DRINKING WATER QUALITY REGULATOR

FOR SCOTLAND

dwqr

Drinking Water Quality Regulator for Scotland

Drinking Water Quality in Scotland 2019 Public Water Supply

SAFEGUARDING YOUR DRINKING WATER QUALITY

Contents

i. FOREWORD

This is the eighteenth report from the Drinking Water Quality Regulator for Scotland (DWQR). The report provides a summary of the quality of Scotland's public water supplies for 2019. My report also describes our work during the calendar year 2019 in scrutinising the quality of drinking water provided by Scottish Water.

The quality of our drinking water is vital to public health – we all depend on it. Scottish Water samples and tests drinking water many times each day of the year. In 2019, 99.92% of these tests taken from consumers' taps met the standards set out in Scottish and EU legislation, an extremely high rate of compliance, and we can be confident in the safety of the public water supply anywhere in Scotland. The compliance figure is slightly higher than in 2018, although the figure has been fairly static overall for the past few years. The largest number of failures were for manganese, iron and coliform bacteria.

We cannot take progress for granted, and challenges such as climate change, altering demand patterns and the existing capability of treatment assets will all have an increasing impact Scottish Water's operations. Scottish Water must meet these challenges by planning ahead and investing appropriately. My team investigated every incident affecting water quality, and I am concerned that there is still a significant number of these. This does not indicate the high level of resilience that is required to provide a consistently high quality of water into the future. Things will always happen unexpectedly, but Scottish Water's assets must be designed, built, maintained and operated with the resilience to cope. Numerous water quality incidents in 2019 demonstrated that such resilience is sometimes lacking.

The greatest asset of any organisation is its people, and Scottish Water is no exception. I continue to be impressed by the expertise, diligence and sheer desire to provide an excellent service shown by almost every Scottish Water staff member I meet. Nonetheless, I have been concerned this year by the number of water quality incidents where human error has played a role. I shall be investigating this further, however I look to Scottish Water to ensure that it has systems in place to ensure and demonstrate the ongoing competence of staff as well as making certain that they have the resources and support needed to fully perform in their role.

I hope that you find this report informative and that it enables you to share the confidence I have in Scotland's public water supply.

Sue Petch
Drinking Water Quality Regulator for Scotland

ii. EXECUTIVE SUMMARY

In Scotland the public water supply is provided by Scottish Water. All other supplies are known as private water supplies, managed by owners and users. The Drinking Water Quality Regulator for Scotland (DWQR) regulates the quality of water supplied by Scottish Water, ensuring that drinking water supplies meet the requirements of The Public Water Supplies (Scotland) Regulations 2014 ("the Regulations"). This report describes Scotland's drinking water quality in the public supply provided by Scottish Water and the regulatory actions that DWQR has undertaken in 2019. DWQR publishes a separate report on private water supplies which you can view on our website at https://dwqr.scot/information/annual-report/.

Scottish Water takes and analyses its own samples to demonstrate that the water supplied complies with regulatory requirements. This sampling and analysis is independently accredited and is consistent with water industry practice in the rest of the UK. The DWQR assesses Scottish Water's monitoring programme and results. These are discussed in Section 1 of this report. We also inspect a range of Scottish Water activities and assets that could affect the quality of drinking water and investigate any water quality incidents that are reported. Information on our audit and investigative work is given in Sections 3 and 5 of this report.

2019 in review
Public Water Supplies in Scotland

233 Water Treatment Works

975 Water Storage Tanks

285 Water Supply Zones

Drinking water sources

There are 30,287 miles of drinking water distribution pipes in Scotland

We assessed:

310,605 tests were taken by Scottish Water

137,783 tests were taken at consumers' taps

99.92% of tests at consumers' taps passed

We reviewed 837 drinking water related events

We declared 29 incidents

We assess **every** fail | We review **every** event
We investigate **every** incident

1. PUBLIC DRINKING WATER SUPPLIES IN SCOTLAND 2019

1.1 Water Treatment Works

Scottish Water has 233 water treatment works (WTW) that treat water to ensure it is safe to drink and complies with the standards set out in the Regulations. Treatment works in Scotland range from large supplies serving whole cities to very small works that supply small communities consisting of a few properties. Regardless of size, DWQR expects Scottish Water to ensure that its water treatment works are capable of treating the range of raw water quality which is found in source waters.

Overall, 61,514 tests were undertaken on samples collected at treatment works, and of these, 43 (0.07%) failed to meet the required standard.

1.1.1 Microbiological Quality at Water Treatment Works

Coliforms and *E. coli* are two variables (known as parameters) measured in water leaving treatment works in order to check that disinfection has been successful. Coliforms are a group of bacteria widely found in the environment and *E. coli* is an indicator of faecal contamination. If either are detected it shows that disinfection hasn't been effective at killing potentially harmful bacteria. The standard is for none to be present and all failures must be fully investigated by Scottish Water and reported to DWQR, the local NHS board and local authority.

When investigating sample failures at treatment works, Scottish Water consider a number of factors, such as changes in the quality of the incoming raw water; issues or unexpected changes in the treatment process; the circumstances of sampling, including the condition of the sample line and sample tap; and evidence from samples taken downstream in the distribution system. They should also consider taking additional samples, including between stages of the treatment process, to establish whether there is a genuine problem and where this might be. Data from on-line monitoring can also yield very useful information on quality around the time of the failure. Scottish Water routinely carries out root cause analysis of investigations of sample failures and this is beneficial in understanding and resolving the causes underlying many failures.

Although microbiological quality at water treatment works improved significantly in the first part of this century, compliance has since plateaued and this year's results represent a deterioration in that trend with a significant increase in the number of failures. Coliform bacteria were detected in 32 samples and *E. coli* in three, the worst performance for this parameter since 2012. Of particular note were three coliform failures in quick succession at Amlaird WTW that were eventually traced to the condition of one of the clear water tanks. This incident highlighted the importance of the maintenance of on-site storage tanks as well as shortcomings with Scottish Water's investigation process.

Scottish Water has made substantial investment in ensuring that water samples are representative of the actual water quality leaving a treatment works. At the request of DWQR, Scottish Water has also investigated the performance of the disinfection process at every treatment works, and in some cases this has been found to be less than optimal. Scottish water has identified improvements to disinfection as a key driver for investment in its Strategic Projections and there is a clear opportunity

for Scottish Water to make the necessary improvements to this most vital of water treatment processes.

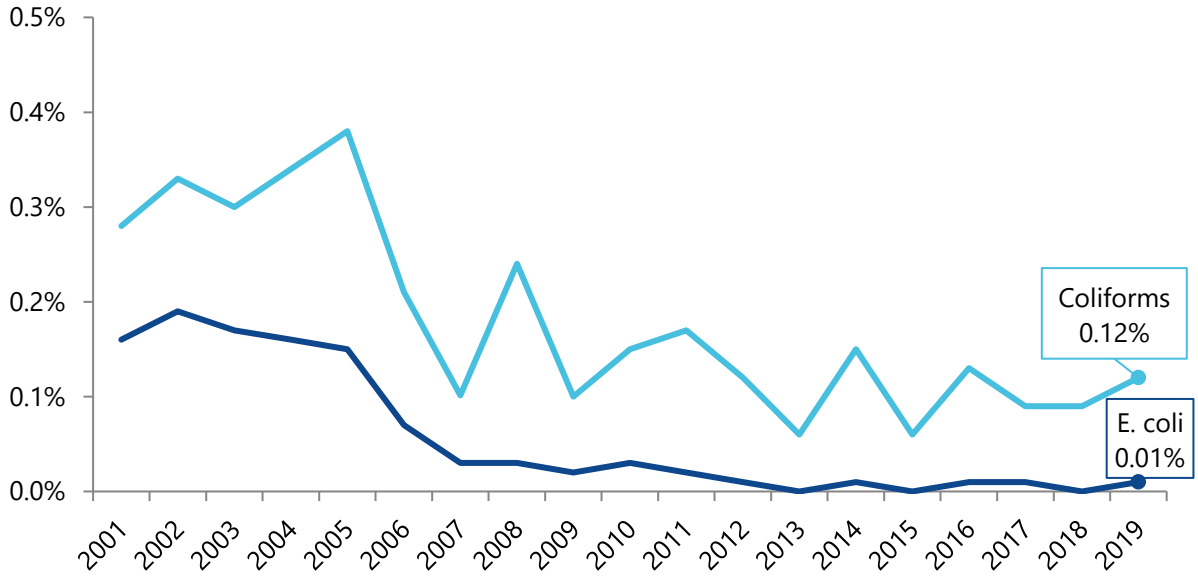

Figure 1 Microbiological Failure Rate at Water Treatment Works

1.1.2 *Cryptosporidium* at Water Treatment Works

Cryptosporidium is a microscopic protozoan parasite that can live in the gut of humans and other animals. *Cryptosporidium* oocysts can enter a water supply if faecal material is washed into the source (raw) water and oocysts are not removed by the treatment process. *Cryptosporidium* is not killed by chlorine and requires the water treatment process to be well optimised and monitored in order to ensure that it is physically removed. Scottish Water tests water supplies for *Cryptosporidium* in order to verify that these processes are effective. Ultra-violet (UV) light can be effective at inactivating oocysts and Scottish Water uses this process at a small number of sites where physical removal of oocysts by the original treatment process is not achieved consistently in all cases.

In 2019, 38 samples contained *Cryptosporidium* oocysts, however all but eight of these detections received a UV dose adequate to inactivate the oocyst. Bonnycraig WTW near Peebles was the source of 22 of the detections, although all but one of these received the required UV dose. Significant investment is scheduled for Bonnycraig as it is currently the subject of a DWQR enforcement notice.

Table 1 *Cryptosporidium* detections at Water Treatment Works

Cryptosporidium	**2019**	**2018**	**2017**	**2016**	**2015**
No. of tests	9,101	8,764	9,087	9,737	9,483
No. of samples containing *Cryptosporidium* oocysts	38	35	44	87	84
% of samples containing *Cryptosporidium* oocysts	0.40	0.40	0.48	0.89	0.89
No. of WTW sampled for *Cryptosporidium*	230	238	234	238	238
No. of WTW with one or more samples containing oocysts	11	23	20	28	26
% of WTW with one or more samples containing oocysts	4.78	9.66	8.55	11.76	10.92

Image 1 UV filters like this one inactivate *Cryptosporidium* oocysts which may be present in source waters.

