Drinking water 2017

Summary of the Chief Inspector's report for drinking water in Wales

July 2018

A report by the Chief Inspector of Drinking Water

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Drinking water 2017

Summary of the Chief Inspector's report for drinking water

Drinking water 2017 is the annual publication of the Chief Inspector of Drinking Water for England and Wales. It is the 28th report of the work of the Inspectorate and presents the summary information about drinking water quality for the calendar year of 2017. It is published as a series of four quarterly reports which cover public water supplies and one report which covers private water supplies. This report is a summary of public water supplies for Wales.

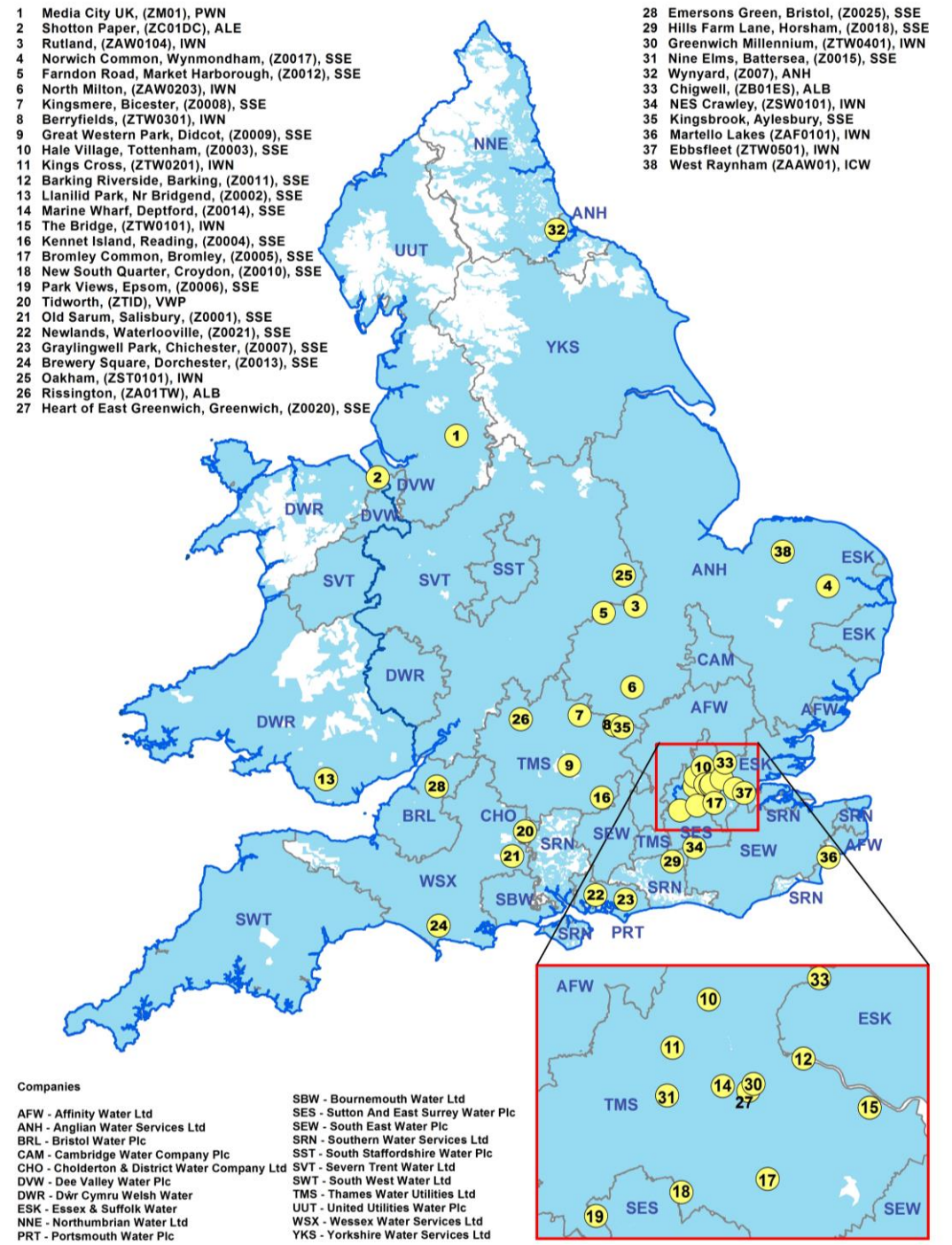
Set out in this report are the key facts about the quality of the public water supplies in Wales, which is served by 4 water companies delivering supplies to 3 million consumers. The area served by each water company is shown in Figure 2.

Table 1: Key facts about public and private water supply arrangements in Wales

Public supplies		Private supplies	
Population supplied	3,133,116	Population supplied	79,503
Water supplied (l/day)	828 million	Water supplied (l/day)	110 million
Abstraction points	87	Approximate number of private water supplies*	14,147
Treatment works	70		
Service reservoirs	418	Total number of local authorities	22
Water supply zones	97		
Length of mains pipe (km)	27,706	Number of local authorities with private supplies	22
Water composition		Water composition	
Surface sources	93%	Surface influenced supplies	87%
Groundwater sources	6%	Groundwater sources	6.5%
Mixed sources	1%	Mains water	5%
		Unknown	2.5%

Changes to water supply arrangements in 2017 were the creation of Albion Eco Limited which took over the supply previously provided by Albion Water in North Wales from 1 January 2017.

Figure 2: Company supply areas



Drinking water quality testing

Throughout 2017, water companies sampled drinking water to verify compliance with the drinking water Regulations. Almost half of the tests were carried out on samples drawn from consumers' taps selected at random. For monitoring purposes, company water supply areas are divided into zones. Sampling in zones at consumers' taps is risk-based with the number of tests being higher in zones with a large population (maximum 100,000). Other sample locations are water treatment works and treated water (service) reservoirs. Collectively, the water companies in Wales carried out a total of 261,831 tests during 2017 and only 50 of these tests failed to meet one or more of the standards set down in the regulations or exceeded a screening value.

The Inspectorate reviews the numbers of samples provided against the target number the company were required to take in order to identify any shortfalls. In 2017, there were no significant shortfalls (see Table 3).

Table 3: Number of tests carried out by companies in Wales

Company	Place of sampling			Number of tests per company	Target number of tests
	Water treatment works	Service reservoirs	Consumers' taps (zones)		
Albion Eco Water	0 (0)	0 (0)	236 (1)	236	236
Dee Valley Water	7,701 (4)	8,268 (28)	7515 (10)	23,481	23,532
Dŵr Cymru Welsh Water	31,615 (62)	98.761 (309)	79,099 (75)	209,475	209,737
Severn Trent Water	5,110 (3)	18,179 (57)	4,530 (10)	27,819	27,910
SSE Water	0 (0)	0 (0)	415 (1)	415	416
Wales overall	**44,426 (69)**	**125,208 (394)**	**91,792 (97)**	**261,426**	**261,831**

Note: Numbers in brackets reflect the number of works, reservoirs or zones operated by that company in Wales in 2017. Some companies are permitted to carry out some tests on samples taken from supply points rather than from consumers' taps.

Measuring Compliance with standards

In 2017, the figure for public water supply compliance with the European Union (EU) Drinking Water Directive Wales was 99.96% and also for the industry across England and Wales. This mean zonal compliance figure (MZC) remains largely unchanged since 2004 but represents the high standards for compliance in England and Wales recorded since 1990. This figure is made up of tests for 39 different microbiological and chemical parameters, and for 31 of these parameters in Wales met the standard for compliance with the regulations in relation to every test. Tests taken, numbers of failures and company figures are provided in Tables 7 ad 8.

In 2016, the Inspectorate introduced the Compliance Risk Index (CRI), a new water quality measure. This measure is required to replace the current Mean Zonal Compliance (MZC) Index for a number of reasons. Recent amendments to regulations transpose the requirements of the drinking water directive that allow companies to move away from the current monitoring programme (based on sample numbers) to a risk-based monitoring methodology meaning that companies will be able to request adjustments to the sampling programme based on risk assessment. Over the next few years, as companies use risk-based monitoring to introduce or remove parameters from their schedule, this would add greater variability to the MZC compliance measure making comparison more difficult.

The Compliance Risk Index is a measure designed to illustrate the risk arising from treated water compliance failures and it aligns with the current risk-based approach to regulation of water supplies used by the Drinking Water Inspectorate (DWI). Unlike MZC, it assigns a value to the significance of the failing parameter, the proportion of consumers potentially affected and an assessment of the company response.

