Drinking water and health: a guide for public and environmental health professionals and for those in the water industry in Northern Ireland.

Acknowledgements

These guidelines are extensively based on the Health Protection Agency and Drinking Water Inspectorate England & Wales report "Drinking Water Safety" and the Republic of Ireland, Health Services Executive Report "Drinking Water and Health". The Drinking Water and Health Liaison Group would wish to acknowledge these organisations and their publications in the compilation of these Northern Ireland guidelines.

Foreword

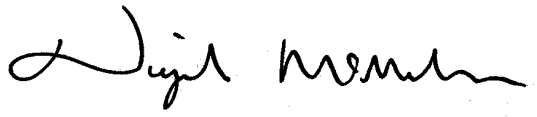
The safety of drinking water is a paramount public health concern. It is a tribute to the skills and expertise of colleagues working for drinking water providers, regulators, health authorities and local authorities that the safety of drinking water in Northern Ireland is something that the public is able to take for granted. If this situation is to be maintained then there needs to continue to be close liaison between those agencies with an interest in and responsibility for drinking water safety.

The Drinking Water and Health Liaison Group is a multi-agency group which considers public health issues associated with the drinking water supply. The Group, which is unique in the UK context, draws its membership from the main stakeholder organisations including the Department of Health, the Public Health Agency, the Drinking Water Inspectorate, the Northern Ireland Public Health Laboratory, Environmental Health Northern Ireland and Northern Ireland Water. Part of the terms of reference of the Group is to enhance working relationships, co-ordination of approaches and understanding between Group members and the organisations they represent.

This document is aimed at professionals from a variety of backgrounds who share an interest and involvement in the safety of drinking water. The purpose of this joint guidance is to set out the roles and responsibilities of the key players, to describe the wider context to the provision of safe drinking water, to detail the arrangements and protocols in place to monitor compliance with standards and to respond to an emergency or incident situation.

We hope you find the guidance useful. It is intended that the document be revisited and updated periodically and to that end, if you have any comments on the contents then we would be pleased to hear from you.

Comments on this document should be sent to dwi@daera-ni.gov.uk



Nigel McMahon
Chair of the Drinking Water and Health Liaison Group
Chief Environmental Health Officer, DoH

Figures and Tables

1 Introduction

This document has been developed by the Drinking Water and Health Liaison Group (DW&HLG). It is intended to inform those who may be required to respond to water quality incidents and/or when there might be significant disruption to supply, be they consultants in health protection, environmental health officers, the regulator or the water provider. It describes the structure and legal framework for public and private drinking water supplies in Northern Ireland. It also explains when and how the consultants in health protection are likely to be called upon to give health protection advice about drinking water quality to the public water supplier, district councils, business, consumers and the Drinking Water Inspectorate. It draws upon existing best practice, professional guidance and learning from recent incidents.

This document is supported by the procedures set in place to respond to a deliberate drinking water contamination incident. If you suspect that drinking water has been deliberately contaminated you should contact the Head of Quality and Compliance, NI Water (or deputy) and the Major Incident Manager, NI Water (or deputy).

2 Drinking water supplies in Northern Ireland

In Northern Ireland drinking water supplies are either provided through the public water supply or private supplies. Northern Ireland Water Ltd (NI Water) is a government owned company that supplies water to over 99% of the Northern Ireland population; the remainder of the population is served by private water supplies.

2.1 **Public supplies**

In Northern Ireland, water supplies are mostly obtained from surface water sources (approximately 99%) which include upland impounding reservoirs, rivers and loughs with the remainder being groundwater sources as shown in Figure 1.

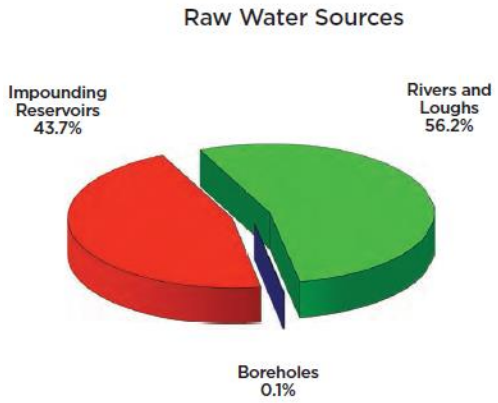


Figure 1: Northern Ireland Water sources

Location Type	Number in Service
Water Treatment Works	23
Service Reservoirs	370
Water Supply Zones	51
Length of mains pipe (km)	26,800

Figure 2: NI Water Assets in service during 2017

Approximately 863,000 domestic, agricultural, commercial and business properties in Northern Ireland are connected to the public water supply. Each day NI Water supplies more than 571 million litres of high quality drinking water to customers.

A higher percentage of the Northern Ireland population, as compared to Great Britain, live in rural areas. As a result there is a greater length of water main per head of population connected to the public supply. The average length of water main per head of population served in Northern Ireland is estimated at 14.9 metres as compared to 6.3 metres in England and Wales, and 9.0 metres in Scotland.

2.2 **Private supplies**

Private water supplies are defined as any supplies of water provided otherwise than by NI Water. Private water supplies are diverse in nature, and range from those which serve single domestic dwellings through to those supplying large commercial properties.

3 Roles and responsibilities

3.1 The Drinking Water and Health Liaison Group (DW&HLG)

The DW&HLG is a multi-agency group which considers public health issues associated with the drinking water supply. The Group has a membership nominated from the main stakeholder organisations including the Department of Health, (DoH), the Public Health Agency (PHA), the Drinking Water Inspectorate (DWI), the Northern Ireland Public Health Laboratory (NIPHL), Environmental Health NI (EHNI) and NI Water.

The terms of reference of the Group are:

1. To advise on public health issues associated with both public and private drinking water supplies including:

    - Review of Health Notification Values (HNVs) and associated procedures and action;
    - Derogation procedures including Authorised Departures (ADs) and notice of acceptance of undertakings;
    - Current issues e.g. lead, *Cryptosporidium*, public buildings, private water supplies, algal blooms;
    - Water quality incidents, shared learning points;
    - Periodic review of drinking water and health guidance;
    - Consideration of potential research topics; and
    - Other matters referred to it by the Chief Medical Officer, DOH (CMO), the Director of Public Health (DPH), PHA, Chief Executive, NI Water, (CX NI Water), DWI or any of the organisations represented on the Group.

2. To refer relevant matters to CMO, DPH and CX NI Water for endorsement/approval.

3. To enhance working relationships, co-ordination of approaches and understanding between Group members and organisations they represent.

The DW&HLG meets twice a year, usually in May and November. Subgroups are established to take forward specific pieces of work. There is also ongoing communication between Group members where necessary to progress and develop items between meetings. A review of the terms of reference and membership of the Group is a standing item for the November meeting.

3.2 **The Department of Health (DoH)**

The DoH assumes the roles and responsibilities of the former Department of Health, Social Services and Public Safety (DHSSPS). It has three main business responsibilities:

- Health and Social Care, which includes policy and legislation for hospitals, family practitioner services and community health and personal social services;
- Public Health, which covers policy, legislation and administrative action to promote and protect the health and well-being of the population; and
- Public Safety, which includes responsibility for the policy and legislation for the fire and rescue services.