1.1.3 Chemical Quality at Water Treatment Works

Water is tested for two chemical parameters, nitrite and turbidity, in samples taken from treatment works. Nitrite is a compound of nitrogen that can occur in supplies where ammonia is added to chlorine in a process called chloramination. This process needs to be tightly managed, and the presence of nitrite in significant quantities can indicate that it is not controlled as it should be. There were no exceedances of the nitrite standard at treatment works during 2019.

Table 2 Nitrite Failures at Water Treatment Works

Nitrite	2019	2018	2017	2016	2015	2014
Number of tests	3,250	2,980	2,853	2,801	2,836	2,856
Number of tests exceeding standard	0	0	0	3	0	0
Percentage of tests exceeding standard	0.00	0.00	0.00	0.11	0.00	0.00
No. of WTW not meeting regulatory requirements	0	0	0	1	0	0
% of WTW not meeting regulatory requirements	0.00	0.00	0.00	0.41	0.00	0.00

Turbidity is a measure of the extent to which particulate matter in the water scatters light – effectively how cloudy the water appears. Turbid waters cannot be properly disinfected, hence a treatment standard of 1.0 nephelometric turbidity units (NTU) has been set in the Regulations. Eight exceedances of the turbidity standard occurred in 2019.

Table 3 Turbidity Failures at Water Treatment Works

Turbidity	2019	2018	2017	2016	2015	2014
Number of tests	7,026	6,859	7,060	7,127	7,150	7,347
Number of tests exceeding standard	8	9	10	10	10	13
Percentage of tests exceeding standard	0.00	0.13	0.14	0.14	0.14	0.18
No. of WTW not meeting regulatory requirements	6	9	9	9	9	12
% of WTW not meeting regulatory requirements	0.03	3.78	3.78	3.73	3.75	4.98

All were investigated by Scottish Water. Two water treatment works recorded two failures each. At Daer WTW in Lanarkshire, the failures occurred within a month of each other. They were attributed to lime deposits within the sample line. The flush time was increased and there are plans to relocate the line. The two failures at Turriff in Aberdeenshire were attributed to problems with the control of the lime dosing.

Image 2 An online turbidity monitor at Poolewe WTW.

1.2 Service Reservoirs

Service reservoirs are located at points in the distribution system to store water for hydraulic reasons and to meet the demand for water from consumers through the day. If these service reservoirs are not maintained they can be prone to inward leakage from contaminated surface water. This needs to be controlled through inspection and maintenance. We inspect a selection of structures each year in order to ensure that they are being maintained and operated in a manner that minimises risk of contamination of the water. Coliform and *E. coli* samples are taken regularly from service reservoirs to check that disinfection is effective within the distribution system and to identify any instances where the water may have become contaminated. All *E. coli* and coliform failures must be fully investigated by Scottish Water and reported to DWQR, the local NHS board and local authority.

In 2019, 72 samples taken from service reservoirs contained coliforms with six of these also containing *E. coli*. This represents a deterioration in performance with the worst coliform result since 2014 and the highest number of *E. coli* detections since 2012. Scottish Water has increased the investment in storage point maintenance; however, a significant backlog of work remains. Figure 2 shows annual performance since 2007.

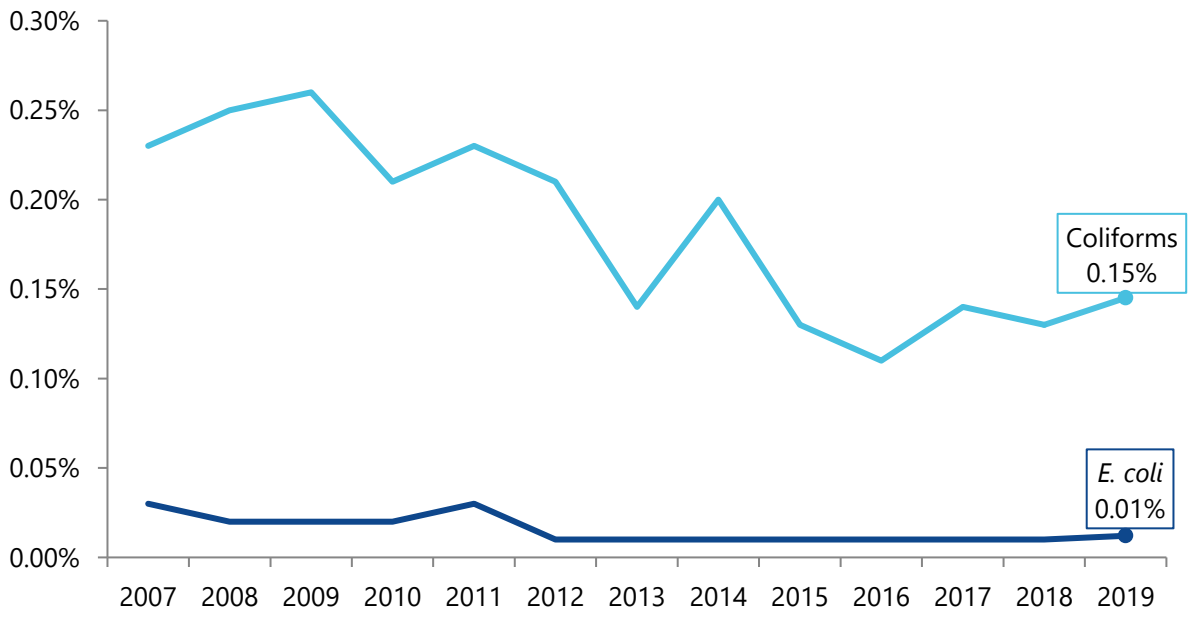

Figure 2 Microbiological Failure Rate at Service Reservoirs

The Regulations require that no sample from service reservoirs should contain *E. coli* and at least 95% of samples do not contain coliforms. Eight service reservoirs failed to meet the 95% requirement, although all but one of these appears to have been out of service for part of the year to enable deficiencies to be rectified following the failures. Northmavine Service Reservoir on Mainland Shetland was in service all year and recorded four coliform failures. Although no cause was conclusively proven, significant work has been undertaken to remove a dead leg of pipe and install a bypass to enable the tank to be cleaned – something which has not been possible previously.

The service reservoirs that reported samples containing *E.coli* were Tolsta Village (since removed from supply), Pitcalzean, Westfield, Achnacarnin, and Dalry South. DWQR visited Dalry South SR in Ayrshire in October and witnessed extensive maintenance work, including the installation of a new roof membrane.

Image 3 A hatch at Fochabers SR with an upstand to prevent ingress of untreated water. Service Reservoirs need to be maintained regularly to reduce risk of contamination.

1.3 Water Quality at Consumers' Taps

Scottish Water's supply area is divided into 285 water supply zones. Most sampling to assess regulatory compliance takes place at consumers' taps and tests for 70 variables known as parameters. Sampling frequencies are determined by the size of the population in the water supply zone.

In 2019, 137,783 tests were carried out on samples taken at consumers' taps. Of these, 114 failed to meet the standard set out in the Regulations. This means that 99.92% of tests carried out at consumers' taps complied with the standards. The equivalent figures for 2018 were 151 failing samples and 99.90% compliance, demonstrating an improved performance. 66 supply zones failed to meet one or more of the standards, which is less than the 69 reported in for 2018, indicating more of the failures were occurring singly, in separate zones.

Table 4 below shows the failing test results of samples taken from randomly selected consumers' taps. Compliance for a number of key parameters is then discussed in more detail. The number of samples taken for each parameter that Scottish Water is required to test for is shown in the Performance Tables in Section 8.1 of this report. In addition to these regulatory samples, Scottish Water also take samples from consumers' taps for further investigation where the consumer reports an issue.

Table 4 Summary of Failing Tests on Regulatory Samples From Consumers' Taps in 2019

Parameter	Total No. of Tests	No. Failed Tests	No. Zones with Failures	% Compliance
Coliform Bacteria	14,925	37	26	99.75
Iron	5,199	37	21	99.29
Manganese	5,199	10	10	99.81
Lead	1,499	7	6	99.53
Odour	5,256	5	5	99.90
Clostridium perfringens	5,217	3	3	99.94
Total Trihalomethanes	1,494	3	3	99.80
Nitrite	2,781	3	2	99.89
E. coli	14,925	2	2	99.99
Taste	5,255	2	2	99.96
Hydrogen ion (pH)	5,254	1	1	99.98
Turbidity	5,254	1	1	99.98
Nickel	1,500	1	1	99.93
SCOTLAND**	**137,783**	**114**	**66***	**99.92**

*A supply zone can fail for more than one parameter. This means that the total number of zones that failed for *at least* one parameter is less than the sum of the 'No. Zones with Failures' column.
** Including other parameters not shown here. You can see the full list of parameters in Table 20.

1.3.1 Microbiological Quality at Consumers' Taps

Coliform Bacteria

Coliform Bacteria or 'Total Coliforms' represent a group of bacteria of which *E. coli* is one species. They are common in the environment and do not necessarily indicate faecal contamination but should not be present in the water supply as they are readily deactivated by chlorine, which is added in controlled amounts to all of Scottish Water's supplies.

Coliforms were detected in 37 samples in 2019 but there does not appear to be a geographical pattern to the exceedances with 18 of the failures occurring singly in different supply zones. Balmore G zone recorded four failures and the investigations carried out by Scottish Water could find no evidence to link the failures together or to any specific cause. Clatto West A zone recorded three failures and six others recorded two failures.

Water supply zones fed from Clatto treatment works in Dundee have exhibited a number of failing samples in recent years and in 2019, DWQR required Scottish Water to carry out a review of microbiological performance across the Clatto supply system. Although there was no single or main cause found for the failures, a range of mitigation measures were identified. These involve treatment process optimisation, improved stability of disinfection levels and storage point cleanliness and integrity. With three of the Clatto supply zones still accounting for six of the coliform failures in 2019, there is a need to ensure attention continues to be given to this system.

When coliform failures occur, Scottish Water takes further samples from the premises and also from neighbours' taps to determine if there is a local property issue or a wider supply system concern. Scottish Water notifies the consumer of the findings and provides the appropriate advice in each case.

Performance against this parameter has plateaued over the past five years with compliance very similar to this year's 99.75%. Although many of these failures are found to be caused by hygiene issues at the kitchen tap and therefore outside of Scottish Water's direct control, Scottish Water has shown that reductions in the numbers of failures in the public supply system are possible through activities such as thorough treatment of water; good maintenance of storage points and distribution systems; and careful management of residual chlorine and water age. A more concerted focus however will be required in this area for improvement to be made.

E.coli

E. coli is an extremely important parameter because it is an indicator of faecal contamination and the microbiological safety of the water. The detection of *E. coli* in a water sample may be an indication that either the supply in that area or the tap from which the sample was taken has become contaminated . Scottish Water must investigate each failure thoroughly to try to determine the cause and respond appropriately.