The following equation describes the calculation:

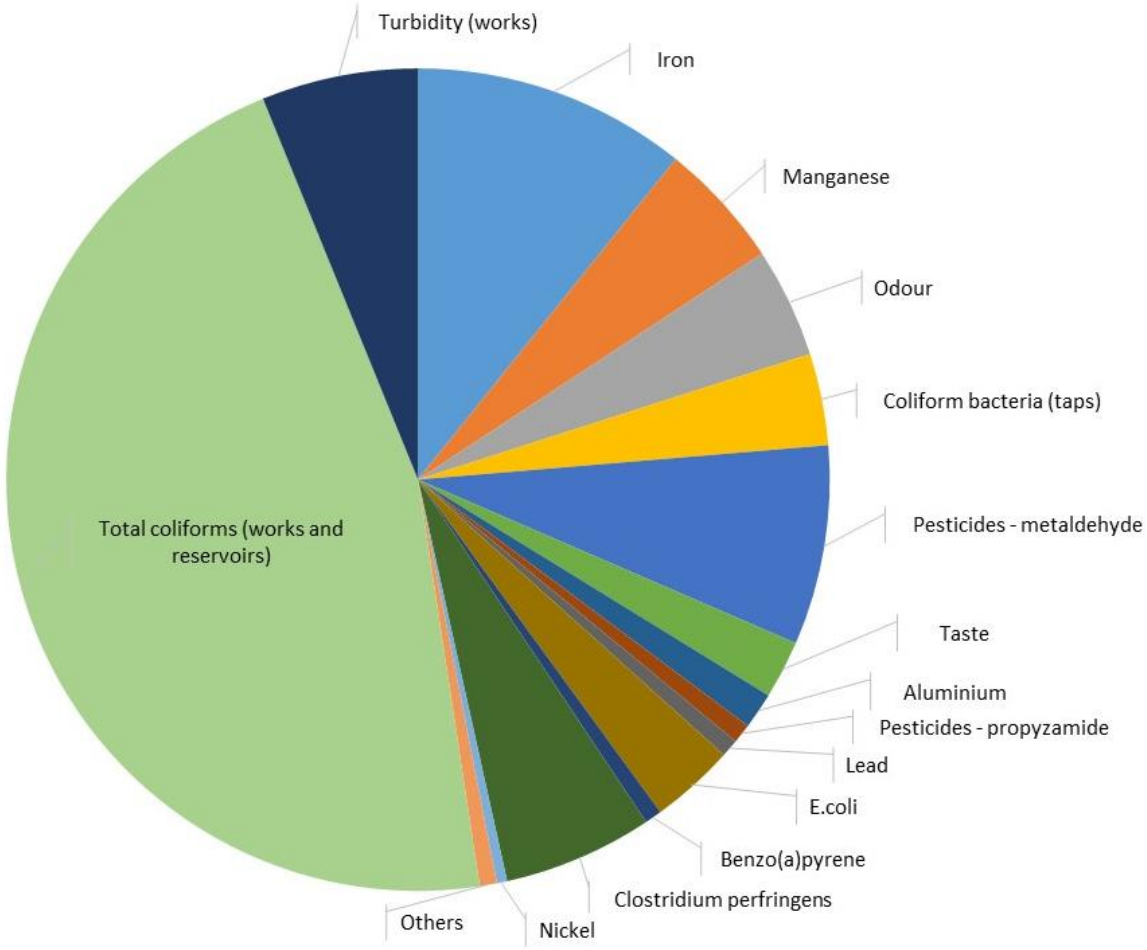
$$CRI = \frac{Seriousness.Assessment.Impact\ (Population\ or\ WTW\ volume\ or\ SR\ capacity)}{Population\ of\ the\ Company\ or\ WTW\ volume\ or\ SR\ capacity}$$

The introduction of CRI creates an understanding of the seriousness and impact of those failures without changes in sample numbers influencing percentage values since it only includes scores for those tests which fail.

In 2017, the CRI for England and Wales combined was 3.56 which is an improvement from 4.78 in 2016. The improving figure is a result of a reduction in the total numbers of failures, reductions in those compliance failures which are more serious, fewer consumers potentially affected by those failures, the company responding in a way to secure future compliance or a combination of these. Similarly the improvement in Wales was from 3.55 to 2.63.

Figure 4: CRI Profile for the industry in England and Wales

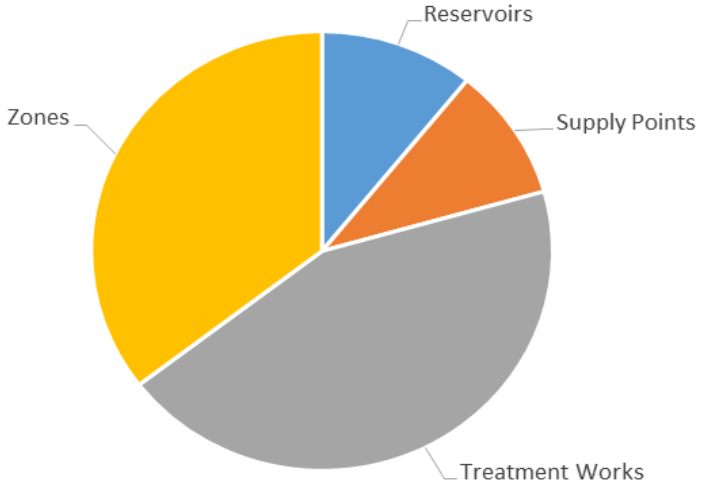
Figures include all failures of EU and national standards taken at treatment works, service reservoirs and taps.



The single largest contribution to the CRI for the industry in England and Wales, accounting for 45% of the total value, were failures due to coliforms at treatment works and reservoirs. The reason for this is that a failure of a coliform at a treatment works will potentially affect a large number of consumers and so the contribution to CRI reflects this widespread risk. Individual coliform failures are discussed later in this report, but for assets which are entirely within the control of water companies, strategic focus is absolutely necessary to reduce this risk. This is equally reflected in the contribution of 6% for turbidity at treatment works which reflects a critical control when maintaining a supply free from particulate matter. Another advantage of the new approach to measuring compliance is that it is possible to make visible the contribution of asset types to the overall index. Added together the combined contribution of parameters failing at treatment works and reservoirs amounts to 55%,

reflecting the importance and the relative risk associated with these assets (see Figure 5).

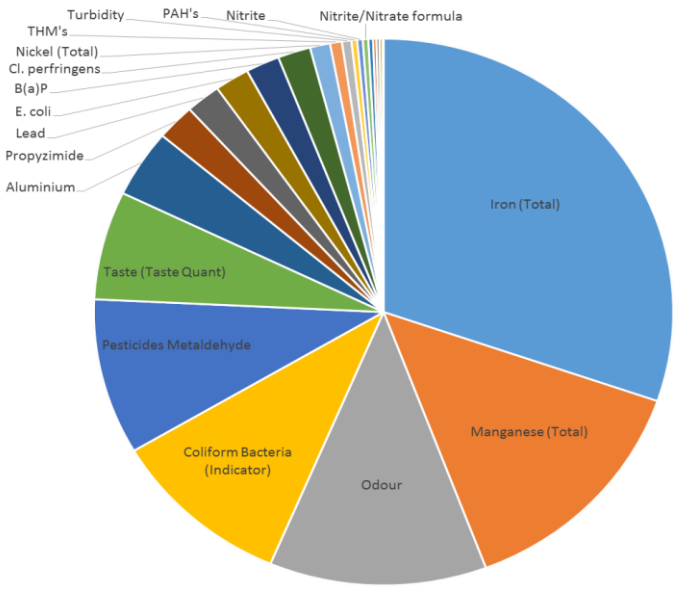
Figure 5: CRI Profile, contribution by location of sampling for the industry in England and Wales



It is then possible to identify the contribution of different parameters at particular assets as illustrated in Figure 6 which depicts the contribution of individual parameters to the overall zonal score.

From samples in zones, iron, manganese and aluminium contribute over 48% of the zonal CRI. This emphasises the impact the potential causes of discolouration can have on consumers.

Figure 6: CRI Profile, contribution by zones for the industry in England and Wales



Learning from compliance failures

All compliance failures are significant and are required by the regulations to be investigated by the company and assessed by the Inspectorate. All failures contribute to the Compliance Risk Index scores and the significance, impact and actions by the companies proportionately attract a score identifying which companies and failures require close examination by the Inspectorate for appropriate action.

The key water quality results for Wales are presented in the following tables, showing the results for microbiological parameters (Table 7), and chemical and physical parameters (Table 8). A summary of the results of testing for all parameters and tables that describe the drinking water quality performance indices of each company can be found on the DWI website (http://www.dwi.gov.uk).