DoH works closely with the Drinking Water Inspectorate (DWI) and has a role in the periodic, multidisciplinary review of Health Notification Values (HNVs) for drinking water parameters; and in the policy level sign off of derogation procedures, including Authorised Departures (ADs) from drinking water standards and associated undertakings from NI Water.

DoH also currently provides the chairperson for the NI Drinking Water and Health Liaison Group (DW&HLG).

3.3 **The Drinking Water Inspectorate (DWI)**

The Drinking Water Inspectorate for Northern Ireland (the "Inspectorate") is a business unit within the Northern Ireland Environment Agency (NIEA), part of the Department of Agriculture, Environment and Rural Affairs (DAERA). It is one of the United Kingdom regional regulatory bodies which have statutory duties in terms of drinking water.

The Chief Inspector is a statutory appointee, acting on behalf of the Department of Agriculture, Environment and Rural Affairs in relation to public and private drinking water supplies. The Order also confers enforcement powers on the DWI in matters arising with NI Water.

The primary legislation regarding drinking water quality is the Drinking Water Directive 98/83/EC on the quality of water intended for human consumption. This is transposed within the United Kingdom into specific regulations. The regulatory responsibilities for public drinking water supplies are contained within the Water Supply (Water Quality) Regulations (Northern Ireland) 2017. For private water supplies the relevant legislation is: the Private Water Supplies Regulations (Northern Ireland) 2017 Copies of these regulations are available from: www.legislation.gov.uk

In addition, there are regulatory responsibilities contained within the Water Supply (Domestic Distribution Systems) Regulations (Northern Ireland) 2010 relating to the supply of water to the public in premises such as schools, hospitals and restaurants.

The Inspectorate's role is to ensure regulatory compliance and provide independent reassurance that human health is safeguarded through the provision of drinking water supplies in Northern Ireland.

The Inspectorate's responsibilities include:

- securing compliance with regulatory standards;
- provision of advice on all aspects of the regulatory requirements;
- applying appropriate regulatory processes to enable NI Water to make the necessary improvements to achieve compliance in a timely and cost-effective way;
- provision of technical advice on drinking water issues, policies and standards to Ministers and officials in DAERA; and
- monitoring and enforcement of water quality standards at private water supplies; and
- responding to enquiries relating to drinking water quality from consumers, organisations and businesses.

The Inspectorate requires NI Water to inform it of all events that have affected, or are likely to affect, drinking water quality or sufficiency of supplies, and where as a result, there may be a risk to consumers' health.

When notified of an event, the Inspectorate assesses NI Water's provisional information to determine whether it is an incident or a non-incident. The Inspectorate defines an incident as a situation where there has been a demonstrable deterioration in the quality of drinking water, giving rise to a significant potential risk to the health of consumers or a significant adverse aesthetic water quality change. Where no such deterioration has taken place, the situation is classified as a non-incident.

The Inspectorate produces an annual report on Drinking Water Quality in Northern Ireland. It can be accessed through the following link: https://www.daera-ni.gov.uk/articles/duties-drinking-water-inspectorate-dwi

The Inspectorate has a regulatory responsibility for private water supplies which are used for: drinking, cooking, food preparation or other domestic purposes; or those used in commercial food production; the manufacture, processing, preservation, or marketing of food or drink for sale for human consumption. This includes monitoring and enforcement at these supplies; however the regulations exclude such provisions at single domestic dwellings.

3.4 **The Public Health Agency (PHA)**

The PHA came into being on 1 April 2009, bringing together a range of existing public health functions to give a renewed, enhanced and sustained focus to improve health and social wellbeing and reduce inequalities. The PHA replaces some of the functions of the former Health and Social Services Boards. The key functions of the PHA include: improvement in health and social wellbeing; health protection; and supporting commissioning health and social care services. Health protection is delivered through a regional Health Protection Service encompassing surveillance, prevention and control of infection and environmental hazards; outbreak management; emergency preparedness and response.

The public health function is professionally led by the Director of Public Health (DPH) who has a statutory responsibility for health protection. The Health Protection (HP) Service is led by an Assistant Director and includes staff from legacy organisations such as the Health and Social Services Boards and the Communicable Disease Surveillance Centre (Northern Ireland). Staff in the HP service therefore include: Consultants in Communicable Disease Control (CCDC); consultant epidemiologists; consultant microbiologists; health protection nurses; scientific and information staff. In future public health medical staff will be described as Consultants in Health Protection (CHP). Consultant staff have particular functional responsibilities and one consultant has a specialist role regarding microbiological aspects of water quality and liaison with NI Water with another dealing with water quality chemical issues.

All health protection reports/incidents including those relating to water quality, irrespective of the geographical location of the incident, are initially reported to the HP service duty room in Linenhall Street, Belfast where the reports are logged, triaged, risk assessed and managed according to agreed protocols. After hours the incident would be reported to the duty public health doctor (contactable through Ambulance Control).

The HP service undertakes surveillance of communicable disease and would lead the public health response to any water quality incident. This would include; leading the multi-agency incident investigation/management team; assessing the health risk to the public; identifying the needs of vulnerable groups; enhancing surveillance, if necessary; leading the epidemiological investigation of an outbreak of waterborne illness; and advising and informing health professionals, district councils and other agencies. Should specialist support/advice be required the PHA would liaise with the Health Protection Agency in England.

3.5 District Council Environmental Health Departments (EHDs)

District Council Environmental Health Departments in Northern Ireland are responsible for enforcing a variety of statutory provisions that have an impact on drinking water safety and quality.

Figure 3: Map of Environmental Health districts in Northern Ireland

The following Environmental Health functions are relevant to drinking water safety:

3.5.1 Food and infectious disease control

Environmental Health Officers (EHOs) regulate a wide variety of food establishments (e.g. catering premises, food manufacturing premises etc.) where water is served or used as an ingredient in foodstuffs. Such establishments also use potable water as part of their cleaning regime in line with statutory requirements relating to hygiene. Regulation (EC) No 852/2004 on the hygiene of foodstuffs requires there to be 'an adequate supply of potable water, which is to be used whenever necessary to ensure that foodstuffs are not contaminated …' The associated regulation defines 'potable

water' to mean meeting the minimum requirements laid down in Council Directive 98/83/EC on the quality of water intended for human consumption.

In relation to food law, water falls within the definition of food by virtue of Regulation EC (No) 178/2002. This legislative measure has the effect of amending/extending the definition of 'food' in the Food Safety (Northern Ireland) Order 1991. The Consumer Protection arm of the Food Safety (Northern Ireland) Order 1991 also contains the offence of 'selling food not of the nature or substance or quality demanded".

Provisions contained within the General Food Regulations (Northern Ireland) 2004 makes it an offence to place food (including water) on the market if it is unsafe and food is deemed to be unsafe if it is considered injurious to health and/or unfit for human consumption.