Compliance for this parameter is relatively stable with only a few failures occurring each year. Two samples failed singly in separate zones in 2019. One was attributed to the condition of the kitchen tap. Scottish Water was unable to attribute a definitive cause to the other failure.

Clostridium perfringens

Clostridium perfringens is a secondary indicator of faecal pollution. Clostridial spores can survive in water much longer than organisms of the coliform group and will resist disinfection by chlorine. Their presence in disinfected waters may indicate deficiencies in treatment. In distribution systems and at consumer taps, they can be an indicator of some historic contamination having occurred.

Three failures of this standard occurred in 2019 in three separate zones. In all cases, resamples were clear and investigations could find no definitive cause for the failures.

1.3.2 Chemical Quality at Consumers' Taps

Iron

Iron occurs naturally in some water supplies but should be predominantly removed by the treatment process. It is used as an alternative flocculant to aluminium at a few treatment works in Scotland. The most common cause of failures of the iron standard at consumer taps is corroding cast iron water mains which can cause sediment to build up in distribution systems. High concentrations of iron can cause discoloured water supplies, greatly inconveniencing consumers.

Scottish Water continues with a programme of renovation and cleaning of the water mains that cause the most significant water quality issues. This should also have the effect of reducing the number of complaints about discoloured water in the future.

Compliance with the iron standard has improved over the years but 2019 saw a similar level of performance to the previous year with 37 samples failing within 21 supply zones. Eleven zones recorded single failures and there were two zones where four failures occurred: Rawburn and Bradan A. It is notable that three Bradan zones accounted for seven of the total number of failures. Scottish Water has carried out extensive investigation and mains cleaning in the Bradan supply zones. DWQR agreed to a proposal for additional mains replacement in some parts of the Bradan network where cleaning has not resolved the issue satisfactorily.

Manganese

Manganese occurs naturally in some raw waters, especially in the west of Scotland. If it is not removed effectively by the treatment process it can accumulate as fine black sediment in distribution system pipework and cause severely discoloured water supplies and great inconvenience for consumers. Even a relatively low concentration of manganese in the final water of a treatment works can build up in pipes and cause problems in distribution pipework. 2019 has shown improved performance with the compliance standard for manganese with 10 failures occurring singly in separate zones.

Lead

In Scotland, lead does not occur naturally in significant concentrations in our water supplies. The problem arises when drinking water comes into contact with lead supply pipes, lead tanks, and lead solder joints on copper pipes, or inferior quality brass fittings and taps, particularly for longer periods (e.g. overnight/ weekends/ holiday periods). This can result in high lead levels in the drinking water supply.

The Scottish Government has a project to review the policy in relation to the reduction of exposure to lead in drinking water. The project aims to raise awareness of consumers to the concerns about lead in drinking water and to promote the removal of lead service pipes and plumbing. Within this, DWQR has commissioned Scottish Water to carry out a surveillance programme for lead within independent schools and nurseries. Scottish Water is also undertaking work to explore the lead issue as part of its lead strategy. This includes work to assess the practical issues encountered in replacing lead pipework in people's homes and gardens.

Although the majority of lead piping is privately owned and therefore outside Scottish Water's direct control, it does have a responsibility under the Regulations to minimise the risk from dissolved lead. In regulatory sampling, there were seven failures of the standard, with only one supply zone recording more than one failure. This was Forehill supply zone in Aberdeenshire where two failures occurred.

Scottish Water reported a further 162 failures of the standard arising from sampling carried out in response to consumer requests. These requests come from consumers who either have a personal awareness and interest in the health impact of lead or in relation to a change of ownership of a property. This number cannot be used to imply a wider issue with lead pipes across supply zones but does illustrate that for some property owners, lead pipes remain a problem. In all the circumstances of a failing lead sample, Scottish Water will check the part of the pipe in their ownership and renew this if it is made of lead. Consumers are advised to replace their own supply pipe from the boundary of the road into the building.

Total Trihalomethanes (THM)

THM is a group of disinfection by-products that can form when organic substances combine with chlorine used to disinfect the water. As Scotland's upland waters are naturally rich in these organic compounds, management of THM formation presents a challenge for Scottish Water. Scottish Water has devoted much effort to reducing the formation of THM in its water supplies and has made significant progress on this issue. In 2019 there was a better performance for THM with three failures occurring in separate zones whereas, in 2018, eight failures occurred in seven zones.

The three areas where failures were recorded in 2019 were Howden, Burncrooks and Burncrooks & Blairlinnans supply zones. Burncrooks WTW which supplies two of those areas had operational difficulties over part of the year with the powdered activated carbon (PAC) element of the treatment process which is in place to moderate the level of organics in the supply. Scottish Water intend to close Burncrooks WTW and this work is well underway. Improvement works are also underway at Howden WTW.

Figure 3 shows the number of zones affected at different levels of THM within the standard. It illustrates that although the number of failures of the standard (also known as the Prescribed Concentration or Value (PCV)) had reduced in 2019, there are more samples exceeding 50% and 90% of the standard indicating continued efforts are needed to minimise the formation of disinfection by-products on an ongoing basis.

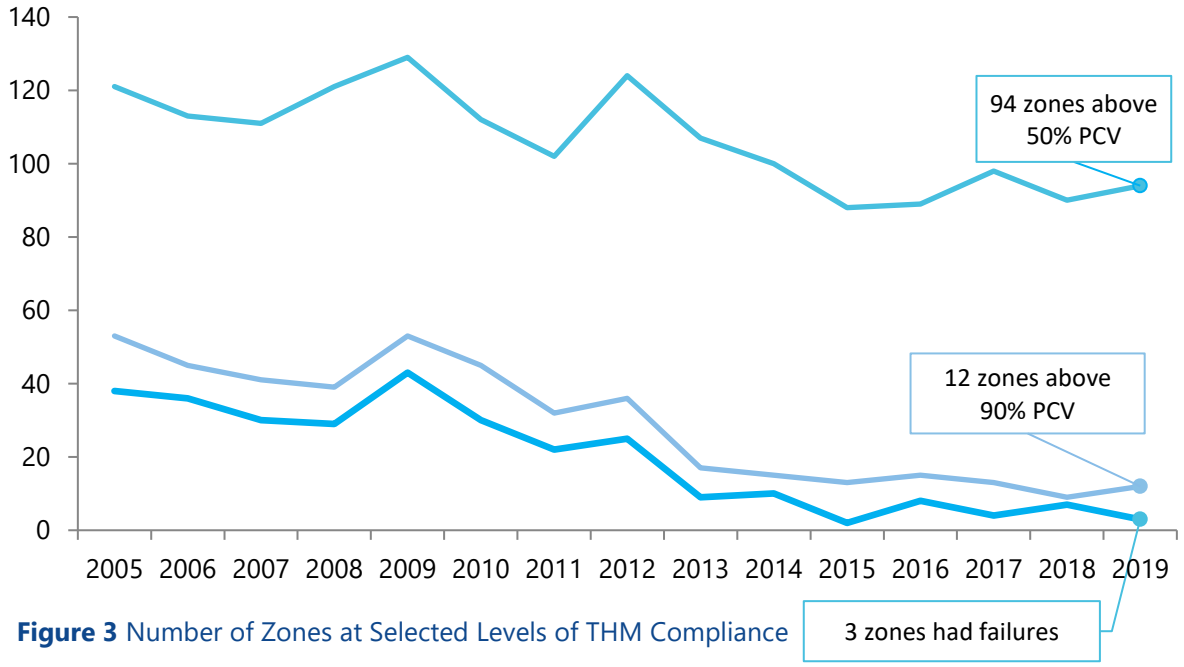

Figure 3 Number of Zones at Selected Levels of THM Compliance

In addition to meeting the standard for total THM, Scottish Water is also required to minimise the production of all disinfection by-products. DWQR has required Scottish Water to carry out additional operational monitoring for other disinfection by-products to demonstrate that they are minimising across a range of substances not just THMs.

During 2019, the results from their extra baseline monitoring for two of the main disinfection by-products groups, THM and halo-acetic acids (HAA), give a clearer picture of the effectiveness of the measures taken to minimise by-products. Although the number of samples exceeding the 100µg/l regulatory standard was relatively small, more than a quarter of the 932 samples collected at storage points exceeded 50µg/l. In 2019, 36 out of 308 water supply zones had an average THM concentration in excess of 50µg/l – an almost identical number of zones to 2015. 177 supply zones actually showed an increase in average THM concentration between 2015 and 2019, while 116 saw a decrease and 14 showed no change.

For HAA, Scottish Water calculated the sum of the five most significant HAA chemicals in the group. The number of supply zones with a Mean HAA concentration in excess of 50µg/l decreased from 12 in 2015 to only one in 2019. Similarly, 46 zones had a mean concentration in excess of 30µg/l in 2015, reducing to 16 in 2019. The overall mean HAA concentration across all supply zones showed little change over the period. It is likely that HAA will become a regulatory parameter in future years and will be regularly monitored.

From this exercise, although the picture for HAA is slightly better than for THM, it suggests that further effort is needed to minimise disinfection by-products. This is likely to take the form of capital investment as well as operational measures. This is increasingly important, given that Scottish Water has highlighted in its strategic projections that the levels of organic substances in Scotland's source waters is rising and will be a significant challenge in the future.

Nitrite

Nitrite forms when nitrifying bacteria react with the ammonia that is added to chlorine in a process known as chloramination. If the process is not carefully controlled and nitrifying bacteria are allowed to persist in the distribution system due to water lying in pipes for long periods (due to the length of the system and/or the amount of water being used by consumers), nitrite can build up and cause failures in the standard. In 2019 there were three failures of this parameter with two occurring in the Rawburn supply zone.

Nickel

Nickel is not found in high concentrations in Scotland's waters. Nickel is, however, used for many different applications but mainly in the production of stainless steel and other metal products. Its presence in drinking water generally arises from contact with plumbing fittings, such as nickel or chromium-plated taps or certain types of kettles. A single failure occurred in 2019 which was attributed to the type of tap or plumbing fittings and infrequent use.

Image 4 Water needs to be treated to remove unwanted substances and then disinfected to ensure it is safe to drink.

Taste and Odour

There were five odour failures in 2019, all occurring in separate supply zones. Two failures of the taste standard were recorded in two separate zones and neither coincided with the odour failures. In all cases, Scottish Water was unable to identify a cause with subsequent investigative sampling being unable to exhibit the same characteristics. Both taste failures were described as TCP type which can be indicative of a reaction of chlorine in the water supply with chemicals in rubber hoses, kettles or tap washers. One odour failure in Clatto East zone was described as a fuel type. Resamples from neighbouring properties were satisfactory though the owner of the property where the failing sample was originally taken, refused Scottish Water entry to take resamples.