Table 7: Microbiological tests - Wales
The number of tests performed and the number of tests not meeting the standard

Parameter	Current standard	Total number of tests	Number of tests not meeting the standard	Additional information
Water leaving water treatment works				
E.coli	0/100ml	5,959	0	
Coliform bacteria	0/100ml	5,959	1	DWR (1)
Clostridium perfringens	0/100ml	2,850	0	
Turbidity[1]	1NTU	9,182	2	DWR (2)
Water leaving service reservoirs				
E.coli	0/100ml	21,477	0	
Coliform bacteria	0/100ml in 95% of tests at each reservoir	21,477	6	DWR (2), SVT (4) All 394 reservoirs in the region met the 95% compliance rule.
Water sampled at consumers' taps				
E.coli	0/100ml	8,315	1	DWR (1)
Enterococci	0/100ml	671	0	

[1]Turbidity is a critical control parameter for water treatment and disinfection.

Microbiological parameters at works and service reservoirs

All compliance failures are significant and are required by the regulations to be investigated by the company and assessed by the Inspectorate. All failures contribute to the Compliance Risk Index scores and the significance, impact and actions by the companies proportionately attract a score identifying which companies and failures require close examination by the Inspectorate for appropriate action.

In Wales, there were no detections of *E.coli* at treatment works. Dŵr Cymru Welsh Water reported a coliform detection at Mynydd Llandegai works which was attributed to ingress into the treated water holding tank and repairs have been made. Two detections of turbidity, both at Alaw South works, in March and September were investigated by Dŵr Cymru Welsh Water. On the first occasion the detection was attributed to re-suspension of lime deposits in an outlet well on restart of pumps following a three minute power outage. On-line analysers indicated there was no risk to the disinfection process. The company updated the risk assessment and put in place a programme of remedial work including cleaning of outlet wells on a three-year cycle, regular planned change-overs between pumps, plus additional operational sampling. The second sample was collected when the site was not in supply following a shutdown resulting from a power failure. It was thought that the pump on the sample line stopped and then restarted causing air to become entrained in the water. The company subsequently installed a visual indicator on the final sample point to show whether the site is in supply.

There were six detections of coliforms at service reservoirs in Wales in 2017 (DWR 2, SVT 4) but no reservoirs had repeated detections within the year. Dŵr Cymru Welsh Water identified ingress into Penrhys service reservoir in April and Crwbin service reservoir in July. In both cases ingress was identified and repaired and at Crwbin, the sample line and kiosk was renewed and a secondary chlorination system installed.

Severn Trent Water reported four detections of coliforms at service reservoirs. It was the case in the majority of instances that the investigation did not identify a cause on initial inspection. In one instance at Briw service reservoir in June, it was considered that the length of the sample line contributed to the failure. This was relocated and new tap installed. These sites are covered by company-wide Notice agreed with the Inspectorate to inspect service reservoirs and rectify any defects.

Chemical and physical parameters

Table 8 sets out the results for those chemical and physical parameters where there has been a failure to meet a European or national standard (mandatory quality standards) and any other parameter of interest.

Table 8: Chemical and physical parameters – Thee number of tests performed and the number of tests not meeting the standard - Wales

Parameter	Current standard or specified concentration[1]	Total number of tests	Number of tests not meeting the standard	Additional information
Aesthetic parameters				
– colour	20mg/l Pt/Co scale	1,811	0	
– odour	No abnormal change	2,329	6	DVW (1), DWR (5)
– taste	No abnormal change	2,171	3	DVW (1). DWR (2)
1,2-dichloroethane	3µg/l	728	0	
Aluminium	200µg/l	2,178	1	DWR (1)
Ammonium	0.5mg NH_4/l	1,891	0	
Antimony	5µg/l	670	0	
Arsenic	10µg/l	686	0	
Benzene	1µg/l	708	0	
Benzo(a)pyrene	0.01µg/l	673	0	
Boron	1µg/l	726	0	
Bromate	10µg/l	695	0	
Cadmium	5µgCd/l	671	0	
Chloride	250mgCl/l	725	0	
Chromium	50µgCr/l	670	0	
Conductivity	2500µS/cm at 20°C	2,242	0	
Copper	2mg/l	671	0	
Cyanide	50µgCN/l	724	0	
Fluoride	1.5mg/l	664	0	

Parameter	Current standard or specified concentration[1]	Total number of tests	Number of tests not meeting the standard	Additional information
Iron	200µg/l	2,817	12	DWR (12)
Lead	10µg/l	670	1	DWR (1)
Manganese	50µg/l	2,156	4	DWR (4)
Mercury	1µgHg/l	726	0	
Nickel	20µg/l	669	2	DWR (2)
Nitrate	50mg/l	681	0	
Nitrite	0.5mg/l	680	0	
Nitrite (taken at works)	0.1mg/l	306	0	
Pesticides – total	0.5µg/l	819	0	
Pesticide – individual[2]	0.1µg/l	6,565	0	
pH (Hydrogen ion)	6.5 – 9.5	2,579	0	
Polycyclic Aromatic Hydrocarbons (PAH)	0.1µg/l	675	0	
Radioactivity[3]				
Gross alpha	0.1Bq/l	103	0	
Gross beta	1.0Bq/l	103	0	
Radon	100Bq/l	61	0	
Total indicative dose	0.1mSv/year	0	0	
Tritium	100Bq/l	5	0	
Selenium	0.1µg/l	670	0	
Sodium	200mg Na/l	671	0	
Sulphate	250mg SO_4/l	725	0	
Tetrachloroethene & Trichloroethene	10µg/l	667	0	The standard applies to the sum of the two
Tetrachloromethane	3µg/l	667	0	
Trihalomethanes Total	100µg/l	673	0	
Turbidity (at consumers' taps)	4NTU	1,902	0	

Notes:

[1]For comparison, 1mg/l is one part in a million, 1µg/l is one part in a thousand million.

[2]A further 3,020 tests were done for aldrin, dieldrin, heptachlor, heptachlor epoxide, all of which met the relevant standard of 0.03µg/l.

[3]These are screening values to trigger action. The standards are radon and 'Total Indicative Dose'.

Taste and odour and the appearance of water arriving at the consumers taps often have a significant impact on consumer confidence as consumers expect their drinking water to be clear and bright in appearance and free from discernible taste or odour. Taste, odour and appearance are the single most important means by which a consumer assesses the quality of food or drink. If this does not meet expectations, rejection and loss of confidence is often the outcome.

In Wales, taste and odour was the subject of over 1,400 contacts to companies and for appearance there were over 8,000 contacts. The most prominent complaint for taste is chlorine and for colour, brown black or orange water. While the overall rate of contacts reporting a discernible issue with water quality remains very small at around 3 per thousand population, the lasting nature of loss of confidence should compel companies to strive towards reducing these figures. It should be noted that in Wales that while there has been steady progress in reducing chlorine contacts, there has been an increase in contacts reporting earthy/musty tastes or odours. For appearance contacts, there has been little progress and total appearance contacts and those reporting black brown or orange water are at a greater level in 2017 than they were in 2011. Contacts reporting problems with the appearance of water to Dŵr Cymru Welsh Water and Dee Valley Water stand 2.7 and 1.5 contacts per thousand population respectively, a level considerably above the industry average of 1.1.

Figure 9: Numbers of contacts to companies reporting taste or odour issues 2011-2017 in Wales