3.5.2 **Port Health**

Safe drinking water on ships is an obvious necessity and Port Health Officers/Environmental Health Officers play a vital role in helping to ensure ships have a safe supply of water by sampling the fresh water, providing advice and by checking that relevant records and procedures are in place.

When carrying out inspections and visits to ships, officers' duties include the enforcement of the International Health Regulations 2005 and the Food Hygiene Regulations (Northern Ireland) 2006. It is a requirement of the International Health Regulations 2005 that every port is provided with a supply of pure drinking water. Officers will check that ships are bunkering water safely by using designated, colour coded hoses which must be stored, handled safely and also cleaned routinely. All Masters are advised to keep a 'Fresh Water System Maintenance Log' which should include details of: tank capacities, distribution systems, filters, construction materials, maintenance schedules, disinfection schedules, sample frequency and sample results and remedial action taken. Potable water can be made on board using desalination techniques and it is recommended that the equipment is not used within 20 miles of any land or other pollution source.

The World Health Organisation (WHO) recommends that international vessels sample their fresh water every six months. Officers carry out water sampling when undertaking a Ship Sanitation Inspection, which is renewed on a bi-annual basis. When sample results are received the ship's agent and/or the ship is contacted with the results. If the result is unsatisfactory advice is given to the Master on how to disinfect the water system. Officers will also sample vessels that have an outstanding unsatisfactory sample to ensure that appropriate remedial action has been taken. Water quality standards specifically relating to water on board vessels are given in the' HPA Guidelines for Water Quality on board Merchant Ships including Passenger Vessels' available on the HPA website www.hpa.org.uk.

Guidance is provided for Officers on drinking water in the WHO 'Interim technical guidance for inspection and issuance of ship sanitation certificates'.

3.5.3 Public Health and Housing

Environmental Health departments enforce provisions under the Clean Neighbourhoods and Environment Act (Northern Ireland) that have a bearing (with regard to specific criteria) on the quality of drinking water in domestic dwellings. Article 63 (1) (a) of Part 7 of Clean Neighbourhoods and Environment Act (Northern Ireland) 2011, deals with, 'any premises in such a state as to be … prejudicial to health'. An example of circumstances that may qualify under this definition is the existence of internal lead pipe work through which drinking water is carried, resulting in elevated levels of lead in the domestic drinking water supply that are prejudicial to health. Each individual case must be judged on its own merits. Where the relevant qualifying criteria are met the Environmental Health Department may use a Clean Neighbourhoods and Environment Act Statutory Notice to seek a suitable remedy.

Article 17 of the Private Tenancies (Northern Ireland) Order 2006 use the criteria as laid down under Article 46 of the Housing (Northern Ireland) Order 1981 No. 156 (NI 3) to determine the standard of fitness for human habitation of a dwelling-house. Among other things the fitness standard requires an 'adequate piped supply of wholesome water'. In qualified circumstances, the Environmental Health Department may use statutory powers as laid down under the Private Tenancies (Northern Ireland) Order 2006 to secure compliance.

3.5.4 Public Buildings

For water quality exceedences within public buildings, where it has been identified that the failure is due to the internal distribution within the building, rather than by the water supplied by NI Water, it is a requirement under The Water Supply (Domestic Distribution Systems) Regulations (Northern Ireland) 2010, to report such failures through to DWI. Reporting through to PHA will follow the usual protocol for public health failures. DWI will then liaise with the person responsible for the building, the relevant local council, and as appropriate with PHA to ensure appropriate remedial measures are put in place. DWI also have the power to issue notices on the building owner, where required.

3.5.5 Health and Safety

EHOs enforce a wide variety of health and safety requirements in specified workplaces.

Regulation 22(1) of the Workplace (Health, Safety and Welfare) Regulations (NI) 1993 is an example of a health and safety related provision that relates to drinking water and require that:

'An adequate supply of wholesome drinking water shall be provided for all persons at work in the workplace'.

Depending on the type of work activity undertaken in the premises concerned, this requirement will be enforced by district council EHOs, or Health and Safety Inspectors from the Health and Safety Executive for Northern Ireland.

3.5.6 **Emergency planning**

No legislative framework exists for emergency planning in NI. However, discretionary powers exist within Article 29 of the Local Government (NI) Order 2005. These powers enable councils to make emergency planning arrangements, or make arrangements with other bodies for reducing, controlling or mitigating the effects of any emergency which may occur. It also provides arrangements for co-operating with other bodies.

The essential infrastructure of Northern Ireland - power, fuel, communications, transport, water, and environmental services - is provided by a range of organisations, some from the public and some from the private sector. Some threats to the infrastructure will be specific to one sector, but most will affect many parts of the infrastructure, either directly or indirectly.

The main way in which District Council Chief Executives will interact with the infrastructure organisations in planning for and responding to a major emergency will be through their co-ordination role.

Emergency planning co-ordinators based within Belfast and the four Environmental Health Group Areas ensure there is a provision of robust 24/7 on call arrangements.

The Chief Executives would not take over responsibility for any of the direct actions of the infrastructure organisations to maintain or restore services, nor, in most cases, would Councils have the sort of equipment, staff or expertise which might be deployed in support of the infrastructure organisations.

The most useful resource which Councils could provide would be manpower for clear up and general manual tasks in circumstances such as severe weather damage, flooding, setting up advice centres etc.

3.5.7 **Emergency response supporting roles:**

To date no Memorandum of Understanding exists to formally request such assistance from councils. Any such assistance is therefore undertaken on an

ad hoc basis and the response may differ dependant on specific council's approaches to emergency planning.

For widespread water supply problems, councils could provide manpower to help deliver notices about water supply problems, if required. This could also include displaying posters and information leaflets in public buildings controlled by the council (leisure centres, community centres, civic offices) and providing advice on the correct response to water supply issues.

For widespread water supply problems, councils could also provide manpower to help distribute bottled water, set up stand pipes or position water tankers.

Councils would contribute to the response in any public health emergency arising from water contamination in partnership with the PHA and other agencies.

3.5.8 Guidelines for the Provision of Drinking Water Supplies at Events

The DW&HLG has produced a guidance document for the provision of temporary drinking water supplies at events, such as music festivals or agricultural shows in NI.
http://www.publichealth.hscni.net/publications/guidelines-provision-temporary-drinking-water-supplies-events-northern-ireland

3.6 **The Northern Ireland Public Health Laboratory (NIPHL)**

Approximately one thousand samples of mains drinking water are submitted to NIPHL annually by EHOs. The laboratory also receives approximately five hundred samples of drinking water from other supplies including wells, private springs, boreholes and ships' tanks. Samples are taken in connection with planned work programmes and as a result of complaints received by EHDs.

In the event of an outbreak or water quality incident, NIPHL could accept water samples for microbiological analysis to provide the Incident Management Team with a source of extra capacity for specimen processing or a parallel independent examination of samples if this was thought to be useful. NIPHL could also liaise with local hospital clinical laboratories and national reference laboratories in the examination of human samples and resultant isolates. The consultant microbiologists would be available to work as part of the Incident Management Team.