Turbidity

Turbidity in water is caused by suspended particles or colloidal matter that obstructs light transmission through it, making it appear cloudy. The standard is primarily an aesthetic one, but high turbidities need to be investigated, especially in water leaving the treatment works, as they could indicate a problem with the treatment process and may mean that the effectiveness of disinfection has been compromised. Failures can occur at consumers' taps for a number of reasons, but the most common cause is the disturbance of sediment in the bottom of corroding iron water mains. There was one failure in 2019 in Afton zone which also failed the iron standard. This failure was attributed to the condition of iron water mains and disturbance of pipeline deposits.

Hydrogen Ion (pH)

The pH of a substance is the measure of how many hydrogen ions it contains, with large numbers of hydrogen ions making it more acidic. Most waters in Scotland are naturally soft and have a low pH. Such water can be corrosive to metals used in plumbing, therefore Scottish Water needs to correct this to bring the pH into the required range. High pH values can sometimes occur where water is in prolonged contact with some water mains containing cement. Waters with a very high pH can have a taste that some consumers find unpleasant. There was one failure for a high pH in 2019 in the Crathie supply zone.

1.4 Consumer Contacts

When a consumer calls Scottish Water regarding the quality of their water supply, the contact is recorded and classified according to the nature of the issue. Scottish Water received 10,658 consumer contacts relating to water quality in 2019, equating to a contact rate of 19.9 per 10,000 population. In August 2018, Scottish Water introduced a new consumer contact management system which is better able to record and categorise consumer contacts. The new system addresses concerns DWQR had of the lack of visibility of some water quality complaints in the former system where requests were made for bottled water or other service activity. As a result, the numbers referred to in the this year's report will be greater than previous years, reflecting the better capture and reporting of consumer concerns around water quality.

Figure 4 shows 70% of calls were received in response to discoloured water and aerated (or milky) water. These two categories not only reflect problems with the condition of the water supply network but they also highlight problems caused by operational activity where flow changes within the water mains are caused by the operation of valves or by burst mains. The chart also shows the 18 per cent of contacts relate to the taste or smell of the water supply causing concern to consumers.

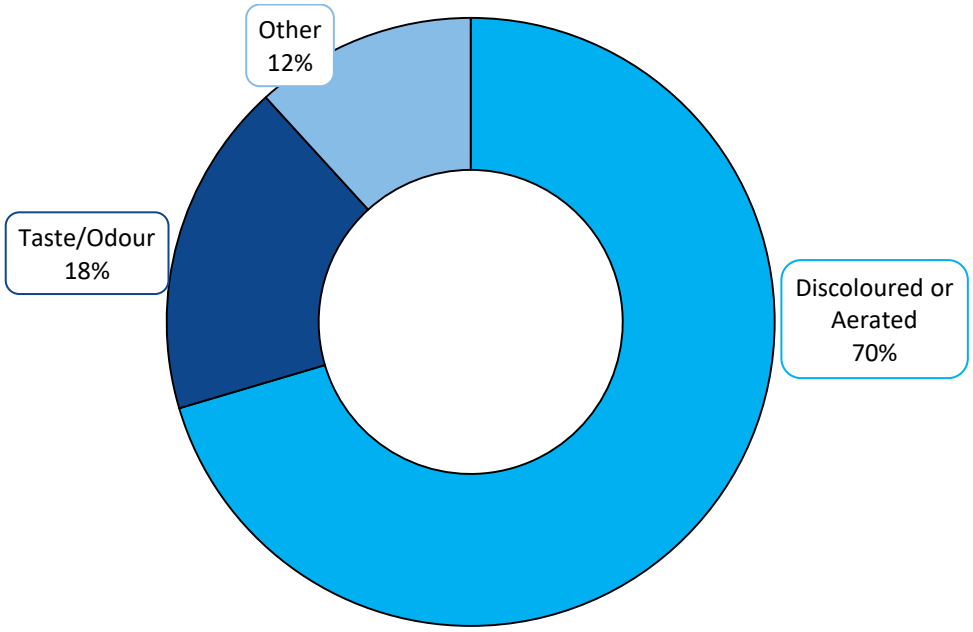

Figure 4 Breakdown of Consumer Contacts by Type 2019

Whilst it is acknowledged that the proportions of categories will shift as the overall numbers change, Figure **5** further illustrates the point in terms of the trends in key contact types. The main driver for consumer contacts remains discoloured water and whilst the other main contact types continue to decline, it is a concern that the past two years has seen an increase in the overall proportion of contacts from consumers concerned with the colour of their water.

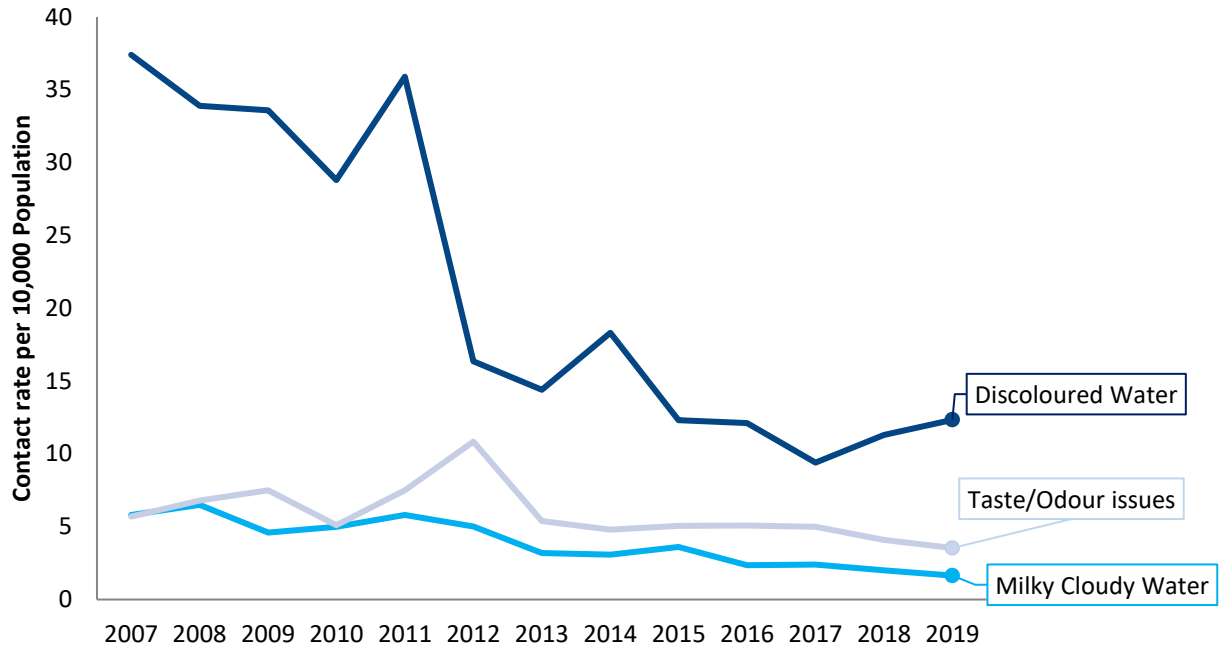

Figure 5 Trend in Key Contact Categories

For taste and odour contacts, the proportion of consumers concerned with chlorine has reduced on the 2018 position at 5% and musty/earthy type tastes and odours at 6%. The majority of musty/earthy contacts were from areas supplied from Carron Valley treatment works due to the presence of geosmin, a substance usually associated with algae growth in source waters.

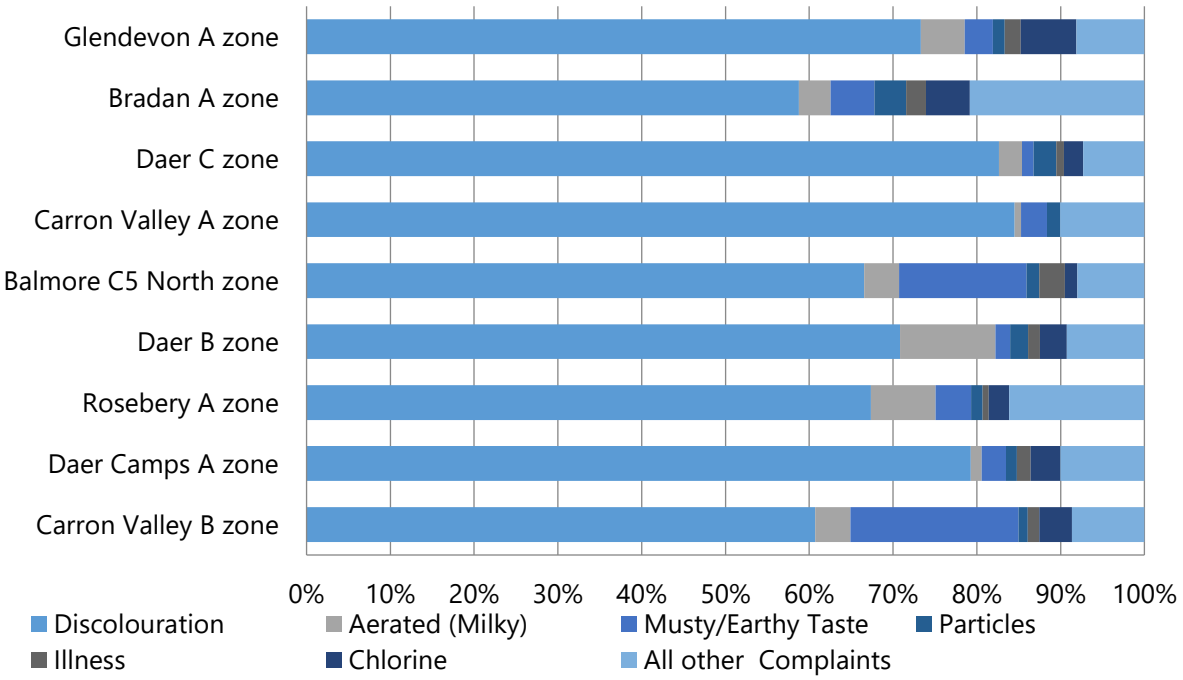

Figure 6 Water Supply Zones with Most Water Quality Complaints 2019

In geographic terms, the areas where most issues were raised by consumers are shown in Figure 6. There are nine zones where more than 200 contacts were received. This has increased from the six reported in 2018. The chart shows the supply zones ranked by contact rate with most being received from consumers in the Carron Valley B zone. The Carron Valley zones illustrate the higher proportion of contacts due to musty/earthy type taste and odours.

