quality incident that require a written notice to be delivered by Royal Mail to a customer billing address.

There are 250,000 pre-printed and enveloped BWA notices (plus 250, 000 rescind notices) held in stock by Paragon Group UK (PGUK) on behalf of YW, together with agreed templates for DND and protocols for using the Service. The procedure is shown in Appendix 17.

The decision to issue advice protecting public health was made by the CIMT. The Company's website was updated with the "do not drink" advice. At this time a webpage dedicated to this Event was set up, with a highlighted link on the Company's main website.

The Company also has over 100,000 copies of DND advice held securely at the Bradford Depot. When these notices were accessed it was discovered that some of the information held on the letters was inaccurate (did not reflect the current Company structure) and therefore could not be used. The Company printed DND notices in Bradford during Friday evening and these were then hand couriered to Nutwell WTW overnight.

On the morning of Saturday 30th July delivery of written 'Do Not Drink' notices was commenced to the 3648 affected properties.

Once further information was made available, the Company was able to reassess the risk to customers and a decision was made to replace the DND with BWA. The change to BWA was communicated to customers via SMS text updates, social media, the Company's website and traditional media. Coordination was carried out with stakeholders, and Company staff were available to advise customers

Boil water advice letters were hand delivered by YW staff to affected properties on Sunday afternoon.

The Company worked with other agencies, Doncaster MB Council and British Red Cross, during the event to ensure that vulnerable customers were supported. Customer teams worked jointly with these agencies to provide a 'door -knocking' service to give advice and bottled water.

The Company also provided customer liaison and support by placing some staff at a large local supermarket.

Business customers were included in all communications, with an additional proactive contact made on Monday 1st August.

During the event additional staff were brought in to the Company's call centre to allow the management of additional customer contacts. (An additional 10 people were provided on Saturday 30th July and a further 11 on Sunday 31st July, working extended hours). Additional staff were also provided in the Bradford Control room.

The provision of temporary alternative water supplies (TAWS) to the affected areas was a key response to the issue of protective advice. Two locations, one in Thorne and the other in Moorends were identified for the deployment of bottled water. These supplies were deployed at 17:00 29th July and throughout the event. The Company also made use of its Arlington water units. These were deployed at the Trinity Academy and could be filled using tankers. See Appendix 21 for the temporary alternative water supplies log.

During the event the Company met the DEFRA Security and Emergency Measure Directive (SEMD) on TAWS. The Company made available a total of 242,160 litres TAWS, significantly above the minimum requirement.

SEMD requirement for 3,600 in 24 hours = **82,800 litres**

YW TAWS supplied in first 24hours = **242,160 litres**

600 customers impacted x 2.3 (people occupancy rate) x 10 = 82,800 litres required.

Within 24 hours, YW deployed and made 221 pallets of water available to Thorne 960litres. $221 \times 960 = 212,160$ litres of bottled water deployed.

And deployed Arlington Tanks which were filled with 30,000 litres of tankered water.

The Company requested mutual aid (from UU and Severn Trent) with regard to TAWS (bottled water). The request was made in the early stages of the event due to the uncertainty around the cause and duration of the event. Severn Trent provided details of their supplier of bottled water (Water Direct). This supplier provided water to the Company during the first 24 hours of the event.

On the morning of Thursday 4th August following the receipt of clear bacteriological results from the previous days samples agreement was obtained with PHE and EHO to lift the Boil Water Advice to all customers. Rescind notices to lift the BWA were issued on Thursday afternoon via letter drop to all affected properties.

3.6 External Communications

The Company kept the following media outlets updated with events in Thorne / Moorends:

Radio: BBC Radio 5 Live, BBC Radio 4, BBC Radio Sheffield, Hallam FM

TV: BBC Look North, ITV Calendar

Newspapers: Yorkshire Post, Sheffield Star, Doncaster Star, Doncaster Free Press, South Yorkshire Times, Thorne & District Gazette, Thorne Times, Goole Times

This resulted in extensive national as well as regional coverage about the incident covering TV, radio, newspapers and online news. In total, there were over 300 media articles about the Event, most of which was largely negative in sentiment. High profile interviews were carried out by Yorkshire Water spokespeople on BBC Radio 5 Live and a live studio interview at ITV Calendar News.

A total of 10 media updates were made throughout the duration of the incident and on each occasion were sent to the media outlets listed above. All media updates were immediately shared with the Company's call centre to help them respond accordingly to the high influx of customer calls via telephone and social media.

Media updates timeline:

Friday 29th July (3pm): Customers told not to drink water. Bottled water collection points listed. Affected post codes listed.

Saturday 30th July

- 08:00 Customers told to continue not to drink water and that 'do not drink' letters were posted. Bottled water replenished at collection points.
- 16:00 Do not drink notice downgraded to a boil order notice. Chlorine levels increased but safe to drink once boiled. Collection point centralised to Trinity Academy School.

-

Sunday 31st July:

- Boil order to remain in place throughout Sunday.

Monday 1st August

- 12:00 Boil order to remain in place throughout Monday. Warning about bogus callers.
- 16:00 £30 goodwill gesture announced to thank residents for their patience with the situation.

-

Tuesday 2nd August

- 16:00 Boil order remains in place. Investigations into the cause progressing well.
- 17:00 Boil order to remain in place until at least Thursday.

-

Wednesday 3rd August

- 13:00 Bacteria revealed as *E.Coli* and source of it found in Coulman industrial estate.