3.7 **Northern Ireland Water (NI Water)**

Northern Ireland Water Ltd (NI Water) is a government owned company within the Department for Infrastructure (DfI) as its sole shareholder. The DfI is responsible under the Water and Sewerage Services (Northern Ireland) Order 2006 to supply and distribute water, and NI Water performs the Department's water supply functions. NI Water is therefore responsible for providing all public water and sewerage services in Northern Ireland.

Water supplied for domestic or food production purposes, must meet the standards contained in the "Drinking Water Regulations" (see Annex 11.3 & 11.4).

NI Water aims to provide high quality drinking water, in a cost effective manner, to meet the requirements of existing and future customers. By doing this it contributes to the health and well being of the community, the needs of commerce and the protection of the environment.

Effective planning for the sufficiency of future water supplies is essential. NI Water, through its Water Resource Strategy, plans to ensure that demand for drinking water is met for the period up to 2030. The strategy emphasises the need to rationalise existing uneconomic water sources and concentrate on the sources that can meet needs cost-effectively and reliably.

NI Water continues to meet the obligations placed upon it to comply with regulatory standards and increasing customers' expectations. Investing in the extension and upgrading of water treatment works remains a high priority for NI Water.

Kelda Water Services (KWS) Alpha are the operators of four water treatment works (WTWs) and one pumping station as part of a Public Private Partnership with Northern Ireland Water called Project Alpha. KWS Alpha now produces almost 50% of the total drinking water demand of Northern Ireland, covering primarily the counties of Antrim, Armagh and Derry and notably a significant proportion of the water requirements for Belfast.

NI Water has responsibility for the water into public supply from all WTW's in operation, including those operated by Kelda Water Services. All reporting arrangements to the PHA, DWI and EHO's are the responsibility of NI Water

NI Water publishes an annual Drinking Water Quality Report which can be accessed via the following link;
http://www.niwater.com/reports/

4 Wholesomeness, testing and drinking water quality standards.

4.1 Wholesomeness

The Drinking Water Regulations reflect the Drinking Water Directive in requiring that water must be wholesome when supplied:

- For cooking, drinking, washing and food preparation (domestic purposes); and
- To premises in which food is produced (food manufacturing).

4.2 Drinking water testing

The Drinking Water Regulations require sampling programmes to be in place across Northern Ireland to test for compliance with standards in both public and private water supplies. Tests are carried out for over forty different substances or organisms, known as parameters.

In respect of public water supplies, water quality is monitored at water treatment works, service reservoirs, water supply points and customer taps in water supply zones. In respect of private water supplies, samples are taken to represent water quality at point of use be that for consumption or for food production.

The regulations require water quality to be monitored using analytical systems which can demonstrate that appropriate accuracy is achieved and maintained. All laboratories used for the analysis of samples taken at public and private water supplies are accredited by the United Kingdom Accreditation Service (UKAS) and to Drinking Water Testing Specification (DWTS), a national scheme agreed between the Drinking Water Inspectorate and UKAS for quality assurance within laboratories undertaking water analysis. The schedule of accredited tests performed by NIPHL is maintained by UKAS and available on their website

4.3 Drinking water quality standards

Statutory water quality standards are contained within the “Drinking Water Regulations”.

Schedule 1 parameters are health based mandatory parameters. Schedule one parameters are specified in definition of wholesomeness (refer to

definition) – their presence or level may be associated with an immediate significant health risk e.g. *E.coli*.

Schedule 2 parameters are indicator parameters - an immediate health risk from an indicator parameter is unlikely.

(For full list of parameters see Annexes 11.3 & 11.4)

The DW&HLG have agreed an additional prioritised reporting protocol using agreed health notification values (HNVs). If a HNV is exceeded for any sample, operational or complaint, it is reported to the PHA and the relevant district council(s). This enables a dialogue on the significance of the exceedence to take place and consideration to be given to the need for appropriate health advice (see Annex 11.5).

The Health Notification Values (HNV) exceedences most commonly reported to the PHA by NI Water and district councils are in relation to the following parameters:-

- **Microbiological**
  E. coli
  Coliform bacteria

- **Chemical**
  Turbidity
  Aluminium
  Iron
  Lead

When microbiological exceedences are reported by NI Water the total and free chlorine residual concentrations associated with the sample will also be provided. NI Water chlorinates the water supply at the WTWs and, if required, boosting of the chlorine residual is carried out at key service reservoirs through the distribution system to ensure that a chlorine residual is maintained to the end of the distribution system. The chlorine residuals can therefore vary depending on the location of the sample point within the distribution system. NI Water will confirm at the time of reporting the microbiological exceedence if the chlorine residual is typical for the area or if this is an unusually low result.

The World Health Organisation Guidelines for Drinking-water Quality established a health based guideline value of 5 mg/litre for free chlorine in drinking water, but noted that this value is conservative, as no adverse effect level was identified. The taste threshold for chlorine is below the health based guideline value. Most people are able to smell or taste chlorine in drinking water at concentrations well below 5mg/l and some at levels as low as 0.3 mg/litre. The typical range for chlorine residual in the distribution system would be 0.02 to 0.5 mg/litre.

4.4 **Drinking water quality sampling at public water supplies**

The Drinking Water Regulations necessitate a thorough and extensive water sampling programme to be undertaken to monitor water quality throughout the supply and distribution systems. The sampling locations and frequencies for the monitoring of drinking water quality are specified in the Regulations. The mandatory sampling programme requires water samples to be collected regularly at WTWs, at service reservoirs and water towers used to store treated water and at customers' taps in the water supply zones.

The regulations have specific sample collection and analysis requirements. NI Water's contracted UKAS accredited water quality sampling provider employs skilled and experienced sampling staff for the collection and delivery of the regulatory samples to the laboratories. All samples are carefully collected, handled and transported to ensure that they accurately represent the water quality which customers receive.

Samples collected from customers' taps are taken at random addresses in each water supply zone. A water supply zone is a designated area with a population of no more than 100,000 supplied with water by one treatment works or blended water from several works. The number and boundaries of water supply zones are subject to change according to operational requirements as supply sources to areas are adjusted to meet demand and infrastructure developments.

4.5 **Laboratory analysis and quality assurance**

The Regulations require water quality to be monitored using analytical systems which can demonstrate that appropriate accuracy is achieved and maintained through the use of **only** appropriately accredited laboratories.

The NI Water laboratories are located at:-

Belfast	**Altnagelvin (including Crypto Lab)**
Westland House	**1a Belt Road**
40 Old Westland Road	**Altnagelvin**
Belfast	**Londonderry**
BT14 6TE	**BT47 2LL**

Analysis are also carried out on behalf of NI Water, under contract, to an accredited laboratory service provider for certain parameters such as pesticides.

NI Water has established a *Cryptosporidium* Analytical Unit at the Altnagelvin Laboratory. This facility provides for the rapid detection of *Cryptosporidium* oocysts and has Drinking Water Inspectorate approval. The laboratory also carries out work that is instrumental in the development of new accredited methods for the water industry.