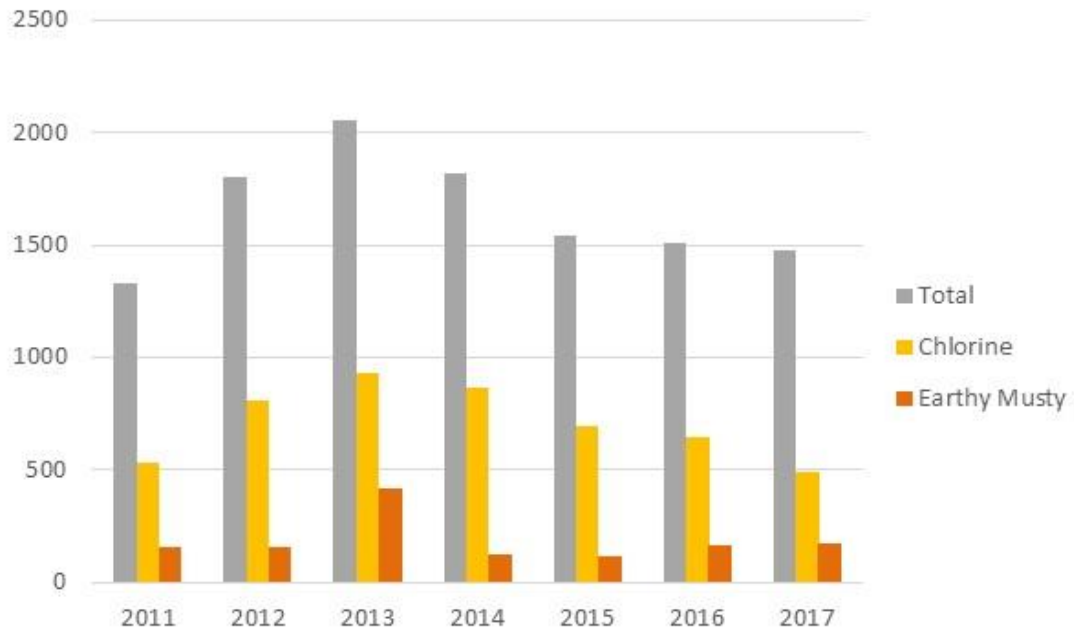
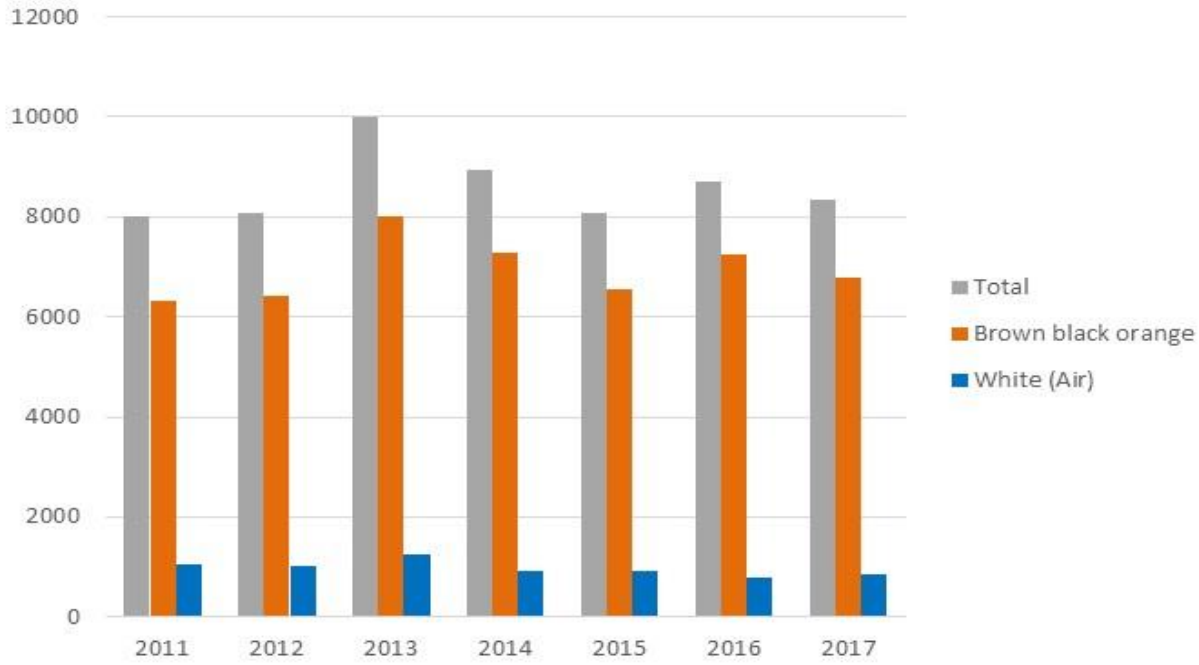


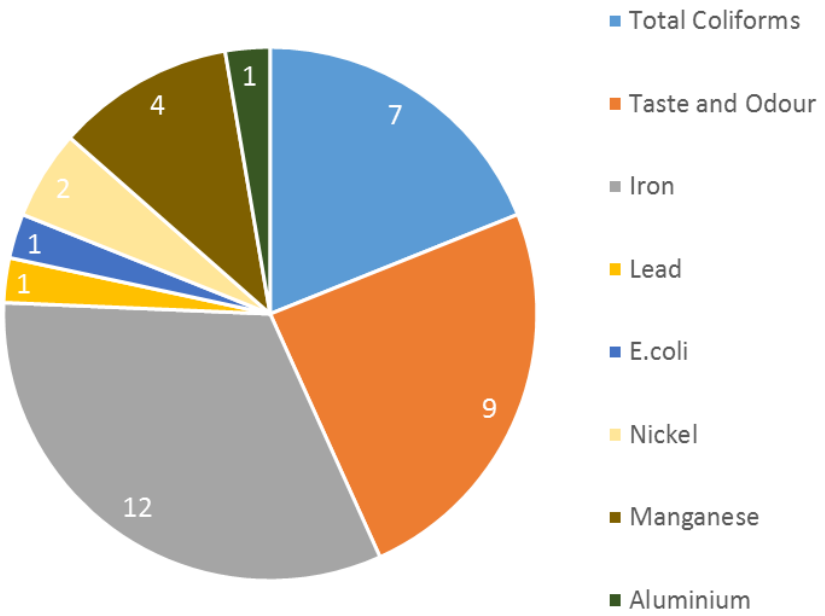
Figure 10: Numbers of contacts to companies reporting appearance issues 2011-2017 in Wales



When considering compliance failures, which all together accounted for 630 failures at taps (England 593, Wales 37), taste and odour account for 23% of these (England 23%, Wales 24%) and iron, manganese and aluminium combined account for 18% (England 17%, Wales 46%) . The impact to consumers when considering iron, manganese and aluminium is emphasised by CRI as they contribute a not inconsiderable 48% of the CRI zonal value as these failures are more likely to occur at a whole zone level whilst taste and odour contribute 18.6% of the zonal CRI as these are mostly related to the domestic premises alone. This comparison relates well to the numbers of complaints received by companies for these two separate categories. However, linking these with the number of complaints, aesthetic parameters are of considerable importance when considering acceptability and continuing confidence in the water supply. Identification of the six worst performing companies causing discolouration has resulted in 135 Notices to drive improvement.

Across England and Wales in 2017, the most prevalent detections at the consumers' taps were for coliforms but lead continues to consistently record a similar number of failures year on year and nickel continues to rise in prevalence from new fittings.

Figure 11: Number of failures of standards – Wales 2017



Figures include all failures of EU and national standards taken at treatment works, service reservoirs and taps.

Considering some of the failures at taps: the most prevalent failure in Wales was the detection of iron.

From the 2,817 tests at taps there were 12 failures in 2017, all in zones operated by Dŵr Cymru Welsh Water. Six of the failures were in zones that are all subject to Notices to address discolouration. Three iron and one manganese failure occurred in the Holywell/Mold zone which also experienced failures in early 2016 whilst the zone was under a Notice to remediate the causes of discoloured water in the zone. These further detections will feed into the Inspectorate's view of risk for this zone.

Lead in tap water typically arises in premises where the pipes and brass fittings have not been refurbished since the 1970s when the use of lead in drinking water installations was banned. The other reason why lead maybe found in tap water is the illegal use of lead-based solder for making joints on copper pipes. In addition to the ban, the standard has been progressively tightened from 50µg/l in 1990 to 25µg/l in 2004 and since the end of 2013 has stood at 10µg/l. During this time water companies have assessed the risk of lead being present in tap water at the point of use and, where necessary, installed additional water treatment (generally phosphate dosing or pH correction) to minimise the propensity of lead to leach out of pipes and fittings within consumers' premises. Whilst recent research commissioned by the DWI has identified that, without phosphate dosing there remains a risk from lead to consumers, this short-term

remedy has now become, over the years, a long-term approach. The inherent problems with this solution are the ongoing cost of dosing phosphate into supply, the food source this provides to microbial biota in the network and the eventual need to remove it from waste water at the end of the water cycle.

Current iterations for the recast of the Drinking Water Directive are considering a 5µg/l limit on lead with a ten year transition period. If this were to be included in domestic secondary legislation the only permanent long-term solution to the issue of lead in tap water is the removal of lead pipes and fittings, including the communication and supply pipes as well as homeowners replacing lead pipes or fittings.

Many or indeed most of the current company strategies are not ambitious enough to consider this forthcoming challenge and may fall short of achieving the future standard. Of the 670 tests in Wales there was a single lead failure in the Lleyn zone. In this instance, the company identified a lead service pipe and lead solder in the property, provided advice to the consumer.

Finally, in consideration of metal failures at taps, nickel failures persist with two failures from 669 tests in Wales failures in 2017. In all cases where a cause was identified, the source of nickel was from taps. Nickel may be present in coatings on modern tap fittings which are widely available, approved and are often the cause of failures in this area. Advice should be offered by companies to consumers where these failures occur.

Events

In 2017 there were 504 events in total across the industry, of which, in Wales 12 were significant, but none were serious. The nature of the events is shown in Table 12.