-

Thursday 4th August

- 11:00 Tap water declared safe to drink. Physical barriers placed around source to stop it contaminating water again.

The Company's interviews with the media:

A total of 12 media interviews were carried out with TV and radio throughout the duration of the Event. This included national radio, but most of the interviews were with regional TV and radio stations.

Friday 29th July:

- Interview with Hallam FM

Saturday 30th July:

- Interviews with ITV Calendar News, BBC Radio 4, BBC Radio 5 Live

Sunday 31st July:

- Interviews with ITV Calendar News and Hallam FM

Monday 1st August:

- Interviews with BBC Radio Sheffield, BBC Radio Humberside, Capital FM, ITV Calendar News.

Wednesday 3rd August:

- Interview with Hallam FM

Friday 5th August:

- Interview with Sheffield Star

Website – dedicated Thorne web page created

A dedicated webpage was created for customers to read updates on the situation. This was <https://www.yorkshirewater.com/thorne>, which went live on Friday 29th July at 3pm. It was a vital way to update customers on the situation and give advice.

A highlighted section of the homepage also directed customers to this webpage.

The webpage was regularly updated at the same frequency as the media; ten times in total. It included details of the post codes affected, maps of the collection points, PDFs of the letters sent out and general important updates on the situation. Throughout the duration of the Event there were 43,804 visits to the Thorne web page, making it the most visited page on the Company's website.

Website issues

During the Thorne Event the Company realised that there was an issue with the website. Although the digital team had updated the website to communicate the Event (including the creation of a dedicated Thorne page), the changes on the website were not visible on certain devices by certain people. It quickly became clear that it was a server issue, as there were no errors on the Content Management System (CMS) itself and when logged in to the CMS the new updates were visible and appearing as published.

The website changes would be published on one of the servers but it was then not replicating properly across the remaining servers, with the result that different customers were seeing different things depending on which server they were accessing. For example, some customers could see the new Thorne page but for others the page was not yet available. In normal conditions the replication across servers should happen fully and with a maximum of 30 minutes delay.

A few hours into the incident a work around was put in place which meant that every time the Company's communications team updated the website, the IT department was informed and they

would then immediately flush the cache on all servers which resulted in the website being made available to everyone.

A number of issues were identified by the Company's IT department which may have contributed to the technical issues experienced during the incident. These included:

- One of the servers seemed to have temporarily been out of service - probably as a result of the surge in traffic on 29th (three times the normal levels)
- A routine core and module patching exercise had been performed on 21st July. This was deemed to have been successful at the time but then the IT department noticed that it had not applied fully on the database. However, it is not conclusive if this is a contributing factor or not.
- One of the settings within the "Wincache" module was identified as one of the possible reasons behind the issue which is now being tested.

Social media

The social media channels used during this Event to communicate with customers were Facebook and Twitter.

Facebook and Twitter were updated following each CIMT meeting, along with additional general updates regarding the situation. There were several updates made each day throughout the Event.

Social media engagement with customers throughout the incident was very high. For example, 16,854 visitors to the Thorne webpage (38%) came from the Company's social media channels, highlighting the importance of social media as a means of communication during the Event.

Many posts were shared or re-tweeted dozens of times and also attracted a lot of customer comments. The average engagement rate with the Company's social media posts relating to this Event was 8.16% (typically the average is 2%, four times higher than usual and highlights the effectiveness of social media during this Event).

Negative social media comments made by customers focussed on their frustration at the incident and also confusion about whether the 'do not drink' or boil order notice applied to their own address. The Company's dedicated social media team at its call centre tried to respond to all customer queries posted on social media as quickly as they could.

Stakeholder Contact / Briefings

Regular briefings were sent to the following stakeholders:

- Caroline Flint MP – asked to be kept up to date by text and email.
- Ed Miliband MP – asked to be kept up to date by text and phone calls.
- Cllr for Thorne: Mark Houlbrook – asked to be kept up to date by phone calls

- Jo Miller – Chief Exec of Doncaster Council – updated by emails
- Cllr for Moorends: Susan Durant – updated by emails
- Thorne and Moorends Town Council: Clerk - Jeremy Sherlock – updated via email.

Following the initial contact with stakeholders on the evening of Friday 29th July, a total of 14 updates were sent to the above stakeholders via their chosen method between the Friday and Thursday 4th August.

5 Assessment of the quality of water supplied

During the Event and following the rescindment of the BWA a total of 200 samples were taken from domestic properties, commercial sites, hydrants and the supplied bottled water (see Appendix 1). Chart 1 illustrates the daily distribution of samples taken over the period of fourteen days before and after the Event. This period runs from when the first sample was taken in association with reported discolouration until after the boil water advice was rescinded and a reduced number of samples were taken in response to localised concerns.