1.5 Consumer Contacts to DWQR

Scottish Water has a responsibility to investigate water quality complaints and supply issues. We guide consumers to report any concerns to Scottish Water in the first instance to enable their investigation and resolution. Where consumers are dissatisfied with Scottish Water's response and have pursued and completed a formal complaint with Scottish Water, the DWQR can carry out an investigation of the issues.

As well as dealing with formal complaints about Scottish Water, DWQR receives contacts from consumers and other organisations about water quality matters. We are able to offer impartial advice and assistance in many cases and a summary of these is shown below in

Table 5.

Table 5 Consumer Contacts Received by DWQR 2019

Contact Category	Number of Contacts					
	2019	2018	2017	2016	2015	2014
Appearance						
Discoloured Water	4	2	4	12	3	6
Aerated (Milky) Water	0	0	0	2	0	1
Particles in Water	1	1	2	1	0	1
Organisms in Water	0	1	1	0	0	1
Taste and Odour						
Chlorine	5	2	5	4	2	9
Metallic	0	0	0	0	1	0
Solvent/Fuel	0	0	0	0	1	0
Musty/Earthy	2	0	1	2	0	0
TCP/Chemical	2	0	0	0	0	0
Other contact about Water Quality						
Illness due to Water	3	2	5	4	2	2
Other Contact	17	21	7	4	6	3
Total Public Supply Water Quality contacts	**34**	**29**	**25**	**29**	**15**	**23**
Public water supply requests for information	6	3	35	21	8	23
Private water supply issues	64	96	59	29	23	16
General Enquiries to DWQR	19	15	5	36	32	37
Total Consumer Contacts to DWQR	**123**	**143**	**124**	**115**	**78**	**99**

Tier two investigations of SW consumer Complaints

We carried out formal investigation of one complaint against Scottish Water in 2019.

The complaint was that Scottish Water had not taken samples correctly when investigating a water quality complaint. The consumer had contacted Scottish Water on several occasions between 2014 and 2018 regarding the quality of water in their home, in particular regarding lead and particles in water. This Water Quality complaint had previously been escalated to DWQR for investigation and we concluded at that time that Scottish Water had acted appropriately and the water supplied met the required standards. Further sampling had however been carried out by Scottish Water in November 2018 and the consumer was concerned that these samples had not been taken correctly and therefore the samples were not representative of the quality of water supplied. The consumer called Scottish Water again in March 2019 regarding the handling of his complaint and Scottish Water indicated they were satisfied with all their actions taken in response to this consumer enquiry.

DWQR reviewed the information relating to the complaint including a further assessment of all water quality data, visited the complainant, witnessed sampling being undertaken by the local authority and contacted one of the individuals from the local authority present during the sampling event in November 2018. DWQR could find no evidence to support the complaint that samples were not taken correctly and the complaint was not upheld. A summary of our complaint determinations may be found on the DWQR website at https://dwqr.scot/regulator-activity/consumer-complaint-investigations/.

2. WATER QUALITY EVENTS AND INCIDENTS

Scottish Water is required to tell DWQR about all events that have affected or could affect water quality or cause concern to consumers. This includes all regulatory sample failures; operational sample failures that are significant or unexpected; any failure of a treatment process; significant numbers of consumer contacts; and issues which attract significant media interest.

Each event is reviewed and classified into one of five categories: not significant, minor, significant, serious or major. Those events categorised into one of the latter three categories are classed as incidents requiring further detailed investigation by DWQR. Where further information is required a full report may be requested from Scottish Water. It should be noted that where a full report is not requested, this does not suggest in any way that the incident is less serious.

Incidents are fully investigated by DWQR Inspectors who produce a written assessment and make recommendations where appropriate. As part of the investigation, DWQR staff often visit Scottish Water sites to talk to Scottish Water employees and examine equipment failures. A short summary of the incident assessment is published on the DWQR website. For the most serious incidents, enforcement action or prosecution are considered and can be taken.

There were 837 events reported to DWQR during 2019, the majority of which were not significant. Table 6 shows the numbers of events and the Scottish Water operating areas where they occurred. A summary of incidents is available on our website https://dwqr.scot/regulator-activity/water-quality-incidents/.

Table 6 Drinking Water Quality Events and Incidents in 2019

	Not Significant	Minor	Significant	Serious	Major
EAST	206	46	11	1	0
NORTH	83	39	5	0	0
SOUTH	151	72	4	0	0
WEST	187	24	6	2	0
SCOTLAND	**627**	**181**	**26**	**3**	**0**

29 of these events were classified by DWQR as incidents which is an increase from the 23 declared in 2018. The reasons why events were classified as incidents in 2019 are illustrated in the chart in Figure 7. Almost half of all incidents were caused by a failure of disinfection or loss of control of a critical treatment process. Seven caused significant concern or media interest over water quality, three were caused by a failure of management processes, three where water already treated was later contaminated, one where alternative water supplies were arranged, and one asset failure.

DWQR is especially concerned about the number of incidents where a causal factor was human error and/or lack of training. In total this was found to be either the cause or a compounding factor in 11 incidents during 2019. Failures to follow procedures, to properly escalate the issue, or to respond to alarms were highlighted. Scottish Water has in place a comprehensive programme of operator

training and whilst only a small number of its 233 treatment works were affected by the failings from these incidents, they do highlight the need for continuous focus on competency and procedures.

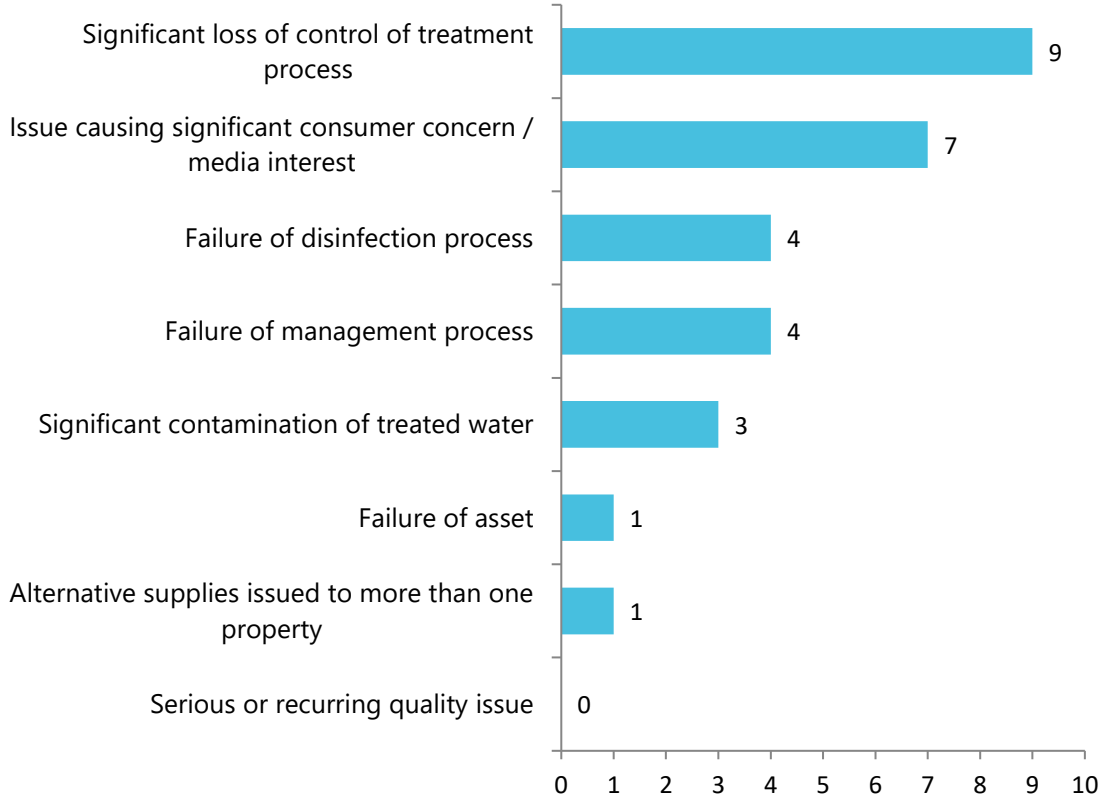

Figure 7 Reasons for Declaration of an Incident in 2019

DWQR is also concerned about the number of incidents relating to asset condition and capability. It is essential that Scottish Water's assets are capable of producing compliant drinking water consistently and that Scottish Water is proactive at ensuring this compliance.

DWQR requires that Scottish Water provide information and a conclusion of their investigation on all events within 30 days of the event occurring. However Scottish Water often fall short of this timescale with many event outcomes and incident investigations taking considerably longer than 30 days. DWQR is extremely concerned about the frequent lateness of outcome information, and has issued Information Letter 2/2020 to ensure compliance and consistency. This Information Letter can be viewed on our website at https://dwqr.scot/regulator-activity/information-letters/public-2020/ .

Each Incident Assessment can be viewed on DWQR website www.dwqr.scot . A number of those are worth highlighting however, as they illustrate significant consumer issues or present important learning points for Scottish Water. These are set out below.

Mannofield East Regulatory Supply Zone – Contamination of water supplies; February 2019

On 6th February 2019, a contractor working on behalf of a shipping company was cleaning brine tanks on a ship in Aberdeen Harbour. The process uses a hose connection to a quayside water fill point and at around 20:50 hrs, a quantity of dirty wash water held in the brine tank was forced back into the water main when the ship's transfer pumps were operated. The error was quickly realised and the operation stopped with the event reported immediately to Scottish Water Horizons, who manage the use of shipping potable water at the harbour. Scottish Water Operations staff were mobilised to attend and the affected section of the water supply network was isolated at 22:30 hrs to prevent any effect on the wider distribution system. The event was escalated to the Public Health team and other managers and bottled water issued to premises within the Quay area with instructions not to use the mains water supply. All affected premises were business premises. A decision was taken to carry out controlled flushing of the water mains system over night and sampling was arranged to be carried out at addresses within the affected area and from properties outwith the area to provide information on the extent of any effect.

Sampling commenced early the next morning and continued over the following days. Results showed the containment of the contamination to the immediate Quay area with hydrocarbons and an elevated level of barium being measured. No impacts were observed in samples taken from the wider supply area. Scottish Water's Byelaws team carried out inspections of the water mains throughout the harbour area and in individual premises. This identified the existence of a number of unsecured hydrants with no backflow protection devices which are used as fill-points. These were capped or dismantled to prevent future use. A non-return valve was also fitted to the incoming water main at the boundary of the Quay supply area as a further safeguard against any future harbour area issue. Restrictions on water use were lifted on 15th February, except at one depot where a separate, unrelated issue with byelaws compliance had been identified. During the course of the event, there were no contacts received from consumers in the area or immediate vicinity concerning drinking water quality.