Table 12: Water quality events in Wales

Nature of event	Risk assessment category (DWI)					
	Minor*		Significant		Serious **	
	2016	2017	2016	2017	2016	2017
Air in water		-	-	-	-	-
Chemical	1	-	-	-	-	-
Discoloured water	2	-	6	4	-	-
Inadequate treatment	1	-	1	1	-	-
Loss of supplies/poor pressure	3	2	-	2	-	-
Microbiological	2	1	-	1	-	-
Taste/Odour	3	2	2	2	-	-
Health concern	-	-	-	-	-	-
Public concern	6	4	1	2	-	-
Other	1	2	-	-	-	-
Wales	**21**	**11**	**10**	**12**	**0**	**0**
England	**302**	**255**	**164**	**216**	**8**	**10**
England and Wales	**323**	**266**	**174**	**228**	**8**	**10**

*Minor category numbers include all not significant and minor events.
**Serious category numbers include all serious and major events.

A summary of the nature, cause and duration of each event categorised as significant, serious or major along with details of the Inspectorate's findings are set out on the Inspectorate's website. Most events were of relatively short duration and the company took appropriate action to inform and safeguard consumers and other stakeholders. Comparing 2017 events with those of 2016 shows the number of overall events remaining at a similar level. There were no serious or major events in Wales in 2017.

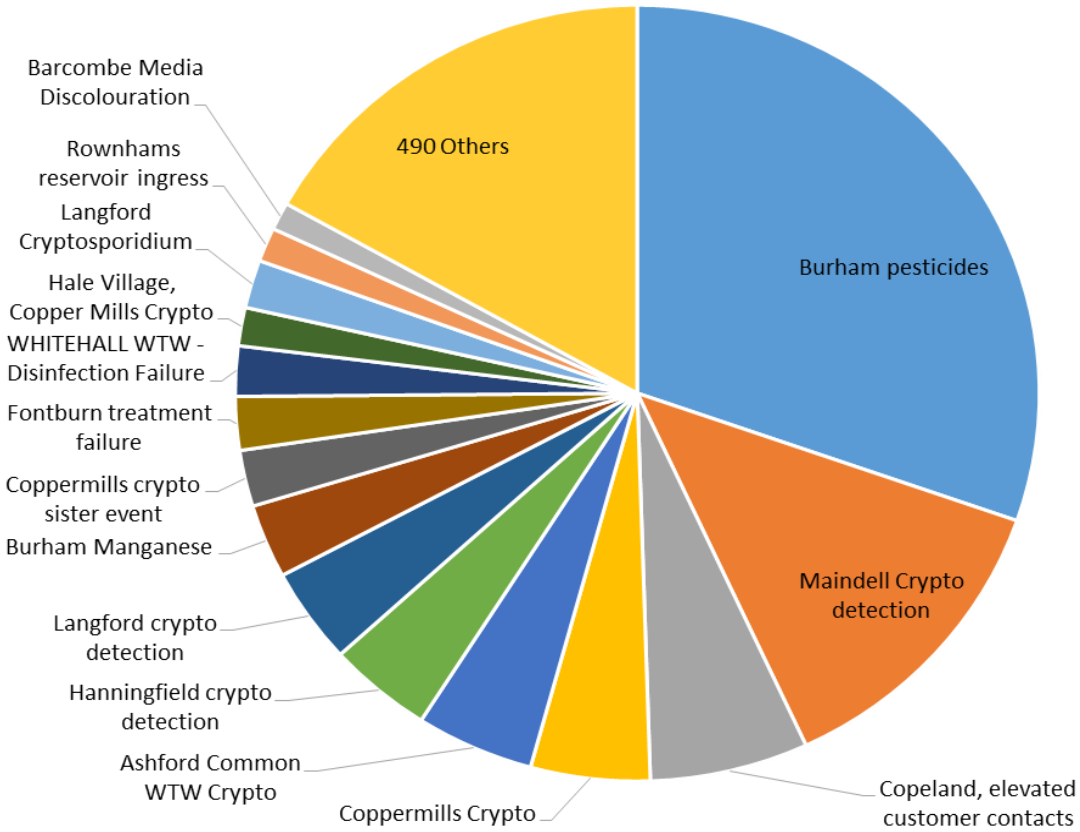
This year, a new drinking water quality measure was introduced to illustrate the risk arising from water quality events, and it aligns with the current risk based approach to regulation of water supplies used by the Drinking Water Inspectorate (DWI). The measure, unlike the current event response categorisation, considers a risk-based methodology to assess consumer impact of events and promote proactive risk mitigation. Like CRI it assigns a value to the significance of the event, the number of consumers that are potentially affected, the event duration and an assessment of the company response thereby deriving a proportional measure across companies.

The following equation describes the calculation:

$$\text{ERI} = \frac{\Sigma(\text{Seriousness} \cdot \text{Assessment} \cdot \text{Impact (population, time)})}{\text{population served by the company}}$$

In 2017, the ERI for England and Wales combined was 249.73 which is an improvement from retrospectively calculated value of 346.54 in 2016. An improving figure not as a result of a reduction in the total numbers of events, but by fewer consumers potentially affected, a shorter duration or an improved response meaning a reduction in the future likelihood of an event, or a combination of these.

Figure 13: ERI Profile 2017, contribution by event for the industry in England and Wales



ERI identifies the most serious events which affect the greatest proportion of consumers for prolonged periods where enforcement may be required. In figure 13, the single largest ERI scoring event was at Burham Works in Kent on 29 December 2017. While this event remains under investigation, the company have been detecting pesticides, (in particular carbetamide and propyzamide), at Burham works as well as exporting an unwholesome bulk supply from the works to South East Water. The detections coincide

with increased raw water concentrations from a source known historically to contain pesticides and where, in the past, these have been detected a number of times in the supply. Compounding this, a Granular Activated Carbon (GAC) contactor had lost a substantial amount of media through broken nozzles, which contributed to an existing operational issue with the treatment on site. The works, which supplies 385,000 consumers in the Kent area, cannot be taken out of supply without losing supplies to customers.

The second event of significance was at Maindell treatment works operated by Portsmouth Water. The company risk assessment identifies *Cryptosporidium* from a number of sources as a high risk in the catchment of this treatment works with no substantive mitigation in place. While the event was relatively short lived as the company implemented procedures to prevent the site returning to supply for 3 days after the heavy rainfall the evidence of a direct route for contamination puts at risk 276,000 consumers. In order to fully consider all mitigation measures, the company were required, through the issue of a formal Notice, to review the risk assessment for this supply.

The third largest event on the ERI scale occurred in the Copeland area of Cumbria, supplied by United Utilities. This is described below for the purposes of learning.

Figure 14: ERI Profile, contribution by level of enforcement necessary for the industry in England and Wales