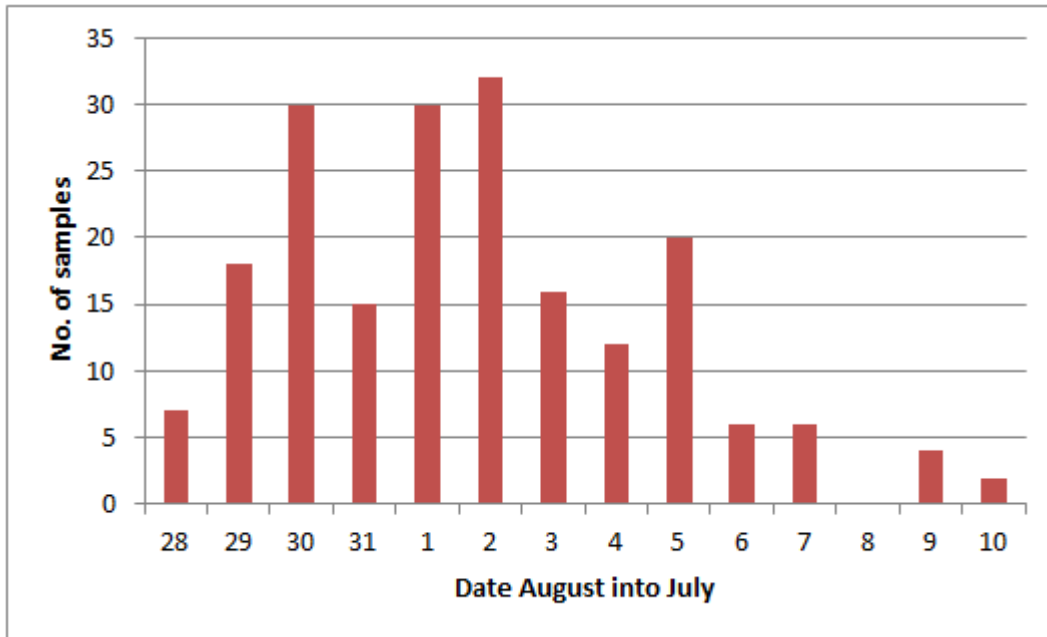


Chart 1 Distribution of daily samples taken during the event

The normal water supply to the area affected by this event comes from Nutwell WTW, a chloraminated borehole source. Normal background values for physico-chemical parameters are given in Table 3 below:

Parameter	Typical concentration or range
Aluminium	<10 µg/l
Iron	<5 µg/l
Manganese	<5 µg/l
Ammonia	0.03 – 0.10 mg/l
Nitrite	0.05 – 0.15 mg/l
Nitrate	20 – 30 mg/l
Phosphorus	920 – 980 µg/l
Turbidity	<0.10 NTU
Colour	<2 Ha
Conductivity	460 – 500 µS/cm
pH	7.50 – 8.00

Table 3 Thorne area typical physico-chemical parameter concentrations

Glossary of sample points:

FM mains inlet: an open ended plastic pipe connected to the mains water feed where this enters the site within an outbuilding on the perimeter of the FM premises.

Hydrant H1: The hydrant outside the PPF on the 6” pipework around the Coulman Rd industrial estate.

Hydrant H2: The hydrant on the 6” pipework in Coulman Rd, between the PPF and the FM.

PPF Hotwell: Tank with mains water feed storing heated water for supply to plant. A check valve was fitted to the supply following the water regulations inspection.

PPF Storage Cistern:

Tank with mains water feed storing water for supply to plant. Following the water regulations inspection, the mains feed pipework was reconfigured to provide an AB airgap as acceptable backflow protection.

- ❖ Coliform, *E.coli* and *C.perfringens* results given below are colonies per 100ml of sample volume.

28th July

The first sample was taken at 00:15 by the Network Technician (NT) who attended the initial discolouration customer contact made by the Food Manufacturer (FM) late on 27th July. The sample was taken from the FM canteen cold tap and was analysed for bacteriological indicator organisms, physical parameters and metals. The results for this sample were all compliant and as expected in terms of chemistry for the water supply to that area. This confirmed the NT's observations on site during that initial visit that the supply to the FM appeared acceptable at that time.

A further six samples were taken between 09:00 and 11:25, following a further call from the FM concerning discoloured water. Five of these samples were analysed for bacteriological indicator organisms, with three of the samples being positive for coliforms, two also confirming for *E.coli*. The highest count of 94 coliforms, 66 *E.coli* and 16 *C.perfringens* was obtained from Hydrant H2 on Coulman Rd, between the FM and Poultry Processing Factory (PPF). The mains inlet to the FM had a count of 2 coliforms and 1 *C.perfringens*. The sixth sample analysed at this time was from a sample of discoloured water retained by the FM. This was only analysed for metals, which were significantly above the baseline level for mains water in that area, particularly iron at 189 µg/l and zinc at 128µg/l.

The bacteriological results from the above round of sampling were reported on 29th July and in association with the rapidly increasing number of customer contacts from the wider Thorne and Moorends area within DMAs D521 and D458 prompted the decision to issue Do Not Drink advice to the impacted area. This decision was made in the absence of any organics analysis available at that time.

One of the samples taken from Hydrant H1 on Coulman Rd, close to the PPF, had a significantly elevated phosphorus level, at 1788 µg/l. The expected level in that area, in direct relation to the applied dose at the supplying WTW is 950 – 1000 µg/l and the majority of samples taken in association with this event had phosphorus levels within this range.

A sample retained by the FM of the discoloured water was analysed separately for phosphorus, with a result of 14900 µg/l. This sample also had a zinc level of 128 µg/l. Zinc concentrations >10 µg/l were obtained from the FM canteen tap and two hydrant samples.