4.5.1 NI Water laboratory analysis turnaround times

The turnaround times show the maximum number of days from when a sample is taken until result availability.

Table 1: NI Water laboratory microbiological parameter turnaround times

Parameter	***Maximum*** **turnaround time (days)**
E. coli	3
Coliform Bacteria	3
Colony counts 22^0	4
Colony counts 37^0 (48hrs)	3
Cryptosporidium oocysts	3
Clostridium perfringens (sulph red)	4
Enterococci	3
Algal analysis	5

Table 2: NI Water laboratory chemical parameter turnaround times

Parameter	***Maximum*** **turnaround time (days)**
Aluminium	4
Iron	4
Manganese	4
Lead	4
Antimony	4
Arsenic	4
Boron	4
Cadmium	4
Chromium	4
THM	5
Odour	3
Taste	3
Colour	1.5
Conductivity	1.5
Hydrogen Ion	1.5
Turbidity	1.5
UV254	1.5
Total Organic Carbon	3
Total hardness	4
Contract Analysis Water (pesticides)	30

4.5.2 **Priority customers**

NI Water holds a database of strategic customers (hospitals and schools, nursing homes etc.), the locations of which are mapped using the NI Water GIS system for use during an incident.

In addition to this NI Water holds a 'Customer Care Register (including Critical Care)'. This service is included in one of the company's Codes of Practice, and has been agreed by both the Northern Ireland Authority for Utility Regulation (NIAUR) and the Consumer Council for Northern Ireland (CCNI).

NI Water consulted closely with CCNI, and considered similar services offered by other utilities. Services offered are Doorstep Service; Password scheme; Carers Contact Service; Special Advice; Information leaflets in alternative formats (see Annex 11.6 for more detail).

In addition, for customers who depend on equipment that is vital to their health and require a water supply, NI Water offer advice on what to do in the event of a loss of the water supply or flooding. These customers are registered on our Critical Care Register, and are primarily customers who require home dialysis.

Customers must register for this service by telephoning **Waterline on 03457 440088.**

More information is available through the NI Water Website:

http://www.niwater.com/customer-care-register/

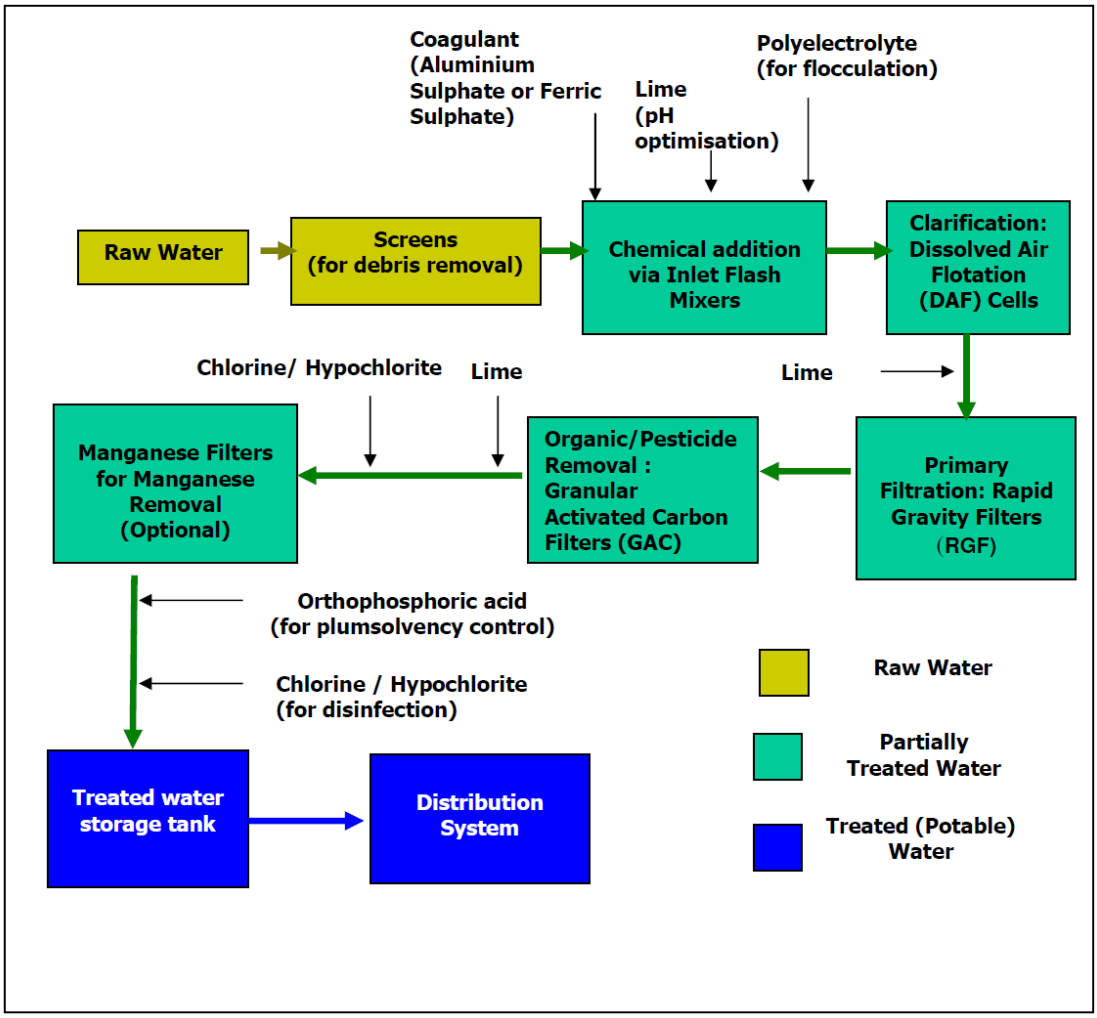
5 Water treatment

5.1 Water treatment processes

The primary aim in water treatment is the elimination of any pathogenic micro-organisms present and to provide a wholesome drinking water supply.

The basic water treatment process for surface waters consists of preliminary screening, followed by coagulation and flocculation, clarification, filtration and disinfection, the various stages of treatment are outlined in figure 4.

Figure 4: Generic water treatment works schematic



5.2 Overview of water treatment stages

5.2.1 Preliminary treatment and screening

The abstracted water is first screened to remove suspended and floating debris, such as leaves or branches, which could interfere with the operation of machinery in the treatment works.

5.2.2 Coagulation and flocculation

Coagulation is always considered along with flocculation and is used to remove particles which cannot be removed by sedimentation or filtration alone. These particles are usually less than 1 µm in size and are termed colloids. They have poor settling characteristics and are responsible for the colour and turbidity of water. They include clays, metal oxides, proteins, micro-organisms and organic substances such as those that give the brown coloration to water from 'peaty' catchment areas. The important property which they all have is that they carry a negative charge and this, along with the interaction between the colloidal particles and the water, prevents them from aggregating and settling in still water. The particles can be aggregated by adding either multivalent ions or colloids having an opposite (positive) charge. These are added as chemical coagulants. Chemicals commonly used as coagulants in water treatment are aluminium and ferric salts.