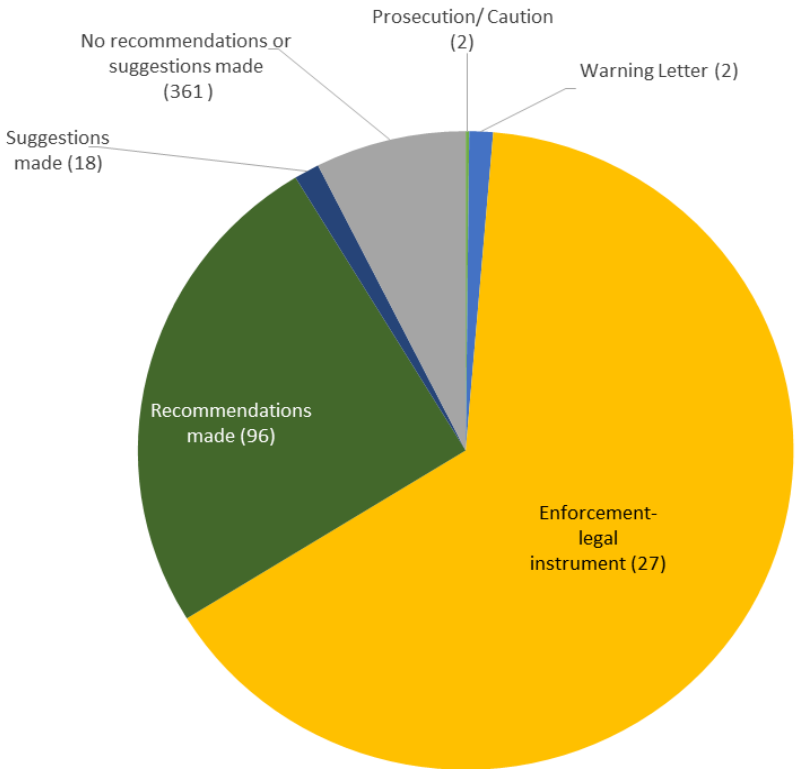
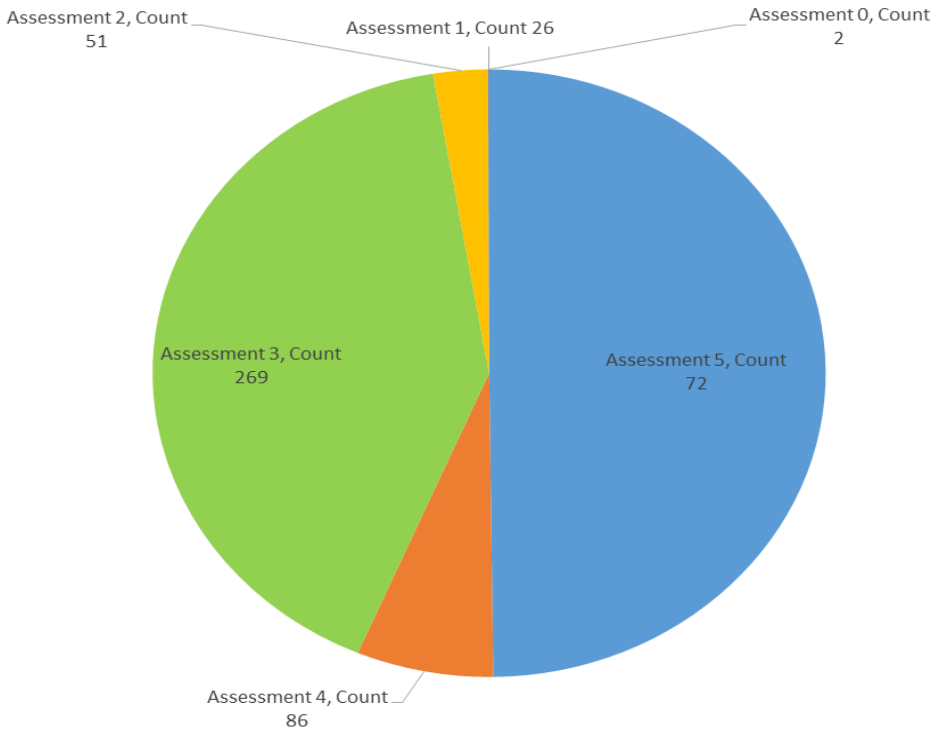


Figure 14 illustrates that the need to issue enforcement by the Inspectorate contributes 65% of the ERI score to 5% of events and where recommendations are necessary this contributes 25% of the ERI score for 19% of the events. Companies can significantly reduce their ERI scores by proactive action, thus reducing regulatory intervention and benefitting consumers.

Likewise, the most serious events as measured by the potential risk to health and attracting a score of 5 contribute to 50% or the ERI score whilst representing only 14% of the events, however, the majority of events classified as assessment 3 contribute 41% of the ERI score whilst accounting for 53% of the events (see Figure 15). Companies can reduce their ERI score by reducing the scale or duration, or by the quality of their response, for those events which may be a risk to health such as where a potential pathogen may be detected,

Figure 15: ERI Profile, contribution by level of seriousness for the industry in England and Wales



Four of the serious events, all of which were in England, were notified to the Inspectorate in 2017. The events are listed below in Table 16 and described for wider industry learning.

Table 16: Events shared for wider industry learning

Company	Name	Date of event
SES Water	Elmer Hypochlorite event	02-Feb-17
United Utilities Water Plc	Copeland, elevated customer contacts	30-Jun-17
Severn Trent Water Ltd	Mapperley Reservoir *E.coli* detection	28-Jul-17
Severn Trent Water Ltd	High Service DSR *E.coli* Detection	15-Dec-17

The events of particular significance in 2017 for industry wide learning include:

Sutton and East Surrey Water Elmer Hypochlorite event

Reported in the CIR Q1 report, in February 2017, SES Water accepted a delivery of ferric sulphate at Elmer water treatment works near Leatherhead in Surrey, from its contracted supplier. The delivery comprised of two 1,000 litre batches of the chemical contained in bulk containers, the contents of each to be delivered into the ferric sulphate storage tank at Elmer works. The delivery vehicle was carrying multiple containers of different treatment chemicals, including two bulk containers of ferric sulphate and one bulk container of sodium hypochlorite solution. On completion of the transfer the driver had incorrectly discharged 1,000 litres of sodium hypochlorite along with 1,000 litres of ferric sulphate into the receiving ferric sulphate storage tank. As a consequence of sodium hypochlorite mixing with ferric sulphate in the storage tank, chlorine gas was released and the works had to be evacuated. This event highlight the continuing importance of controlled deliveries and the risks associated with them. In this case there was no impact on water quality however lack of diligence in receipt of treatment chemicals means this remains a possibility.

Copeland, elevated customer contacts

The nature of this event was the rejection of water following a change of source water resulting in loss of acceptability to consumers. This event occurred in Cumbria during June and July and affected consumers supplied by Ennerdale treatment works operated by United Utilities. The affected areas included the towns of Workington and Whitehaven and

surrounding areas, mainly within Copeland Borough Council's (BC) area. Some consumers in Allerdale District Council's (DC) area were also affected. This was a serious event which resulted in large numbers of consumers contacting the company because of concerns about noticeable changes to their drinking water quality, in particular the hardness of the water and unacceptable tastes and odours. Consumers made direct contact with the Drinking Water Inspectorate, Copeland BC and the local Member of Parliament who was inundated with contacts from concerned consumers. The event was caused when United Utilities made a planned change to the supply from Ennerdale works, introducing a 50:50 blend with local borehole sources following a change in licencing by the Environment Agency. In 2009, United Utilities' licence allowing the abstraction of water from Ennerdale impounding reservoir (IR) was reviewed by the Agency, with a consequential reduction in the maximum permitted amount of abstracted water, until March 2022 when the licence will be revoked entirely. These changes were made by the Agency to comply with European environmental directives, including the Habitats Directive, because the flow of water out of Ennerdale IR is important to support flow in the River Ehen, which is designated as a European Special Area of Conservation for freshwater pearl mussels and Atlantic salmon, and also as a Site of Special Scientific Interest. While the company tested the borehole water to be blended, and this was compliant with all standards, the change of the source was sufficiently different in composition for consumers to notice and by definition had become unwholesome due to widespread loss of acceptability. In response, the company reduced the blend to improve acceptability. However, the company should have consulted with consumers and other stakeholders before implementing the operational changes. This should have included the change to hardness that would result, and the likely effects of this change. Such action would have significantly reduced the potential for consumers' anxiety and rejection of their tap water, had they known in advance that the primary factor was a change to the hardness of the water, with no predicted health effects.

Severn Trent Water, Mapperley and High Service DSR *E.coli* Detection

Service reservoirs at strategic points in the distribution system must be adequately maintained through regular inspection, assessment, testing and repair as necessary. This gives reassurance that the quality of water held in service reservoirs at strategic points in the distribution system is stored and monitored to secure public health. In 2017, there were two significant events at reservoirs, (SVT), in July and December. These followed on from an event in March 2016 in which 3,700 properties supplied from the Castle Donnington service reservoir, (SVT), were instructed not to use their water because a failure of the chlorine dosing system resulted in highly

chlorinated water being supplied. This event arose due to failures in maintenance which were avoidable and there were a number of missed opportunities to identify and rectify the problem before the event and to mitigate its impact. In the event in July, *E.coli* was detected following over-filling of Mapperley reservoir beyond safe limits which resulted in contamination. Ultimately the result of operational errors, the company were in an unprepared position over whether the reservoir could be removed from supply without interrupting the supply to consumers. Additionally there was a conflict in that there were multiple indications of faecal contamination but removing the reservoir form supply risked discolouration to consumers. This led to indecision on the action to take. The company were ill informed about the condition of this reservoir as the last inspection at least 15 years ago.

In the December event at High Service Reservoir, the company identified defects with the sampling facilities and poor condition of the roof membrane. A subsequent dip sample taken on 9 December contained coliform bacteria (31 per 100ml). The company procrastinated about removing the reservoir from supply following this sample result with an identified risk of ingress, and low chlorine concentrations. It rained heavily on 14 December, and samples taken on 15 December contained high levels of *E.coli*, Enterococci and *Clostridium perfringens*. The reservoir was isolated from supply on 16 December. While the company were slow to act on information relating to a coliform detection and this increased the risk to consumers, the company had no idea the site had been in supply since January 2017 due to a misunderstanding, caused in part by the unnecessarily confusing naming of the cells. The monitoring team understood wrongly that the entire site had been taken out of supply, when actually it was only one cell. The inadequacy of information on this site, as with Mapperley, meant indecision about necessary action to manage discolouration and public health risk. These events highlight the need for critical information to be clear and available, decisions to be prioritised and informed by those who have knowledge of water quality and health, and pre-planned actions to ensure responsive solutions to protect consumers.