DWQR categorised the incident as 'significant', and is content that the likely cause of this contamination event has been identified as the backflow of wash water from a ship-based cleaning operation, into the water mains. Scottish Water advise that these stanchion hydrants should only be used for potable water supply as shipping export water and shouldn't be used for cleaning purposes. There is a dedicated shipping/export water operator on site through Scottish Water Horizons, to supervise use of the hydrants. It is reported that this particular use of the hydrant by the cleaning contractor was unauthorised and therefore unsupervised. Scottish Water Horizons has introduced new procedures to bring tighter control to access shipping water, also introducing a mobile tanker to form a physical break from the water mains network. We consider these to be a robust response to the risk of backflow. It is however of serious concern that this risk of backflow from shipping water fill points had not been previously addressed and the only control was administrative. It is reassuring that a speedy response was made to the alert given by the shipping contractor of the backflow event. Scottish Water took the necessary action to firstly contain the effects of any contamination to the immediate harbour area and then to establish a controlled flushing of the water mains. A thorough

sampling operation was established too, to monitor the extent of the contaminant and ultimately confirm that supplies had returned to normal.

Skerries WTW – Disinfection failure; March 2019

On 3rd March, the standby treatment operator was called out to attend a final water low chlorine alarm from the works. The chlorine dosing equipment was found to be operating normally but bench tests carried out noted an elevated colour in the combined filtered water off the secondary membrane stage, Reverse Osmosis (RO) unit. Following escalation of the situation to the Public Health Team, the clear water tank was partially drained and samples were arranged to be taken from the treated and final water. Final water chlorine levels had then recovered to above 0.4mg/l, the minimum operating level.

In the days prior to this event, a contractor had been working to install arrangements for a second RO unit and new, larger pumps to feed the enlarged RO capacity. On 26th February, the first pump was commissioned on the live plant and this caused a pressure surge through the RO unit but also appeared to affect the primary Nano Filtration (NF) stage. The following day, the second pump was commissioned and again, a large pressure surge occurred through the system. With the disinfection call out and elevated colours experienced, the contractor was called back to site to check both membrane stages. The NF and the RO membranes had been due to be replaced in July as part of the normal maintenance cycle and as a precautionary measure, the NF membranes were replaced on 7th March. No faults however were found on the RO unit. Water quality improved following this action but only for a short time.

On 16th March a low final water chlorine alarm again required the attendance of the standby operator. The chlorine dose set point was increased to effect a recovery but with the final water showing a still reduced chlorine level, additional chlorous was manually added to the lime contact tank and the dosing set point increased to 1.8 mg/l. Monitoring of the processes over subsequent days showed a varying but unsatisfactory level of chlorine in the final water and on 21st March the RO membrane was replaced and the second unit installed. Over the course of the event, the poorer performance of the filters and the increased level of chlorine being applied resulted in increased levels of trihalomethanes (THM) in the supply. There were however no failures of the standard for Total THM in samples from consumers taps or in final water. A single failure of the standard for iron occurred in one final water sample (238 µg/l) from the works taken on 18th March, which was attributed to a scouring of the pipework during the work to drain-down the clear water tank. Following the work on the RO stage of the process, there was a marked improvement in the quality of the produced water, restoring the supply to normal.

It is clear from the evidence submitted by Scottish Water that the efficiency of the membrane filtration units at the works were adversely affected by pressure surges caused by commissioning of the new RO stage pumps. Both pumps were commissioned on the maximum setting before being corrected to the required setting. The damage to the filters resulted in poorer quality water being produced, increasing the chlorine demand of the water and impairing the disinfection process. The event was categorised as ‘Significant’.

Glenlatterach WTW – Disinfection failure; March 2019

On the evening of the 11th of March, a low chlorine alarm from the works was received at the Control Centre and the standby treatment operator was despatched to investigate. The operator found the chlorinated (dosed) free chlorine analyser to be reading zero and validated the position with a bench test. Investigation of the disinfection process found that neither the duty or standby banks of chlorine gas cylinders had gas available to dose and the situation was escalated to the team leader. A second treatment operator had been alerted to the chlorination failure at the works and upon arrival at the site, they replaced the emptied cylinders in the standby bank and switched those to duty, restoring the flow of gas to the dosing pumps. There had been a loss of disinfection for a period of some 75 minutes. A deeper inspection of the failed duty bank established that only one of the outlet valves on each of the three cylinders had been opened. The other two were closed, resulting in the expected life of the duty bank being reduced by two-thirds. The operators corrected the outlet valve positions to open, replaced the empty cylinder and placed the bank in standby mode. A sample was taken of the final water and the operator confirmed the process had restored to normal on monitors before he left the site. The sample confirmed that there was no failure of microbiological standards and that there was no issue with the level of chlorine residual in the supply.

The cause of the disinfection failure was a failure by operators to follow the procedure for changing chlorine cylinders and ensuring all outlet valves were in an open position. DWQR considers this to be a serious failure of operating procedures and categorised the event as 'significant'. Glenlatterach Water Treatment Works provides the sole supply to 1,297 consumers but contributes to a further 47,000 consumer's water supplies in the Elgin area. Whilst ultimately there was no failure of water quality standards in the water supplied from the works, this event put these consumers at risk, as disinfection of drinking water is a key public health safeguard.

Tullich WTW - Taste and odour complaints; May 2019

On 25th May 2019 the operator at Tullich WTW noticed a musty taste from his water bottle. He informed his team leader and they checked that the works had no ongoing performance issues. It was escalated to Water Operations North Manager and the Public Health Team (PHT) where it was discussed as a possible algal issue. During the conversation it was noted that nine taste and odour contacts had been received from 23-25 May, so sampling for algae and geosmin (an earthy-musty taste produced naturally by algae) and a catchment review were scheduled. The operator checked the source at Loch Na Gleann A Bhearraidh but found nothing of significance. The standard for taste and odour is 'acceptable to consumers and no abnormal change', and the level of detection of geosmin by taste and odour is 5ng/l.

By Monday 27th, 23 consumer contacts had been received. An incident team discussed and planned to change the source water to Loch Nell, which had been used during the commissioning of the new WTW and as a result was still connected to the works. On Tuesday 28th the sampling confirmed that the source loch had geosmin levels of 383ng/l and there were elevated levels in the filtered and final water at Tullich WTW (13.3 and 15.1ng/l), and in the zone (15.7ng/l). This indicated that the treatment process was removing the majority of geosmin, but not eliminating it completely. In addition the

supernatant return was recirculating water with a level of 34-46ng/l to the head of the works and this was diverted to waste. The proposed alternative source – Loch Nell – had very low levels of geosmin and these results were consistent over the next few days of sampling. On the 28th the plans to change the source water to Loch Nell were agreed with SEPA and finalised. The pipework was flushed and Water Operations input was increased to manage the new raw water and optimise treatment control. The source was then changed on the 29th and an immediate decrease in geosmin levels was demonstrated after the Dissolved Air Flotation (DAF) and RGF stages, with interstage, final water and zonal samples reducing the following day to <5.0ng/l. Elevated levels were found in service reservoirs over the next few days and by 6th June all samples demonstrated normal levels of geosmin. The final consumer contact was recorded on 8th June.

Geosmin levels in Loch Na Gleann A Bhearraidh dropped to 58ng/l by 4th June, but remained elevated around this level until the end of June. After several off-line trials to ensure that low level (30-40ng/l) of geosmin from Loch Na Gleann A Bhearraidh could be removed by the WTW, the raw water was returned to this source in mid-August, where the geosmin level in the loch was now 5ng/l. During the incident a total of 39 taste and odour consumer contacts were received.

We categorised the event as a 'significant' incident, caused by high levels of geosmin in the raw water from Loch Na Gleann A Bhearraidh, which was not removed by the WTW and persisted in the network - despite the change of source water - for two weeks. Scottish Water was unaware that geosmin was a potential issue in the raw water, as the previous WTW used a different mix of treatment solutions which would have removed any geosmin present.

Rosebery WTW – Power and treatment failure; July 2019

On 25 July, Rosebery WTW was being run on its standby generator as a precaution due to forecast bad weather in the area. At 16:45, the generator failed but no alarms were produced – a lack of Uninterrupted Power Supply protection (UPS) meant that the raw water inlet valves could not close, so water kept flowing through the works with no chemical dosing and no outbound telemetry signals to alert the control centre. Following "No water" calls from some pumped direct-fed properties, a Scottish Water operator was called out and attended site at 20:23. Mains power was restored and the raw water inlet valves closed but by this time water had been flowing untreated from the works for 3 hours and 40 minutes. The operator added sodium hypochlorite to the tank and returned the filters to service at 01:25 the following day, although at this point chlorine concentrations leaving the final water tanks were less than half what they should have been.

The root cause of this incident was the failure of the standby generator, which had been running the works as a precaution, as well as an absence of back-up power supplies to enable the treatment process to fail safe and shut down forward flow. Without power, no chemical dosing could operate, but there was also no means of shutting down the works safely. Although the control centre undertake regular checks on site telemetry signals, these are every four hours and one had just taken place prior to the power failure, resulting in untreated, undisinfected water being supplied for a period in excess of three hours. An intermittently faulty phone line may also have played a part. The event has been categorised as Significant.

Port Charlotte WTW – Coagulation failure; October 2019

On 2nd October 2019 the standby operator attended Port Charlotte WTW on Islay following an alarm call-out and found both the coagulation and interstage soda pumps in fault. These were reset but immediately failed. The operator discovered that both suction lines to the pumps and delivery lines were blocked with crystallised soda. These were stripped and cleaned, but re-blocked after 15 minutes. A further attempt to strip and clean resulted in both lines failing again another 15 minutes later.

The operators continued working to resolve the soda dosing problems. They eventually restored soda dosing and coagulation pH returned to within normal operating conditions. However as the loss of coagulation had lasted almost five hours and water with a high concentration of aluminium was passing through the WTW, the escalation team agreed further action to minimise non-compliant water quality. A submersible pump was used in the clarifiers to remove poorly coagulated water and minimise forward flow. The combined clarifier water was also scoured to waste. The inlets to all service reservoirs (SRs) were closed to allow final water to back up in the Chlorine Contact Tank (CCT) and overspill to waste as Port Charlotte WTW has no Clear Water Tank (CWT). The escalation team could not find a way of isolating the supply from the CCT to 12 direct fed properties due to concerns over air locking of the main and there was no resource available to switch off consumer stop cocks and deliver Do Not Drink water notices. Once water quality had fully recovered, the SR inlets were reopened and full forward flow was re-established.