5.2.3 Clarification

Clarification is used to remove solids from waters which are high in sediment content, and also to remove particles rendered settleable by coagulation and flocculation.

Dissolved air flotation (DAF) is a treatment process that clarifies water by the removal of floc particles. The removal is achieved by dissolving air in the water under pressure and then releasing the air at atmospheric pressure in the tank. The released air forms tiny bubbles which adhere to the floc particles causing the suspended matter to float to the surface of the water where it is periodically removed. Clarified water exits towards the bottom of the tank.

5.2.4 Filtration

The partially treated water is passed through a medium such as sand or anthracite, which acts as a 'strainer', retaining the fine organic and inorganic material and allowing clean water through. The action of filters is complex and in some types of filter biological action also takes place. Rapid gravity filters are used in water treatment to remove the fine particles which cannot be economically removed by sedimentation.

5.2.5 Disinfection

Water is disinfected before it enters the distribution system to ensure that all potentially pathogenic micro-organisms are inactivated. Chlorine or sodium hypochlorite are most often used because they are very effective disinfectants, not only at the treatment plant but also in the pipes that distribute water. Water is disinfected to a set point at the WTWs. Regulation 26 of the Drinking Water Quality Regulations requires that water is disinfected and that sufficient treatment is in place to prepare it for disinfection. NI Water is required to have a disinfection policy and procedures in place to verify disinfection of the water supply. The disinfection policy covers the design, maintenance and operation of all relevant components of the treatment works. The Regulations specify that the preliminary treatment must ensure turbidity in the raw water is reduced to below 1 NTU before water enters the disinfection stages of treatment and NI Water must be able to demonstrate that the disinfection process is appropriate and operating within the design criteria. Compliance with Regulation 26 goes hand in hand with the Drinking Water Safety Plan approach (Section 6)

Public buildings with large distribution systems, particularly healthcare facilities, often use chlorine dioxide as the means of primary or secondary disinfection of water intended for human consumption and for the control of legionella. Chlorine dioxide is usually produced on-site from a chlorite-based precursor using a chlorine dioxide generator. The levels of chlorine dioxide dosed needs to be controlled so as to maintain adequate disinfection of the water supply (usually a residual of between 0.1 – 0.5 mg/l chlorine dioxide) while keeping the disinfection by-products, chlorate and chlorite, as low as possible. Both the drinking water guidelines for approved products (http://www.dwi.gov.uk/drinking-water-products/approved-products/soslistcurrent.pdf and the HSE guidance for the control of legionella bacteria (http://www.hse.gov.uk/pubns/priced/hsg274part2.pdf) state, that in using chlorine dioxide, the level of total oxidants (chlorine dioxide, chlorite and chlorate) should not exceed 0.5 mg/l.

5.3 Optional treatment processes

The process requirements at each WTW vary according to the type and quality of the source water. Some waters may require additional treatment: for example:-

- Granular Activated Carbon (GAC); this process is an advanced system used to remove pesticides, organic compounds and unpleasant tastes and odours.
- Ozone dosing; this involves injecting ozone into the water to breakdown pesticides and organic material. Ozone is a very reactive molecule that attacks and destroys these compounds.

5.4 **Orthophosphate treatment**

Water leaving treatment works and in the distribution systems contains only trace amounts of lead. However, where lead has been used for service pipes between the water main and the kitchen tap or in domestic plumbing, there may be a risk of concentrations at the customers' tap exceeding the lead standard. All major water supplies in Northern Ireland are modified through the addition of orthophosphoric acid in the treatment process. This process enables a protective coating to be formed over lead pipes, to minimise levels of lead in the water supply.

NI Water monitor lead and phosphate levels at customer taps. NI Water is required under the Drinking Water Regulations to inform the customer in writing when a lead sample taken at the customer's tap exceeds the regulatory limit for lead in the drinking water supply. NI Water will replace the section of lead pipe to the boundary of the customer's property (on a priority basis) when testing indicates that the water supply exceeds the regulatory limit for lead. It is the responsibility of the customer to replace any lead pipe within their property. The PHA, DWI and EHO's are informed of any exceedence of the lead standard of 10µg/l through the Health Notification (HNV) procedure.

It is recognised that the most effective solution to reducing lead in drinking water is to remove all lead pipes and fittings from the drinking water system. However this would be both expensive and difficult, particularly as a large portion of lead pipes line in private property. NI water currently has a number of procedures in place to facilitate the removal of lead form the drinking water system:

- Opportunistic replacement during mains rehabilitation
- Customer replacements, when a customer requests replacement when replacing their lead supply pipe.
- Replacement on an exceedence of the lead standard on a priority basis.

NI Water has a new programme of targeted sampling at vulnerable customer properties for example schools and children's hospitals.

5.5 **Treatment of small private water supplies**

The scale and nature of many private water supplies in comparison to the public water supply means the type of treatment used for these supplies is often simpler. In particular, as many private water supplies are groundwater as opposed to surface water supplies means the levels of treatment required to treat these supplies is much more basic. Specialised filter units may be used for the removal of specific metals such as iron, manganese or arsenic. The method of disinfection of private supplies is often ultraviolet (UV) irradiation, with the minimum dose generally taken to be in the range 16 to 40

mW.s/cm2 (milliwatt seconds per square centimetre). UV units should have a pre-filter fitted to reduce fouling of the UV lamp thereby maintaining the effectiveness of UV disinfection. The routine maintenance of any filters and the UV unit should be carried out in accordance to the manufacturer's instructions to ensure the optimum performance of the water treatment.

Where a private water supply is very hard water, softening treatment can be used for the removal of calcium and magnesium in order to prevent a build up of limescale. During this process the calcium and magnesium ions are replaced by sodium ions. In these cases, where possible, a separate unsoftened drinking water supply should be maintained.