29th July

Eighteen samples were taken on 29th July, although four of these were sub samples from the FM's own retained discoloured sample taken from the site mains inlet on 28th and 29th July. These samples were analysed for chemical parameters, including phosphorus, sulphate and nitrogen to increase the chemical fingerprint and allow comparison to be made with water taken from other locations. Both of

Of the fourteen samples analysed for bacteriological indicator organisms, three were positive for coliforms, *E.coli* and *C. perfringens*. These were taken from the FM and nearby hydrants on Coulman Rd. These samples also had elevated turbidity, iron and manganese and, notably, phosphorus. The highest concentration of phosphorus of 4027 µg/l was in the sample taken from Hydrant H2, between the PPF and the FM. This sample also had a corresponding true colour of 10.7 Hazen, which is anomalous in comparison with the typical value of <1.0 Ha in that area's supply.

Four samples taken from customer properties in both affected DMAs were positive for *C. perfringens* but not coliforms. The contemporaneous phosphorus concentrations were slightly above the baseline for the area in three out of the four samples. Phosphorus levels were also appreciably higher in two other customer samples but these did not report with associated positive coliform or *C.perfringens*. However, the 2- and 3-day total viable counts (TVC) and non-lactose fermenters (NLF) were significantly elevated in those samples compared with typical results for that distribution system, indicating the presence of an enhanced microbial loading.

30th July

Thirty samples were taken in total, the majority of which were from domestic properties. One of these samples was positive for *E.coli*, with a 1:1 result and five were positive for *C.perfringens* in single figures.

Samples were also collected from the PPF hotwell and storage cistern by the Water Regulations Inspectors (WRIs) but unfortunately not analysed for bacteriological parameters. The WRIs do not routinely collect samples and did not possess the necessary equipment to collect representative bacteriological samples. These samples from the PPF were analysed for physico-chemical parameters, the highest concentrations of which were of the same type that were elevated in the samples obtained from the Coulman Rd hydrants, FM and domestic properties. The most consistent of these parameters was phosphorus, with a result of 5210 µg/l obtained from the storage cistern. Zinc levels were around 50 µg/l in both hotwell samples and 93.3 µg/l in the storage cistern. By way of comparison, significantly elevated zinc levels were found in Coulman Rd hydrant samples taken on 28th July and in particular in the sample of discoloured water retained by the FM on that day.

The samples from the PPF tanks also showed comparatively high levels of ammonia (2.0 mg/l from the hotwell and 0.2 mg/l from the storage cistern) and nitrite at almost 0.4 mg/l from both tanks. A nitrate result of 44.2 mg/l was recorded from the storage cistern.

Results of the FM's own discoloured samples from 28th and 29th July were elevated for ammonia (max 0.164 mg/l on 28th July) and nitrite (max 1.54 mg/l on 28th July). Nitrate levels were also significantly higher than is typical of the supply water. The sample from 28th July contained 71.3 mg/l nitrate and the sample from 29th was 41.4 mg/l.

Attempts were made to sample from those properties that did not meet regulatory levels from samples taken on 29th July. Of these properties, it was only possible to gain access to two original addresses (10 Darlington Gr and 41 Alexandra St) but samples from all four failing streets were collected. Darlington Gr and South Rd samples were positive once again for *C.perfringens*. Micklethwaite Rd and Alexandra St were clear of indicator organisms on this occasion.

All addresses with non-compliant samples were subsequently re-visited as part of the investigation until access could be gained and compliant results had been obtained.

31st July

Fifteen samples were taken, thirteen from domestic properties in the two affected DMAs and two from hydrants on Coulman Rd. The hydrant samples were clear for coliforms and *C.perfringens* but did have elevated NLF counts, with a maximum of 236 /100 ml from the hydrant between hydrants H1 and H2. Neither of these samples were analysed for physico-chemical parameters at that time.

Of the six properties with non-compliant samples on 30th July it was possible to obtain follow-up samples on 31st July from two: Longmeadow Farm and Nunmoor Farm, both on Moor Edges Rd. However, both samples were positive for coliforms and *C.perfringens* in low numbers.

A compliant sample was obtained from 26 Church St but not this was not from the address which was positive from 30th July.

One other sample was positive for coliforms but not *C.perfringens* and a fourth sample, from 8 Coulman St (just to the north of the industrial estate) contained a single count of *C.perfringens*.

Physico-chemical results from those domestic properties were generally within the expected range, with the exception of the sample taken from 8 Coulman St. The phosphorus level in this sample was 1210 µg/l, which is significantly above the expected and comparative results for that area of 920 – 980 µg/l, indicating the presence of a supplementary source of phosphorus in the mains water at that time.

1st August

Thirty samples were taken on 1st August, again predominantly from domestic properties. Four of these samples were non-compliant for indicator organisms. One of these samples, from 1 Newfields Ave, had a count of 20 coliforms, 13 E.coli and 28 *C.perfringens*. The sample had a contemporaneous turbidity result of 48.5 NTU, with associated elevated levels of iron, manganese and aluminium. It was subsequently confirmed that this sample had been taken whilst flushing activity had been taking place in and around Newfields Ave, thereby temporarily concentrating a proportion of the mains contamination in that location at the time of sampling. Compliant samples were subsequently obtained from this property and another in Newfields Ave on 2nd August.

It was possible to obtain two samples from Nunmoor Farm on 1st August, one at 14:15 and a further at 19:10. The earlier sample had a 1:0 coliform count but the second was clear of indicator organisms.

A further two samples were positive for indicator organisms: Four Winds Farm (on Moor Edges Rd) with a single coliform and 12 Micklethwaite Rd with 3 *C.perfringens*.

The available physico-chemical results were all within acceptable limits with the exception of 1 Newfields Ave discussed above.