Several hours later the standby operator was recalled to site due to rising primary filtered colour, with interstage aluminium and turbidity also rising. The operator discovered that the clarifier desludge process had been left in manual mode from the earlier recovery actions and the clarifier blankets had lifted and spilled forwards. The operator reset the desludge process into automatic mode and primary filtered water quality recovered.

A second increase in interstage aluminium occurred several hours later when the backwashed filter – still with significant floc from the overspill – came back online. The loss of pH control resulted in elevated dissolved aluminium passing through the works, with the interstage filtered water aluminium monitor exceeding 1000µg/l (the maximum recorded by the monitor) for approximately five hours. There is no final aluminium inline monitor at Port Charlotte WTW, but a final water laboratory test confirmed a result of 1580µg/l. Final water pH was below the regulatory limit for approximately three hours until it recovered when the dosing lines were re-established. Interstage pH dipped again as a further volume of poorly coagulated water with a low pH passed through the works, although final pH remained compliant. The clarifier blankets spilling caused the interstage aluminium monitor to again exceed 1000µg/l for approximately three hours.

Sampling was undertaken from final water, service reservoirs and in distribution on 3rd October. Aluminium failures were recorded from SRs and consumers' taps, including one direct fed property. Microbiological samples were satisfactory. Samples were not taken for laboratory analysis on the day of the incident or on 4th or 5th October. Resamples for aluminium from consumers' taps taken on 15th October were satisfactory.

The incident was caused by a blockage of crystallised chemical in the soda dosing lines. To minimise handling it is made to a strength of 15%, however at this viscosity it can crystallise at temperatures below 10°C. On the night of 1st -2nd October the minimum temperature was 3.5°C. Trace heating installed to remove this risk had been disconnected by operators during the summer due to an intermittent fault on the thermostat but not reported for repair.

The incident was prolonged due to a lack of understanding that the loss of coagulation pH had on water quality. This is a fundamental part of water treatment chemistry and is extremely concerning, particularly since previous incidents have featured loss of coagulation pH and Scottish Water has committed to improving operator training in this critical aspect of water treatment. The second aluminium exceedance was caused by the clarifier desludge being left in manual after the recovery actions of operations and not returned to automatic by operators. This allowed the clarifier blanket to rise and spill forward, which had a knock-on effect in raising the aluminium a third time when the backwashed clarifier came back online, still with excess floc from the blanket spillage.

The level of aluminium recorded was in excess of the Short-Term Health Risk Action Value (SHRAV) set by Health Protection Scotland of 900 µg/l and DWQR would have expected that immediate contact would be made with the Health Board to discuss this and review what measures might be considered necessary to protect consumers. In fact, the incident was only reported to stakeholders two days later.

Twelve direct fed properties were not protected from receiving this water. The operators would have had to go door-to door to turn off individual stop cocks and deliver Do Not Drink notices. That the decision to take no action regarding these consumers was made because of a lack of resource and without any consultation with the Health Board is unacceptable. DWQR believes that some intervention could have been achieved in the short term by telephone contact (if contact numbers were available to Scottish Water) by personnel remote from the immediate works. It is inevitable that operators will be busy and resource limited during a water quality incident, and this should be planned for, to ensure that public health is protected.

In summary, DWQR has concluded that Scottish Water's actions, both in creating this incident and in responding to it, fall well short of expectations and indicate both a lack of operability of the treatment works and a fundamental lack of understanding of the significance of process events among operational staff. The incident was categorised as 'Significant'.

3. AUDIT AND INSPECTION

3.1 Water Treatment Works and Service Reservoirs

An important part of DWQR's scrutiny role is to audit and inspect activities undertaken by Scottish Water. We can choose to inspect any aspect of Scottish Water's activities that could affect water quality. Inspections commonly undertaken include water treatment works, storage points, distribution system activities, response to consumer water quality issues and analytical services. We audit against the requirements of the Regulations, as well as water industry best practice. We also audit the completion of investment projects. Typically site visits will be completed before DWQR sign off the larger water treatment works projects and DWQR will audit a selection of Scottish Water's self-certification projects. The inspection process provides a number of benefits:

- It enables DWQR to verify that Scottish Water is complying with regulatory requirements at sites across Scotland;
- It allows DWQR to see new initiatives and areas of best practice;
- It is an opportunity for DWQR staff to meet site-based Scottish Water staff and discuss water quality issues with them;
- It raises awareness of DWQR and the regulations amongst Scottish Water staff;
- It enables verification of the delivery of investment work;
- It enables DWQR to build an awareness of common trends, risks or deficiencies across Scotland and use these to inform future policy and guidance.

We select sites for inspection using a risk based process that takes into account sample failures and water quality events and incidents. DWQR may also choose to inspect sites randomly or directly following incidents. Other types of inspection may be undertaken in response to a particular issue or concern. In the past, we have inspected the procurement of services affecting water quality and actions to complete DWQR recommendations.

To make sure we are consistent, all our inspectors use standardised inspection templates and the audit process is subject to an ISO accredited procedure. DWQR also participates in benchmarking audits with other regulators in the UK and beyond to drive consistency and to spread best practice.

Where issues are noted during an inspection, these are recorded as recommendations that are tracked and followed up. If common themes are identified, these are progressed centrally with senior Scottish Water staff. Elements of best practice are also highlighted. Scottish Water has an opportunity to comment on draft inspection reports and co-operates fully during the technical inspection process.

Once an inspection report has been finalised, the completed report is sent to Scottish Water and a summary placed on the DWQR website. You can view DWQR audit and inspections reports on our website at https://dwqr.scot/regulator-activity/audit-and-inspection/ .

Water Treatment Works

In 2019 DWQR carried out nine technical inspections of water treatment works shown in Table 7. Scottish Water staff operated their plants with a high degree of professionalism and many examples of best practice were noted. As the inspections were risk or incident-based, particular attention was paid to the deficiency that had triggered the audit, whether this was asset based or procedural.

Most sites visited were maintained and operated to a high standard but a number of issues were identified including:

- The ability for works to respond to changing raw water quality;
- The need for automatic control of critical processes which can respond to changing water quality demands;
- Deficiencies in alarms, control systems and their resilience;
- Concern about the resilience of filters and the need to ensure filter improvements are successful;
- The need for continued operator training;
- The need to provide resilient disinfection processes and improve contact time.

Table 7 DWQR Technical Inspections of Water Treatment Works in 2019

Site	Date	Reason for Audit	No. of Recommendations
Bradan (Ayr)	March	Risk based	9
Achiltiebuie	May	Risk based	1
Lochinver	May	Risk based	3
Ullapool	May	Risk based	3
Turret (Alloa)	May	Risk based	7
Finlas (Helensburgh)	August	Risk based	16
Glengap (Kirkcudbright)	September	Event	3
Ringford (Kirkcudbright)	September	Risk based	0
Sandy Loch (Shetland)	October	Incidents	4

Image 5 Ullapool WTW

In addition to full site audits we also visit sites which have had water quality events, to do incident investigations and to follow up on remedial works recommended by DWQR following previous incidents. The sites visited are listed in

Table **8** below.

Table 8 DWQR Site Visits for Event and Incident Investigations in 2019

Site	Date
Whalsay WTW (Shetland)	March
Eela Water WTW (Shetland)	March
Sandy Loch WTW (Shetland)	March
Bonnycraig WTW (Peebles)	March
Savalbeg WTW (Lairg)	May
Turriff WTW	May
Herricks WTW (Keith)	May
Glenfarg WTW	May
Glenlatterach WTW (Elgin)	June
Glenconvinth WTW (Drumnadrochit)	July
Assynt WTW (Dingwall)	July
Greenock WTW	July
Clatto WTW (Dundee)	August
Aberdeen Harbour	September
Kyle of Lochalsh WTW	September
Finlas WTW (Helensburgh)	September
Picketlaw WTW (Eaglesham)	September
Castle Moffat WTW (Haddington)	November

During 2019 DWQR undertook a number of targeted inspections to investigate specific issues. This included a detailed audit of chemical delivery and storage at a number of WTWs. Scottish Water use a number of different chemicals to ensure water is treated effectively and the purpose of these visits was to ensure that the chemical delivery process has adequate governance and is undertaken consistently across Scotland to eliminate the possibility of the incorrect delivery of chemicals with potentially severe consequences. The audit report included observations relating to record keeping, security, supervision, storage and infrastructure. The sites visited for this audit are listed in Table 9.

Table 9 Targeted Audits Undertaken in 2019

Site	Date	Reason for Audit
Marchbank WTW (Edinburgh)	August	Chemical delivery and storage
Glencorse WTW (Edinburgh)	August	Chemical delivery and storage
Rosebery WTW (Midlothian)	August	Chemical delivery and storage
Balmore WTW	August	Chemical delivery and storage
Carron Valley WTW (Falkirk)	August	Chemical delivery and storage
Aviemore WTW	August	Chemical delivery and storage
Clatto WTW (Dundee)	August	Chemical delivery and storage
Glenfarg WTW	August	Chemical delivery and storage
Perth WTW	August	Chemical delivery and storage

Glendevon WTW	August	Chemical delivery and storage
West area	April	Plumbosolvency control

3.2 Storage and Distribution

We audited nine distribution systems and storage reservoirs in 2019. Our recommendations included preventing ingress of contamination, valve protection and quality of information.

Table 10 Distribution System Audits in 2019

Location	Date	Reason for Audit	No. of Recommendations
Upper Braes SR (Ullapool)	May	Risk based	1
Lower Braes SR (Ullapool)	May	Risk Based	1
Achnahaird SR (Achiltiebuie)	May	Risk based	0
Elphin SR (Ledmore)	May	Risk based	0
Fochabers SR	June	Risk based	2
Lossiemouth SR	June	Risk based	1
Badentinan RSZ (Lossiemouth)	June	Risk based	0
Assynt RSZ (Dingwall)	July	Risk based	0
Kilmarnock RSZ	October	Risk based	4

Image 6 A temporary overland pipe was being used while this pipe replacement project was being completed in Kilmarnock.