6 Drinking water safety plans

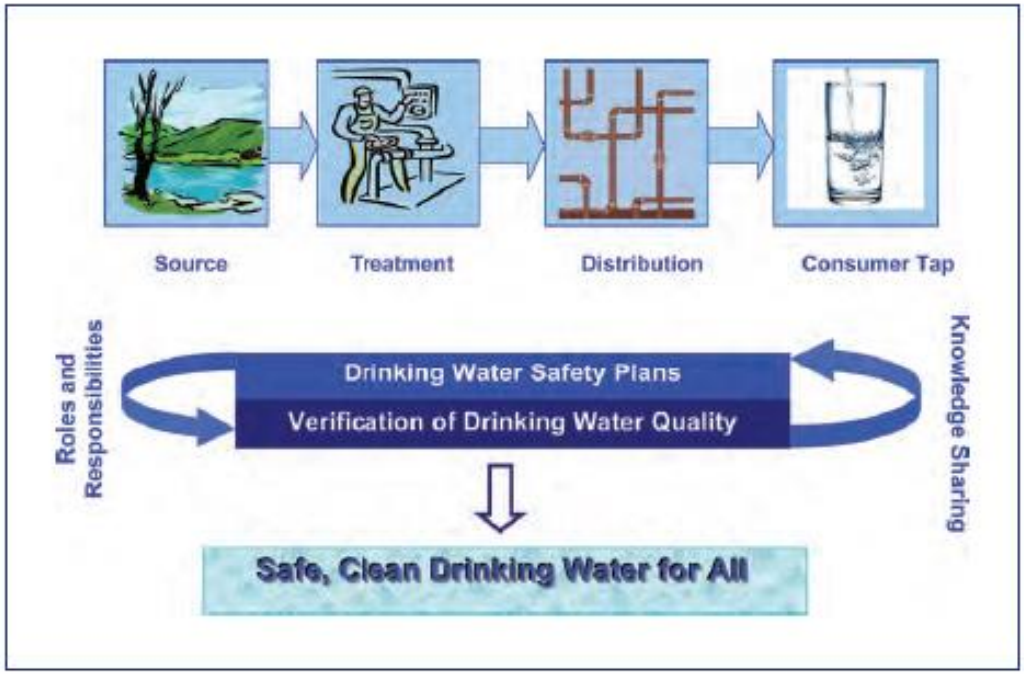
In the third edition of the Guidelines for Drinking Water Quality, published in 2004, the World Health Organisation (WHO) presented a new approach to assuring drinking water safety and quality called Drinking Water Safety Plans (DWSPs). This risk based approach was a move away from relying on monitoring quality in the final water, particularly at the tap, to a much more proactive risk-based approach that concentrated on preventing water quality problems and using final water monitoring against a list of parametric values as an audit rather than an operational tool. This process has been rapidly adopted as best practice around the world and has been adopted by the UK Drinking Water Quality regulators. The regulatory framework in Northern Ireland requires risk assessments to be carried out for both public and private water supplies. NI Water has adopted DWSPs for all water supply systems which are kept under regular review and risks updated as required. Additionally the risk assessment approach has been applied to private water supplies.

The principle of a DWSP is to map and understand water supply systems, determine the hazards at each stage from the catchment through treatment and distribution to consumer premises, and assess the risks that these hazards pose in each stage of each supply. Figure 5 provides a diagrammatic representation of the DWSP approach. Barriers or procedures and actions, collectively called control measures, are put in place to mitigate those risks but the process also allows the risks to be prioritised and so helps inform investment requirements.

In addition the control measures are monitored to ensure that they are working and continue to work. In the case of treatment processes this includes measurement of operational parameters, often using continuous monitors, setting operational limits on those parameters and establishing procedures to ensure that the treatment processes remain optimised. In other cases, operational management procedures are documented and those procedures form the basis for ensuring that the system will operate at its optimum at all times. For other parts of the system, such as the distribution network, management procedures will provide a generic basis for ensuring that failures to meet the regulations arising in distribution will be minimised.

The adoption of the DWSPs provides a means of meeting the goal of supplying good safe drinking water through the proactive prevention of non compliance, and will greatly contribute to the work ongoing to secure safe and wholesome drinking water across Northern Ireland.

Figure 5: Diagrammatic representation of the DWSP approach



The DWSP risk based approach is a regulatory requirement from which there will be additional significant benefits;

- Reduces the risk of incidents occurring;
- In the event there is a failure, the existence of a DWSP demonstrates due diligence on the part of NI Water and facilitates the discovery of the cause of failure;
- Enhanced ability to input into a Health Risk Assessment following activation of the Health Notification Procedures;
- In the long term DWSPs will lead to improved security of supply, a reduction in regulatory failures, incidents and customer complaints and hence increased customer confidence;
- Identify potential failings in a system and the investment required to address these through capital, operational and training programmes; and
- Input positively to the Water Framework Directive Programme of Measures with the NIEA and other government and non-government organisations, with a view to Drinking Water Protected Area catchment management.

6.1.1 *Cryptosporidium* risk assessments

NI Water carry out C*ryptosporidium* risk assessments on an annual basis as per the Drinking Water Inspectorate guidance document ; Guidance for the Monitoring of *Cryptosporidium* in Treated Water Supplies in Northern Ireland.

The risk assessment methodology takes into consideration the potential hazards within the raw water source catchment for exposure to C*ryptosporidium* oocysts, the water treatment process and water treatment monitoring at the water treatment works. The risk assessment score is used to develop the sampling programme for C*ryptosporidium* monitoring of the water supply.

The NI Water C*ryptosporidium* monitoring sample programme for WTWs is agreed with the PHA and the DWI on an annual basis.

Under the Health Notification Value (HNV) procedure NI Water is required to notify the PHA and the DWI of any occurrence / detection of C*ryptosporidium* oocysts in the treated water supply.

The PHA will advise NI Water what action, if any, is required to be taken following the detection of C*ryptosporidium* oocysts at the notification levels as stated above. NI Water will carry out the remedial actions as instructed by the PHA. This may if required include notification and advice to customers.

6.1.2 **Drinking water quality at private water supplies.**

The quality of drinking water at private water supplies in Northern Ireland is monitored under the Private Water Supplies Regulations (Northern Ireland) 2009 (as amended). The statutory body responsible for the monitoring and enforcement regimes under these regulations is the Drinking Water Inspectorate for Northern Ireland (the “Inspectorate”).

In implementing the requirements under the regulations the Inspectorate works closely with the Environmental Health Departments (EHDs) who carry out sampling and risk assessment of private water supplies and liaise with owners/users of these supplies during the investigation of exceedences of water quality standards.

The requirements and mechanisms in place to ensure safe and clean drinking water at private supplies monitored under the regulations is similar to those in place for the public water supply with a monitoring programme to determine the compliance with drinking water quality standards along with a risk assessment being required at each registered supply. The Inspectorate is responsible for ensuring that all aspects of the regulations are carried out.

There are approximately one hundred private water supplies which are monitored by the Inspectorate under the regulations and these are split between 85% commercial premises and 15% domestic premises (groupings of two or more houses only). If your private water supply is in one of these categories then you are required to register your supply with the Inspectorate under the private water supplies regulations. The registration form can be downloaded from:

https://www.daera-ni.gov.uk/publications/new-private-water-supply-registration-form
The commercial premises mainly relate to food production, but would also cover hospitals, hotels, guest houses, and holiday rentals. Private water supplies to single private domestic dwellings are not monitored under these regulations but there is a requirement to offer appropriate advice to such supplies. An information leaflet entitled 'Is your private water supply safe?' can be downloaded from the Inspectorate website at:

https://www.daera-ni.gov.uk/publications/your-private-water-supply-safe

The EHDs of councils will normally sample such supplies in their area on request.

6.1.3 **Sampling and analysis at private water supplies**

The Inspectorate has an arrangement with EHDs to undertake sampling at private water supplies on its behalf. An annual sampling programme is issued to councils which details the frequency of sampling for each site. The frequency of sampling is set within the Regulations and is proportionate to the volume of water used or the population served by the supply.