2nd August

Thirty two samples were taken on 2nd August from the affected DMAs, with a particular emphasis on farms on Moor Edges Rd. This was due to the apparent concentration of contaminated water in that particular section of mains network, the single 4" - 3" diameter main of which effectively forms a "dead-leg", terminating in a closed valve after approximately 2km.

All samples were clear for coliforms. However, single counts of *C.perfringens* were found at 7 Thrislington Sq and Four Winds Farm.

A further compliant sample was obtained from Nunmoor Farm and from Micklethwaite Rd, although this was taken from No.17, as access could not be gained from No.12 on 2nd August. A compliant sample was subsequently obtained from No.12 on 3rd August.

Physico-chemical results were within acceptable ranges. Elevated levels of zinc were reported from a sample taken from Barnsley Rd, Moorends but the origin of this may have been the customer's tap, as is commonly the case.

3rd August

Sixteen samples were taken on 3rd August. One of these had a result of a single coliform from the kitchen tap at 13 Locarno Rd. This sample was one of three taken in response to a customer illness contact. As per the Company's usual procedure for illness sampling, at the time of the visit a further sample was obtained from a second tap at the property in question (a bathroom tap on this occasion) and a neighbouring property. Free and total chlorine readings associated with all three samples were similar, thereby giving confidence that they were all representative of mains water. This also provided some evidence to conclude that the 1:0 coliform count obtained from the kitchen tap may have been caused by localised domestic tap/pipework contamination rather than being symptomatic of persisting contamination within the distribution network.

No further non-compliant samples were reported from Locarno Rd. Samples were obtained from other properties in Locarno Rd on 4th and 5th August and two samples were eventually obtained from 13 Locarno Rd on 6th August.

Physico-chemical results were all within acceptable range.

4th August

Twelve samples were taken on 4th August, the date on which the Boil Water Advice was rescinded.

One of the samples taken, from 47 Newfields Ave, had a 1:0 coliform result. However, this may also have been due to localised domestic tap contamination, as the sample had low numbers of associated NLFs and no TVCs. Samples associated with the network contamination typically had significant NLF and TVC counts. The same address had also been sampled on 3rd August and was found to be compliant.

It was not possible to gain entry to 47 Newfields Ave immediately following this positive coliform detection. However, two samples were taken from 45 Newfields Ave and one from 49 Newfields Ave on 5th August and all three samples were compliant.

5th – 10th August

Thirty eight further samples were taken between 5th and 10th August inclusive and all were compliant, with the associated physico-chemical results as expected for that water source. NLF and TVC counts had also returned to expected background levels, providing confidence that the contamination had been purged from the distribution network.

Flow cytometry

Flow cytometry (FC) analysis was performed on samples throughout the course of the Event, although not on the initial hydrant and FM samples on 28th and 29th July. The reason for this was that up to this time the nature of the Event was considered to be one of local mains network disturbance, rather than third party contamination.

Where FC results were available with contemporaneous coliform and *C.perfringens* data, some samples had a significantly elevated total cell count in association with positive coliform and

C.perfringens detections, particularly where these were >10/100ml. FC values were higher where associated NLF and TVC counts were also significantly elevated, which appeared to be associated with the spread of contamination of the wider distribution network, even in the absence of positive coliform and/or *C.perfringens* detections.

The typical FC values in the affected area are in the region of 20,000 cells/ml Total, with 500 – 2000 Live cells. During the event, the sample containing the highest number of indicator organism, from 1 Newfields Ave on 1st August, had a count of 893,040 Total and 38,780 Live cells per ml.

Bacteriological identification analysis

During this Event, bacteriological samples were archived with a view to additional investigations to link both the potential source of the pollution and the distribution network.

These bacteriological samples were assayed by various means with a view to providing species or strain specific information. One organism potentially in common between the PPF and the mains network appeared to be *Aeromonas veronii*. However, the matrix assisted laser desorption/ionisation (MALDI-TOF) mass spectrometry method used to attempt to match the DNA of the organisms found at the PPF and in the mains network proved inconclusive.

The samples selected were those from the PPF taken on 30th July and those from the hydrants nearby on 29th and 30th July.

5 Assessment of Public Health Impact

In reviewing the potential impact of the Event we have aimed to base this on validated data, from results of analysis, health practitioner referrals and pathology results. In this type of Event it can be difficult to interpret the significance of customer contacts in relation to illness. Indeed a recent BWA Event in a neighbouring company doubled the numbers of illness contacts received by YW, despite being geographically unrelated. However, these are still considered in detail as the “worried well” can be a significant issue for both Company and PH specialists. In discussion with PHE a final review of potential illness cases will be undertaken in early September. This will include a review of all GI cases from the affected area, and compare the incidence of disease, prior to, during, and following the Event. It is considered that a month of baseline data, either side of the period of interest is the minimum required to allow a reasoned assessment of impact. This outcome review will be briefed to relevant parties.

5.1 Sample Result Evidence

On the late evening of the 27th July the Company received a call regarding discolouration of water supply from a business customer located on Coulman Road Industrial Estate. Subsequent investigation has identified that this discolouration was associated with contamination of the Company’s mains network by a third party. The first instance of discolouration appears to have rapidly cleared, and indeed a sample taken by that business customer reporting the discolouration at 00:15 on the 28th July was found to be free from any indicator bacteria.