In 2017, the Inspectorate carried out two prosecutions for events that occurred in England and cautioned one company that supplies in England and Wales (See tables 17 and 18). The caution related to the loss of control of a chlorination system in England and did not impact Welsh consumers however the learning from it should apply to all relevant assets in England and Wales.

Table 17: Cautions and Prosecutions completed in 2017

Details of these can be found in Q1 and Q2 CIR 2017 reports

Date of Event	Date of Court Case	Company	Event	Offence	Outcome
Aug-Sept 2015	Guilty plea 19/07/17 Sentencing 10/10/17 Preston Crown Court	United Utilities Water Ltd	Franklaw works - detection of *Cryptosporidium*	Section 70 supply of water unfit for human consumption	£300,000 With £150,000 costs
Oct 2015	Guilty plea 14/08/17 Sentencing 25/08/17 Southampton Magistrate's Court	Southern Water Services Ltd	Discolouration due to burst main	Section 70 supply of water unfit for human consumption and use of non-approved products (Reg 33)	£400,000 for Section 70 offence £80,000 for Reg 33 offence With £50,000 costs

Table 18: Cautions completed in 2017

Date of Event	Caution Date	Details
11 March 2016	21 June 2017	Severn Trent Water accepted a caution following the investigation of an event where highly chlorinated water was supplied to 3,700 properties supplied from Castle Donington Service reservoir in Derbyshire due to the loss of control of chlorination from a secondary chlorine dosing rig.

Audits

In 2017, there were three major audit programmes covering catchment risk, consumer complaint handling and critical works (See Table 19). The outcomes of the first two of these were reported in Q2 and Q3 of the CIR 2017 and are summarised below. A fuller account of the critical works audits can also be seen below.

Catchment risk audits

In March 2017, the Inspectorate began a series of audits to assess water companies' approaches to assessing risks associated with the raw water catchments supplying their treatment works. This followed on from the analysis of 691,233 lines of risk assessment data submitted by companies and subsequently published in the Chief Inspectors Report Q1 2016.

The audits were carried out at seven companies and included both surface water and ground water catchments. In summary, the audits resulted in 35 recommendations to address or prevent regulatory breaches and additional enforcement action has been taken to remedy more significant deficiencies.

There was clear evidence that a number of companies had well-established teams carrying out catchment risk assessments and had formed an array of relationships with external stakeholders, including tenant farmers, the local rivers trust, the Environment Agency and Natural England. The consideration of land use in the catchment, to assess the well-established risk of pesticide exceedances, clearly shows in the reduction of pesticides detected in the final water. This practice is commended to those companies who were found to have made little progress.

For drinking water safety planning, again there was clear evidence, for a number of companies, that safety plans were routinely and regularly reviewed and the process consisted of a desktop review, site meeting and subsequent review meeting. This was less consistent across companies with a number found to not have fully embedded this fundamental principle.

The identification of risks is merely the first stage in the process for protecting public health and it is incumbent upon water suppliers to address the identified risks in a proactive, robust and timely manner which is the purpose of risk assessment methodology. Companies have some way to go to fully achieve good risk management of both ground and surface water sites.

Consumer complaints audits

A key objective of protecting public health is that consumers must remain confident in their water supplies. A series of audits focussed upon consumer complaints and contacts with water companies as this interface maintains and builds confidence through well planned and efficient communication. Good practice was seen in Dŵr Cymru Welsh Water and Severn Trent Water and this was maintained through internal and independent audits designed to identify and correct sources of error and companies are encouraged to follow this example.

The audits, however, identified that companies were not all using data from social media, largely relying on well-established contact centres. While working well overall, advances should be made such as by Northumbrian Water, who are using an 'app' which allows users to provide live video of the quality issue they are experiencing.

The compliance section of this report focusses on discoloration as a major source of contacts to companies from consumers. Discolouration may be caused by poorly performing water treatment works but is more often caused by deterioration of iron mains within the water distribution network and this was targeted as part of this series of audits.

The response to discolouration by companies was found to be varied:

Dŵr Cymru Welsh Water had demonstrated plans to reduce discolouration such as the replacement of 1.2 km of cast iron pipe in the Monmouth Trellech zone to reduce protracted problems with a supply to a business property: Yorkshire Water were able to demonstrate that flushing programmes in its Hull West and Airedale supply zones had had an effect in reducing consumer complaints mid-way through 2017. The company has put a considerable effort into reducing consumer complaints and now has 24 flushing teams to target poor performing areas and is an excellent example of tackling long-standing and historical problems.

Conversely: Northumbrian Water had not undertaken any analysis either in response to the increase in consumer complaints or to detect emerging issues. Among other companies that could improve are: South West Water, where a Notice was considered if sufficient progress in resolving these issues cannot be demonstrated: Severn Trent Water, where the cumulative nature of the high consumer contact rates did not appear to have informed the company's drinking water safety plans and Notices are being considered for two zones: United Utilities, where a recommendation was made for the company to carry out appropriate risk mitigation measures for such planned work and give consumers advanced warning of the likelihood of discolouration from these activities: South East Water, where the

company was unable to demonstrate robust processes for addressing water quality issues due to a lack of documented procedures.

Critical works audits

In the third series of audits in 2017, 'critical works' were the focus. A 'critical works' may be defined as one where no alternative means exists to supply all or part of the supply area. This means loss of treatment results in complete loss of supplies to consumers, and provision to potentially protect public health could be required within hours of the loss of supply. Eight works were selected for audit based on whether companies had in place any additional control measures, had appropriately addressed risks, and were prepared for emergency eventualities. As a result of the audit 67 recommendations were made in the following areas:

-Risk assessment and risk management

I am pleased to report that all companies had in place risk assessments for the supply systems from the works audited. However, risks had not all been adequately mitigated. The supply, by a single main, such as at Thames Water's Cleeve works near Reading and Essex and Suffolk Water's Ormesby works, near Great Yarmouth (whether it be raw or final water) clearly presents a considerable risk should the main fail. This was realised in 2015 when a 1000mm GRP main failed at Affinity Water's Egham Works.

Equally, flooding is a clear risk to a works, as seen in the event of 2007 at Severn Trent Water's Mythe works, where the resultant loss of supplies to over 245,000 consumers for 16 days still remains the largest event caused by this risk. At Dŵr Cymru Welsh Water's Bolton Hill works, which supplies Milford Haven and Haverford West both raw water supplies to the works had been subject to flooding historically. As an example of good risk management, Anglian Water had engaged with the farming community to work together the resolve catchment challenges and the flood plan provides clear guidelines on how to react to a flood warning. Flood gates and barriers have been installed around assets at risk from fluvial or pluvial flooding. The company have trained various staff in incident management over the last 12 months.

When considering risks, it is clear that single validation points, single processes, inadequate maintenance, ongoing work upgrades and environmental risk may all stop production unexpectedly. The audits identified risks associated with the breakage of UV bulbs at Anglian Water, disinfection by-products associated with sodium hypochlorite dosing on the raw water main at Anglian Water's Barrow works on the Humber and Essex and Suffolk's Ormesby works, and upgrade and refurbishment work at Dŵr Cymru Welsh Water's Bolton Hill works. Maintenance frequencies which

were not risk-based were identified at South East Water's West Ham Pumping Station, in Basingstoke and rabbit faeces were found on top of Severn Trent Water's Mitcheldean contact tank

It was disappointing to note some unacceptable risks were identified during the audits. In particular, companies should ensure that water supplied from treatment works is appropriately disinfected at all times and appropriate control measures should be in place to deal with improperly treated water by containment and/or removal of the water from the treatment stream. At Mitcheldean works, the post contact tank had failsafe turbidity shutdowns which had been disabled for ten months. These issues illustrate failure to comply with the requirement to design and continuously operate an adequate disinfection process for the works. Additionally, disinfection is carried out using sodium hypochlorite, control of which had been poorly designed and was subject to short-term under dosing due to gas collecting in the dosing lines. A review of chlorine residual trends identified that Severn Trent Water had poor control of the disinfection process, with company staff failing to act on circumstances where the chlorine residual was outside control bands. It was identified that a changeover of the sodium bisulphite dosing equipment was coincident with the dips in chlorine residual. The company had not addressed this deviation, which had become commonplace and accepted practice. Likewise, reductions in the pre-contact tank chlorine residual coincided with the changeover of hypochlorite dosing pumps as there is a short period when neither pump is dosing. Normalisation of risks is not an acceptable approach.