3.3 Services and Benchmarking

Services

Scottish Water has two UKAS-accredited laboratories which undertake all sample examination and analysis for Scottish Water under specific Drinking Water Testing Specification (DWTS) accreditation. The laboratories also undertake sampling and analysis for some local authorities and private contractors. As the Regulator, DWQR is the primary customer for the labs for drinking water analysis and as such we audit the labs every two years (in addition to the audits undertaken by UKAS). Both laboratories were audited in 2019, the findings of which are shown in Table 11. In addition to the recommendations made by DWQR, many examples of good practice and excellent scientific rigour were noted throughout the laboratories.

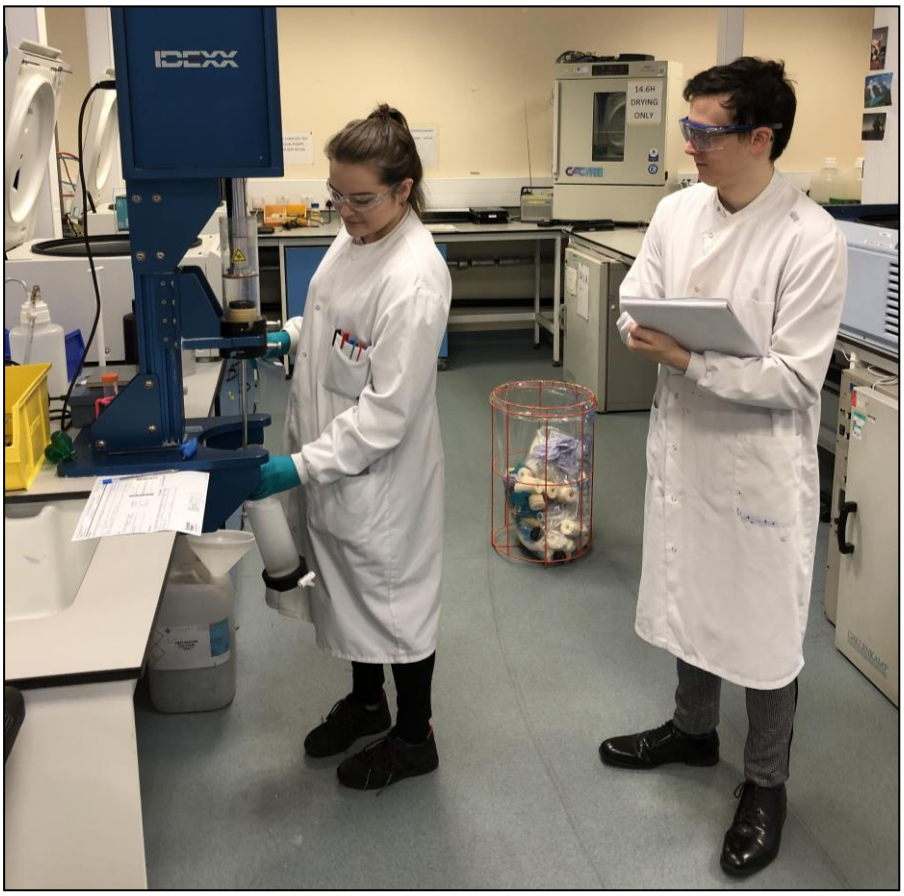

Image 7 DWQR audited the *Cryptosporidium* testing in Inverness.

DWQR also routinely carries out audits of consumer contacts. These audits are undertaken to see how well information is taken and recorded from consumers when they contact Scottish Water in relation to a water quality event; how this is reported to DWQR in water quality event notifications, outcomes and incident reports; the use of and reporting of social media interactions and the overall reporting of consumer contact numbers to regulators and stakeholders. In August 2018 Scottish Water introduced and embedded a new software system to record, track and drive resolution of their customer contacts. Many of the issues raised in our audit carried out in 2018 should not arise under the new contacts

system. We will audit this new system to ensure it accurately captures and fully addresses the concerns of consumers and reporting requirements.

In 2019 DWQR carried out an audit on Scottish Water's Drinking Water Safety Plan (DWSP) process. The 2014 Regulations require Scottish Water to carry out risk assessments on all of its drinking water supplies, using a method which complies with BS EN: 15975 and which is approved by DWQR. The Burncrooks drinking water supply system was audited, and the DWSP process was found to be severely lacking and 34 recommendations for improvement were made. Following this audit we instructed Scottish Water to undergo a gap analysis on its DWSP process using an external accreditation body; this was completed in February 2020 with 15 major non-conformities recorded. DWQR requires Scottish Water to obtain accreditation with BS EN: 15975 by 31 December 2021, and thereafter to maintain this accreditation by participating in an appropriate surveillance programme.

Table 11 Audit of Services

Location	Date	No. of Recommendations
Drinking Water Safety Plans and DWSP process	September	34
Laboratory (Transportation and analysis) - Edinburgh	November	4
Laboratory (Transportation and analysis) - Inverness	December	0

Benchmarking

DWQR retains close contact with the other water quality regulators in the UK and Europe to share knowledge, learning and best practice. These are excellent benchmarking opportunities: both to ensure DWQR inspectors are auditing to a high standard; and to make sure Scottish Water's standards for operations and procedures are of the same quality (or better) than other water providers. No benchmarking audits were done during 2019, however it is intended that these shall be continued in future; and DWQR has extended the invitation to colleagues in England and Northern Ireland to accompany DWQR on benchmarking opportunities in Scotland.

3.4 Investment

Scottish Water has been directed by Scottish Ministers to achieve a number of different objectives to improve and protect drinking water quality. DWQR has a role to monitor progress with delivery of these outputs through the Outputs Monitoring Group (OMG) and also signs off those outputs associated with water treatment works improvements from the 2010 – 2015 period, a small number of which remain outstanding. The replacement treatment works for Tullich near Oban went into supply in November 2018 and was signed off in early 2019. A new treatment works for Lochmaddy on North Uist was also completed and signed off in 2019; this works now also supplies Bayhead. This just leaves one scheme from the 2010 – 2015 investment to finalise at Laggan Bridge: this is completed and in supply though not yet signed off.

Scottish Water's current investment period runs from 1 April 2015 until 31 March 2021. This includes a number of outputs for improving and protecting drinking water. Scottish Water self-certifies completion of these and DWQR audits a selected number. There are 30 outputs to be delivered at water treatment works during this period and 13 had achieved sign off by December 2019.

DWQR staff undertook a number of sites visits and audits during the year, either to review progress or for the purposes of assessing the project's readiness for the output completion to be signed off. These are shown in the table below.

Table 12 Investment Site Visits in 2019

Location	Solution	Reason for Site Visit
Desk-based review	Audit of evidence provided for sign off	Sign off
Tullich WTW	New water treatment works	Sign off
Lochmaddy WTW	New water treatment work	Sign off
Glenfarg WTW	Options appraisal ongoing	Investment needs review
Carron Valley WTW	Options appraisal ongoing	Investment needs review
Black Esk WTW	Options appraisal ongoing	Investment needs review

4. NETWORK INFRASTRUCTURE SECURITY (NIS) DIRECTIVE

The Network Information Systems Directive was introduced to improve the levels of cyber security and resilience of essential services across the EU. It provided the basis of Network Information Systems Regulations that were introduced in 2018, which you can view at https://www.legislation.gov.uk/uksi/2018/506/made.

These regulations have identified Scottish Water as an 'Operator of Essential Services' and designated the Drinking Water Quality Regulator for Scotland as the relevant Competent Authority in Scotland. They require that there is a national framework to manage cyber security incidents and maintain and improve cyber resilience. Further information on these regulations may be found from the UK Government Department for Digital, Culture, Media & Sport at https://www.gov.uk/government/collections/nis-directive-and-nis-regulations-2018 and the National Cyber Security Centre at https://www.ncsc.gov.uk/collection/caf/nis-introduction.

During 2019, Scottish Water submitted to the DWQR its assessment of compliance with the Regulations as assessed using the Cyber Assessment Framework (CAF). Following further discussion of the CAF an improvement plan was submitted by Scottish Water to DWQR and this forms the basis of on-going discussion and monitoring of progress.

5. ANNEXES

5.1 Information Letters issued during 2019

There were no Information Letters issued during 2019.

Information Letters are published on the DWQR website which you can view here:
https://dwqr.scot/regulator-activity/information-letters/

5.2 Current Undertakings and Enforcement Notices

When DWQR has evidence that Scottish Water has contravened a drinking water quality duty and the contravention is likely to recur and Scottish Water does not appear willing to take timely steps to rectify the situation, DWQR may serve an Enforcement Notice on Scottish Water under Section 10 of the Water Industry (Scotland) Act 2002. Such an Enforcement Notice must set out specific actions to be taken by Scottish Water within specified timescales. Failure to complete such actions by the due date is a criminal offence under Section 12 (5) of the Act.

In 2019, there were two active Enforcement Notices:

Bonnycraig WTW *Cryptosporidium*

Turriff WTW *Cryptosporidium*

Enforcement Notices are published on the DWQR website which you can view here:
https://dwqr.scot/regulator-activity/enforcement/

5.3 Abbreviations and Glossary

BH	Borehole
Bq/l	Becquerels per litre, a measure of radioactivity
CAF	Cyber Assessment Framework
DCMS	Department for Digital, Culture, Media and Sport
DMA	District Metered Area
DOC	Dissolved Organic Carbon
DOMS	Distribution Operation and Maintenance Strategy
DWSP	Drinking Water Safety Plan
DWTS	Drinking Water Testing Specification
DWQR	Drinking Water Quality Regulator for Scotland
EAL	Emergency Action Levels
HAA	Halo-acetic acids
HMI	Human Machine Interface
IPPF	Investment Planning and Prioritisation Framework
ISO	International Standards Organisation
MCC	Motor Control Center
mg/l	milligrammes per litre
NCSC	National Cyber Security Centre
NF	nanofiltration
NHS	National Health Service
NIS	Network Infrastructure Security
NSO	Network Service Operator
NTU	Nephelometric Turbidity Unit
OMG	Outputs Monitoring Group
PAC	Powdered Activated Carbon
PACL	Polyaluminium chloride
PCV	Prescribed Concentration or Value
PHT	Scottish Water's Public Health Team
PLC	Programmable Logic Controller
RO	Reverse Osmosis
RSZ	Regulated Supply Zone
SCADA	Supervisory Control and Data Acquisition
SEPA	Scottish Environment Protection Agency
SR	Service Reservoir
THM	Trihalomethanes
TOMS	Treatment Operation and Maintenance Strategy
TWS	Treated Water Storage
µg/l	microgrammes per litre
UKAS	United Kingdom Accreditation Service
UV	Ultraviolet Light
WiS	Water into Supply
WQIG	Water Quality Investment Group
WTW	Water Treatment Work

Cover picture: membrane filtration units at Poolewe WTW.

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