Unfortunately, discoloration of supply recurred in the early hours of the 28th July. At this stage an attempt to clear the local distribution network was carried out by the standby Network Technician.

Again it was found that the discolouration cleared. Samples taken at the hydrant at which flushing was taking place and another nearby hydrant were found to contain the indicator bacteria coliforms, *E. coli*, and *Clostridia perfringens*. In the context that the likely source of this bacteria is now known the Company takes this evidence to indicate that the water consumed from this point in the network could have contained microorganisms which could have put health at risk. In this regard, it is relevant to note that samples of water were discoloured, and this would have influenced customers propensity to consume such water in significant quantities.

It is also relevant to note that samples collected in the morning of the 28th July from hydrants in neighbouring areas of the network outside of Coulman Road Industrial Estate were found to be absent of any indicator bacteria. The arrangement of the mains network at this stage provided two imports into the industrial estate. Therefore, it is considered that it is unlikely that the contaminated water entered the mains system supplying the vast majority of customers in DMAs D521 and D458, but instead was drawn into the local areas of network in the industrial estate due to the demand exerted by the FM Factory. Hence, the risk to consumers on the 28th July was probably limited to a small number of non-household customers.

In the early morning of the 29th July discolouration was again observed in Coulman Road Industrial Estate. Flushing and sampling was again carried out, and the presence of faecal indicator organisms was subsequently reported. Although the Company responded rapidly to this report of discolouration the closure of the valve restricting flow to be only via the southern end of the industrial estate had altered the flow of discoloured contaminated water. Consequently, on Friday 29th July discoloured water had the potential to enter the supply to all customers in DMAs D521 and D458.

It is notable that although faecal indicator organisms were detected in samples collected from hydrants in Coulman Road Industrial Estate, none of the samples collected from customers properties on the 29th July contained *E. coli*. This includes a sample collected during the afternoon from a customer reporting illness. A subset (4 of 11) of samples collected from customer's properties on the 29th July contained *Clostridia perfringens*.

The Company considers that this sample result evidence indicates that there was presence of unexpected micro-organisms in water supplied via the Company's network on the 29th July. The specific bacteria detected are not in themselves likely to constitute a significant impact on the health of consumers, and, although the risk was significantly reduced compared to the quality of water in mains network within the industrial estate, an impact on the health cannot be ruled out.

From mid-afternoon on the 29th July customers in the affected DMAs were advised to take health protection measures and alternative water supplies were made available. From this point onward there should have been no impact on the health of consumers. In fact, the quality of water in samples was predominantly compliant with normal standards of water quality.

One sample collected during the 30th July was found to contain 1 *E. coli* per 100ml. However following this no further *E. coli* was detected, excepting one sample collected during a period of flushing designed to remove contamination from within the mains system. *Clostridia perfringens* were infrequently detected until the 3rd August. However, the advantage of this organism is not due to its direct impact upon health but because as a spore former it is relatively resistant to chlorine and hence is a good indicator of contamination which is temporally or spatially distant from the point of sampling. In normal circumstances it is a good trigger to prompt investigation into the source of potential contamination. However, in this case the potential source of contamination was known and had been removed on the 28th July.

A positive dialogue was maintained between the Company, its independent medical advisor, and Public Health England. By mutual agreement it was determined that by the 4th August sufficient evidence was available to remove the health protection advice for customers.

Subsequently, on the 5th August two separate samples analysed on the 4th August were reported as containing coliform bacteria only. Neither of these samples contained faecal indicator organisms. Follow up samples at both locations indicated the absence of bacteria. Hence, it is most likely that these detections represent contamination of domestic fittings due to the prior standard of water in the mains network. It is not considered that either of these detections represents a significant risk to health of consumers.

5.2 Choice of Monitoring Strategy to protect public health

It is not practical, or indeed possible, for water companies to undertake analysis of water samples for all known pathogenic organisms. Indeed, in this case as the likely source of the contamination was not known at the point the greatest contamination was identified this further restricted the ability to identify specific pathogens. Instead the approach taken by water companies is to test water samples for indicator organisms. The primary indicator is *E. coli*.

Although *E. coli* bacteria have previously been associated with health impacts upon consumers that is not considered to be directly relevant in this case. The virulence of *E. coli* varies between detected strains. However, at the concentrations detected in water samples it is likely that many 100's of ml, if not litres, of the mostly highly contaminated water would have to have been consumed in order to have an impact on health.

In this Event the primary advantage of testing water samples for *E. coli* is that this organism is found in the guts of most animals, and it is therefore considered that its detection in water samples is good evidence of contamination from faecal matter. Evidently, faecal matter is likely to contain other organisms which could be pathogenic, however, they are generally present in lower numbers. Hence, following the Event it has been possible to make an assessment of the likely impact on the health of consumers.

5.3 Presentation to Medical Establishments

The Company has maintained a close liaison with Public Health England throughout the course of the Event in order to identify if the contamination caused to the Company's network had resulted in increased levels of illness in the community. Initial indications suggested that there had been an increase in the number of "worried well" presenting to medical establishments. Many of these case present to medical establishments before the normal incubation period of the likely pathogenic organisms had elapsed.

However, the Company is aware of one minor being admitted to hospital on the 30th July. The linkage of this case to the contamination observed is not clear.

It was now been reported that there has been a relatively high number of cases of *Campylobacter* reported. *Campylobacter* is almost universally found on chicken carcasses. However, this observation must be made in the context that an increased number of patients were presenting to medical practitioners, and an increased number of samples were analysed by pathology laboratories.