Affinity Water failed to demonstrate appropriate standards were in place for verification and maintenance of online monitors at Horsley Cross works and monitoring and recording of chlorine checks was not robust. It was not possible to accurately calculate a Ct value and a definitive policy on how disinfection is achieved was not evident. In the event of high turbidity the borehole flow is stopped. However, there is a risk that forward flow would continue as the filters continue to drain and that a similar draining situation may occur in a complete power failure. Both these scenarios presented disinfection risks that needed addressing

-Emergency preparedness

Well thought through contingency plans can be particularly beneficial in ensuring measures to protect public health are taken quickly and that public concern can be addressed promptly. I am pleased to note that at Mitcheldean works, Severn Trent had implemented a scheme of alternative supplies and were able to stop flow from the works and maintain supplies from alternative sources. However, the company had further work to do on notifying other water companies who received bulk supplies from the works

and training staff on these notifications and there could be further benefits from liaising with local councils to identify vulnerable consumers. However, I am pleased to state that Severn Trent Water had good contingency plans in place to support the public in the event of an emergency.

Equally at Barrow works, Anglian Water had carried out a project on works 'Too big to fail', which identified single points of failure across the supply system and the findings have contributed to programmes of work to address these risks over the coming years. There is a much welcomed longer-term plan, to be enacted over 10 to 15 years, to address resilience issues at West Ham works. The Inspectorate recommended that, in the interim, the company improve the resilience of the site and develop alternative network arrangements to maintain supplies should there be an issue at the works.

However, formalising plans to cope with a single point of failure and recovery options at Affinity Water's Horsley Cross works, near Clacton was identified as being potentially beneficial. Likewise, contingency arrangements need to be documented and incorporated in Drinking Water Safety Plans for Thames Water's, Cleeve works and Essex and Suffolk Water's Ormesby works. While contingency plans exist for Dŵr Cymru Welsh Water's Bolton Hill works, the arrangements would benefit from a clear plan for provision of alternative supplies should they be needed. The loss of the control system at the works would require the plant to be operated manually, there was a need for a written plan to ensure that such an operation would be sustainable or that staff were trained to be able to undertake this task. The contingency plan developed for Portsmouth Water's Farlington works requires further detail on emergency supply points to support the wider supply network and further consideration of the feasibility of importing water from neighbouring companies for meeting demand in a range of scenarios.

As best practice in strategic resilience planning and mitigation, Essex and Suffolk Water are introducing a new resilience scheme, due to be commissioned in March 2019, that will allow Lound works to supply South Gorleston which will reduce the demand on Ormesby works and South East Water are refurbishing West Ham Pumping Station on a scheme to be completed in summer 2018.

-Continuing assessment of risk

A continuing assessment of risk, remediation of those risks, verification and re-assessment is an ongoing process designed to ensure public health is protected. The following observations will help companies to understand some of the site specific findings to enable assessment of similar matters at their sites:

At Horsley Cross works (AFW), some of the boreholes require camera inspection. Several process bypass options exist which may help in resilience scenarios, but in some cases treated and untreated water is separated by a single closed valve. These risks need to be reviewed and action taken such that processes cannot be inadvertently or maliciously bypassed. Arrangements to bypass tanks and processes should be appropriately managed such that the treatment process is not compromised. Plans should be in place to ensure removal from supply, of any structure containing treated water, such that internal inspection and structural repairs can be carried out. Physical disconnection of bypasses should occur wherever possible. Horsley Cross works itself has no run to waste facility and there are no drains on the storage reservoirs making it difficult to remove any unwholesome water. The works has no programme for water quality failsafe shutdown testing, which presents a risk in a water quality emergency.

At Thames Water's Cleeve works audit, air valves present a risk of ingress. This knowledge represents an opportunity to reduce this risk if applied at all relevant sites.

Anglian Water identified risks to the headworks of two boreholes supplying Barrow works including the need for some priority work on a head plate that had not been actioned. The Inspectorate recommended that the remedial work was completed and that an effective system is introduced to track the progress and close out inspection recommendations. A chemical delivery point drain was partially blocked and required improved maintenance.

Unprotected pipework in storage was lying in mud and overgrown with brambles at Ormesby works. This is not in accordance with water supply hygiene principles and not to the standard required of water companies.

Similarly, at Bolton Hill works, new pipework associated with the works refurbishment was left unprotected. While Dŵr Cymru Welsh Water acted immediately to rectify the issue this is still poor practice and raises the issue of whether companies have appropriate control over contractor activities on site. The contact tank at Bolton Hill cannot be bypassed when the works is in supply and a full internal inspection was last carried out in 2006. This, again, is not in accordance with the principles of water supply hygiene and is something companies have been regularly reminded of by the Inspectorate. Structural issues found on the tank have been addressed externally but, at the time of the audit, there was no opportunity to carry out remedial repairs internally. Dŵr Cymru Welsh Water had also identified that remedial repairs were required on seals and hatches of the potable water reservoir, but the required actions had not been completed.

It was not clear to the Inspectorate that Portsmouth Water had appropriate procedures in place to control coagulant dosing or whether this was effective. There were inconsistencies, in information provided, relating to the filter media at Farlington works and issues were identified with regard to backwash inspection.

Unhygienic equipment storage was also an issue for South East Water, where GAC floor nozzles were not stored in a sanitary condition. It was also identified that the company's policy for triple validation monitoring at critical sites was not adhered to at West Ham Pumping Station. The audit also identified that the company had not been notifying consumers when lead pipes were found on the consumers' side during routine meter box replacement. The company plan to retrospectively inform all consumers where lead pipes were detected.

At Mitcheldean works, couplings to the GAC eductor system were found to have been left in an unhygienic condition on the ground and unprotected. A number of structural issues were noted on the audit including the need to re-bed hatches on the old contact tank, retention tank and treated water reservoir. There were also unsealed ducts and detritus around the chemical dosing lines at the final treated water stage. Severn Trent Water had also failed to complete and record inspections of its rapid gravity filters as required by a Notice issued by the Inspectorate.

There is no reason that companies should fall short of the standard required for ensuring equipment is stored hygienically. A proactive and conscientious culture of identifying and addressing hygiene risks should be instilled within all operational staff and contractors.

Table 19: Audits carried out in 2017

Company	Audit Title	Date	Reason
SRN	Burpham works	30/03/2017	Catchment risk assessment
SVT	Chaddesley Corbett BPS	06/04/2017	Catchment risk assessment
BRL	Chelvey Well	12/04/2017	Catchment risk assessment
YKS	Albert works	19/04/2017	Catchment risk assessment
SRN	Eastling works	21/04/2017	Event follow up
TMS	Datchet and Eton works	25/04/2017	Catchment risk assessment
UUT	Wayoh works	26/04/2017	Catchment risk assessment
WSX	Ashford New (Danesborough) and Bridgwater Taunton Canal	27/04/2017	Catchment risk assessment
SVT	Small Heath zone and Newtown zone	05/07/2017	Consumer complaint
SES	Kenley works	05/07/2017	Complaint follow up
UUT	Concessionary supplies	06/07/2017	Event follow up
NNE	ZN106 Low service res and ZN101/ ZN102 High service reservoir	13/07/2017	Consumer complaint
NNE	Murton works	18/07/2017	Event follow up
SEW	Burwash zone and Cuckfield zone	18/07/2017	Consumer complaint
YKS	Hull West zone and Airedale zone	19/07/2017	Consumer complaint
UUT	Carlisle South zone and Haydock zone	25/07/2017	Consumer complaint

SWT	Pynes West Zone and St Cleer East Zone	31/07/2017	Consumer complaint
SRN	Testwood WSW	03/08/2017	Event follow up
DWR	Monmouth Trellech zone and Dolgellau zone	15/08/2017	Consumer complaint
YKS	Langsett WTW Disinfection policy	22/09/2017	Compliance follow up
SBW	Alderney WTW	09/10/2017	Notice compliance
SVT	Mapperley SR	16/10/2017	Event follow up
PRT	Lavant and Funtingdon Disinfection	17/10/2017	Legal instrument follow up
AFW	Horsley Cross WTW	31/10/2017	Critical works audits
SST	Seedy Mill WTW	09/11/2017	Compliance follow up
TMS	Cleeve 2 Gatox WTW	09/11/2017	Critical works audits
ANH	Barrow WTW	15/11/2017	Critical works audits
DWR	Bolton Hill WTW	22/11/2017	Critical works audits
ESK	Ormesby WTW	22/11/2017	Critical works audits
SEW	West Ham Pumping Station	22/11/2017	Critical works audits
SVT	Mitcheldean WTW	28/11/2017	Critical works audits
PRT	Farlington WTW	30/11/2017	Critical works audits
SRN	Nitrate Sites	04/12/2017	Notice compliance
CAM	Horseheath and Response to recommendations	12/12/2017	Compliance follow up

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