At present the review of cases and results from pathology labs is on-going and is expected to be complete in early September. The results from this review will be provided at a later date.

5.4 Customer Reports of Illness to the Company

Over the period of the Event a relatively raised number of customers from the affected area reported illness to the Company. The Company's standard approach to investigation of customer reports of illness is that, where it is convenient to customers, water samples are collected the same day for laboratory analysis. Wherever possible this approach was maintained by the Company. However, during this period some customers reporting illness were satisfied by advice provided by the Company and did not request that water samples were taken.

Seven properties were visited by the Company in the affected area between the 28th July and 6th August. None of the samples collected from customers properties contained any faecal indicator organisms. As discussed above one samples collected on the late evening of 3rd August was found to contain coliform bacteria at a concentration of 1 per 100 ml. It is not considered that this detection represented a significant impact upon health.

Is notable that the Company received more contacts from customers reporting illness from DMAs neighbouring the affected area than from the affected DMAs. Eight properties were visited across two other closely related DMAs in the same period as above. None of the samples collected from any of these properties contained any indicator bacteria.

It is therefore concluded that although there was a relative rise in the frequency of contacts to the Company, this phenomenon did not represent a good predictor of deterioration of water quality such that it was directly impacting the health of consumers. It is more likely that the entirely understandable customer concern related to the nature of the Event led to the association of drinking water with the occurrence of possibly unrelated symptoms.

5.5 Involvement of YW's Independent Medical Advisor

As the significance, impact, and potential consequences of the event grew, the Company's Independent Medical Advisor Prof. Nigel Lightfoot was consulted regarding the potential risks to Public Health and as a dispassionate reviewer of the protective actions being taken and planned. Prof. Lightfoot also participated in conversations with Public Health England which lead to the changes to and ultimate removal of protective advice. A log of the timing and focus of these conversations is given at Appendix 28

5.6 Public Health Impact Conclusions

Taking into the consideration the known nature of the Event, the available samples data, and the observation on illness reported by patients it is considered unlikely that there has been a real impact upon the health of consumers. While reports of illness from the customer to the Company were not an good indicator of real deterioration in water quality this phenomenon is not uncommon. It is much more relevant that samples did indicate a potential for the presence of pathogens and an increased number of patients were diagnosed with infection with organisms likely to be associated with contamination from the likely source.

6. Assessment of actions taken

6.1 Advice and timing of Do Not Drink Advice

The need to provide customers with do not drink advice was quickly identified by the Company Incident Management during their meeting at 13:00 on 29th July. This decision was taken following a review of the event and the events and information which become available during the morning of 29th July. During the morning the Company had started to receive customer contacts for discolouration and taste and odour spread across the two DMAs D521 and D458. The Company's laboratory analytical service provided reported the presence presumptive of indicator bacteria including faecal indicators on samples taken on Coulman Road the previous day. This along with further information from the Water Regulations Team following their follow up visit to the Poultry Processing Factory (PPF) on the morning of the 29th which discovered a further contravention involving a direct mains feed with no protection. The combination of all of these factors together resulted in the decision to provide the do not drink advice to customers in the afternoon of 29th July.

Up to the morning of the 29th of July there had only been contacts for discolouration in the affected area from the Food Manufacturer and In response to the contacts from the FM on 27th and 28th July the action of flushing the local networks on Coulman Road had been carried out by the Company's Network Technician and the water had been flushed until clear. A series of Samples were taken by the Water Quality Scientist to prove the quality of water in the mains networks. The Water Regulations Team (WRT) visits to several Industrial premises around Columan Road were carried out on the 28th July had not flagged up any risks to the networks. The WRT visit to the PPF on 28th July had found the only contravention to be a possible link to a category fluid 2 risk via a hot water cistern at the PPF which did not prompt the Company to provide protective advice to customers at that point.

6.2 Change from Do Not Drink to Boil Water Advice

During 30th July an assessment of the event by senior water quality and operational managers was carried out and after consultations with Public Health England and local EHO the advice not to drink the mains tap water was replaced with boil water advice to all customers with the exception of those on the industrial estate on Coulman Road.

The change to boil water advice was made following an assessment of the results of physico-chemical, microbiological and organics sample analysis which became available, during the morning and results were correlated with hydraulic measurements for the zone indicating now no unexpected inlet flows to the main network

Early microbiological indications from samples obtained on the 29th July indicated the presumptive continued presence of indicator bacteria, although not faecal indicators, in the at-risk area. However the organics and physio-chemical results showed no evidence of chemical contamination. The replacement to BWA was made to help ease the burden on customers of having to collect water for drinking purposes from the provided drinking water storage locations nearby.

For customers on the Industrial estate the DND advice was not replaced with BWA until the 1st of August. This was to ensure that the localised area where it was assumed the contamination had occurred been checked by taking several water quality samples on 31st July to prove the area free of indicator bacteria. It was correct for the Company to ensure the area where the contamination originally occurred was now clear.

6.3 Communications to customers

The Company reviewed its strategy with regard to issuing written advice to customers in Autumn 2015. The contingency service (The Service) has been put in place by the Company's Emergency Planning team (YWEP) for any future water quality incident that require a written notice to be delivered by Royal Mail to a customer billing address.

The Service was not as robust as anticipated and it was not possible to get hold of any pre-printed documents outside of normal working hours. PGUK require the Company to notify them by 3pm on and given week day that working is required outside or normal working hours (08:45-17:00). CIMT did not agreed the decision to issue letter advice for DND until 3pm. The Service could not be accessed over the weekend.

Printing of letters was undertaken at various locations and hand delivery organised as there would have been a delay in arrival of letters given that the Royal Mail does not deliver on Sundays. Both of these actions creating a delay in getting written advice out to customers.

A full review of the service and protocols will be undertaken – with a particular emphasis on what is needed out of normal hours.

6.4 Temporary Alternative Water Supplies (TAWs)

The first delivery of the nineteen pallets of bottled water was made at 5pm to the two designated locations. However, deliveries was rapidly depleted by customer demand. Bottle water deliveries was supplemented by a tanker of bulk waster sent throughout the evening to the affected areas. TAWs centres were operated by the Company in order to provide advice to customers. However, the assistance of security contractors and the Police was also required due to concerns for the safety of colleagues.

The information with regard to the potentially affected properties took the form of partial post codes, these used five digits of the postcode instead of the full six, e.g. DN8 XX. The decision to present the affected areas in this way was due to the more than 200 streets impacted, which was considered to be too many to list on the website. Whilst this approach did make the information on the website less overwhelming, it soon became apparent that addresses outside of the two affected DMAs were included in the do not drink advice to this list of partial postcodes, due to their geographical proximity. This information may have contributed to the initial overwhelming demand for bottle water. Some of the zone boundaries were down the middle of streets meaning that one side of the street was in the affect area and the other side of the street were not. When only using a 5 digit post code this was confusing for both the Company and cusomters. Lessons learnt will be taken from this event and the Company will ensure that a review of the postcodes and zone information so that in the event of an incident a detailed list (postcodes matched with zones) of affected customers can be provided at short notice.

6.5 Increasing Chlorine in system

The Company considered options for enhancing the chlorine residual in the system during the event but there was no obvious location to do this without potentially affecting the whole supply

to Doncaster if changes were made at source. Doncaster is a known sensitive area for customer contacts with respect to chlorine changes.

More locally to the affected area was Thorne Water Tower but this would also have involved chlorine changes to the downstream neighbouring DMA of D475 which was not in the affected area, and as this was a chloraminated supply the continuous dosing sodium hypochlorite to this water would have run the risk of forming taste and odour compounds which could be unpleasant to customers. A decision was taken to only periodically increase the chlorine residual at Thorne WTR by the means of manually dosing sodium hypochlorite.

6.6 Closing a valve on the Industrial Estate.

In response to the discolouration contact at the Food Manufacturer on 28th July the Network Technician flushed several hydrants and found the two hydrants most local to the FM were discoloured. Following approximately 30 minutes of flushing the NT observed that the water flushing from the hydrants was still discoloured. In response to this it was agreed that the NT should close a valve on the mains network in Coulman Road which would allow for a flush in one direction enabling the ring main around the industrial estate to be flushed thorough. This was effective in removing the discoloured water in the mains on Coulman Road at the time and the absence of customer contacts on 28th July supports this. However the closing of the valve may be likely to have meant that further backflow into the system on 29th July could have been more likely to be transported beyond Columan Road and into the two downstream DMAs which in turn would explain the customer contacts on 29th July.

6.7 Network Flushing.

Flushing of the hydrants on Coulman Road was carried out in the early morning on 28th of July in response to the contact for discolouration. Two hydrants were flushed for upto eighty minutes before the supply became clear. It is likely that the action of this flushing removed a significant amount of the suspected backflow from the mains system around the industrial estate and potentially from the wider downstream network.

The flushing programmes that were carried out in DMA D521 and D458 on 31st July and 1st 2nd of August respectively were found to be effective in removing contamination from the system and allowed for the boil water advice to be rescinded on 4th August. This was shown by improving water quality sample results over the period. For the areas of the network where water quality results were not showing improvement one stretch of main was given a localised chlorination on 2nd August and the other areas was given a second flush on 3rd August. Both these actions were proved to be effective by obtaining clear water quality sample results.

7. Actions Taken to Prevent Recurrence

A review of The Service for issuing written advice to customers will be undertaken. The emphasis will be on the out of hours and weekend service, and stock items held.

Review of communications method with the aim to reflect the relevant medium to the demographic of any incident.

Review the need for more frequent updates to DWI, especially in situations where politicians and media are involved.

Review the postcodes and zone information ensure that in the event of an incident a detailed list (postcodes matched with zones) of affected customers can be provided at short notice.

The event will be tested/re-run (starting September) through the Wholesale/Retail NHH process to ensure that the Market Opening and associated processes does not create blockers to the effective management of such Events.

Water Regulations Team (WRT) to promote the requirement to notify alterations of pipework, change of use, etc under Regulation 5 of the Water Supply (Water Fittings) Regulations 1999 and also the hiring of Water Safe registered plumbers through both an external communications campaign.

WRT to work collaboratively with WRAS (providing a statement) to highlight the issue within the sector.

8. Notifications

29th July

13:38 Public Health England. Yorkshire Duty Room
Followed up by updates to Helen McCauslane.

13:46 Nick Wellington. Doncaster Metropolitan Borough Council Food Safety Team.
Followed by updates to Diane Glancy

15:37 Steve Youell. Drinking Water Inspectorate.

CCWater by voicemail & email

Further updates were provided regularly to key contacts during the course of the Event

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