A contracted service managed by the Inspectorate has in place arrangements for the collection of samples from the councils, onward transportation to laboratories, and their subsequent analysis and reporting to the Inspectorate. The council staff who take samples on behalf of the Inspectorate have received formal training from the Inspectorate relating to industry best practice and follow the procedures for sampling detailed in 'Private Water Supplies Sampling Manual – A Field Guide' [ISBN 978-1-907053-11-5] published by the Inspectorate:

https://www.daera-ni.gov.uk/publications/private-water-supply-sampling-manual

6.1.4 **Risk assessments at private water supplies**

The Inspectorate has provided training and the appropriate resources to undertake (on the Inspectorate's behalf) risk assessments at private water supplies. The regulations require that risk assessments are completed for any new private water supplies within 6 month of such supplies coming into

service. For existing supplies the risk assessment should be reviewed every 5 years or earlier if it is considered the current risk assessment is inadequate.

7 Surveillance of waterborne illness

The surveillance, investigation and control of infectious disease is the statutory responsibility of the Director of Public Health (DPH) or designee. A list of possible waterborne pathogens is given below. Most of these pathogens can be transmitted by other means, as well as by water. More detailed information on these and other potential waterborne pathogens is given in Annex 11.7 & 11.16.

Figure 6: Known waterborne pathogens

Bacterial

- *Campylobacter*
- *Legionella*
- *Shigella*
- *Salmonella* species
- *Salmonella typhi*
- *Salmonella paratyphi*
- *Vibrio* species
- VTEC (e.g. *E. coli* O157)

Viral

- Hepatitis A
- Hepatitis E
- Norovirus
- Enteroviruses
- Rotavirus

Protozoal

- Toxic cyanobacteria
- *Cryptosporidia*
- Giardia

The most common waterborne pathogens are those that have high infectivity and either can proliferate in water or possess high resistance to decay outside the body. Most waterborne pathogens are introduced into drinking water supplies in human or animal faeces, do not grow in water and initiate infections in the gastrointestinal tract following ingestion. However, some organisms can grow in water distribution systems e.g. *Legionella*. Other possible routes of transmission are inhalation and contact.

The effects of exposure to pathogens are not the same for all individuals or populations. Some organisms may cause illness only in people with impaired immune systems or in vulnerable groups such as the elderly and very young.

Repeated exposure to a pathogen may be associated with a lower probability or severity of illness because of acquired immunity. For some pathogens (e.g. hepatitis A virus) immunity is lifelong, whereas for others the protective effects may be restricted to a few months (e.g. *Campylobacter*).

7.1 **Surveillance information**

Surveillance information on waterborne, or suspect waterborne, illness in humans comes from four sources:

- **clinical** notification of infectious diseases;
- **laboratory** notification of pathogens;
- **consumer complaints**
- **outbreak** surveillance information.

7.2 **Notifications of Infectious Disease**

Doctors are required under the Public Health Act (NI) to notify the Director of Public Health as soon as they become aware that a person they are attending is suffering from a notifiable disease or is suspected of having a notifiable disease. Laboratory confirmation is not a pre requisite for the purposes of notification. There are 33 notifiable diseases in Northern Ireland some of which potentially could be transmitted by water.

7.3 **Laboratory reporting of pathogens**

Hospital microbiology laboratories voluntarily report pathogens of public health concern to the PHA for public health action and for surveillance purposes. These would include pathogens as described above and in Annex 11.16. However this requires the patient to seek medical advice, the relevant clinical samples obtained, a pathogen being identified and then reported to the PHA.

The PHA, in conjunction with local EHDs, would investigate those affected, seek risk factors contributing to their illness, offer control of infection advice to prevent or limit spread to others, and take any other appropriate action either directly or with partner agencies.

An agreed dataset of information is collected on each case of infectious disease clinically notified or reported from laboratories. This enables analysis of cases by time, place and person and early identification of outbreaks. Enhanced surveillance is carried out for some pathogens e.g. *E. coli* 0157 and *legionella.*

7.4 **Consumer complaints**

Occasionally consumers may complain to the PHA, NI Water or their local Environmental Health Department about water quality issues. This may lead to them being referred to their general practitioner for assessment/investigation and arrangements made for water quality sampling.

7.5 Outbreak surveillance information

Investigations of notifications of infectious disease and laboratory reports may suggest or indicate an outbreak is occurring. An outbreak can be defined as: two or more cases linked through a common exposure, personal characteristics, time or location; or when a greater than expected rate of infection occurs when compared with the usual background rate for a particular place and time.

The PHA Health Protection Duty Room routinely liaises with NI Water to map reports of cryptosporidiosis by water supply zone as such mapping constitutes an important aspect of investigating a potential cluster of cases in time or place. The first indication of a potential water quality problem may be a rise in cases of acute infectious gastroenteritis or cryptosporidiosis in a particular supply zone.

If water quality indicators suggest a risk to human health, surveillance would be enhanced and case finding optimised. This may include infections that are not normally notifiable.

Figure 7: Enhanced surveillance summary

Enhanced surveillance may include:

- contacting GPs/GP Out of Hours centres and hospitals (incl. A&E Depts) to identify additional cases
- monitoring symptoms in congregate settings (e.g. nursing homes and schools)
- monitoring anti-diarrhoeal sales in community pharmacies
- requesting laboratories to increase testing for the relevant organism/pathogen, if not routinely sought
- identifying school absence rates
- monitoring hospital admissions, A&E consultations etc.

Routine surveillance information:

- provides baseline levels of illness against which trends can be measured both at a local and NI level by the PHA;
- detects outbreaks of illness with potential links to drinking water where routine water monitoring programmes may not be sufficiently sensitive to establish contamination or treatment failure (e.g. *Cryptosporidium*, *E. coli* 0157);
- may identify emerging pathogens;
- forms an important element of a shared approach via the DW&HLG to evaluating drinking water treatment programmes;
- can provide reassurance to the public that systems and processes are in place to detect outbreaks of human illness which could potentially be related to water quality issues; and
- provides data for epidemiology.

There is no routine surveillance for illness caused by chemical exposure. However surveillance may be established for potential effects of chemical exposure, for example by contacting local GPs, pharmacists, A&E Departments concerning any unusual patterns of illness depending on the nature of the incident.

8 Protecting the public when something goes wrong

8.1 Public Supplies

Due to the nature and complexity of operational activities involved in the supply of drinking water, NI Water undertakes a number of actions to protect public health. Reference has been made earlier to Drinking Water Safety Plans, water treatment and monitoring processes. Other actions include the provision of advice to customers. On many occasions NI Water will also inform the PHA and EHDs as part of this process (as outlined below).

For routine water supply operations, temporary precautionary advice is issued by NI Water to householders by means of letters, leaflets or warning notices. This would include the relevant contact details and NI Water's Waterline 24 hour contact point. Some typical situations where precautionary advice is issued include:

Planned work on the water supply: NI Water supplies advance notices to affected buildings giving details of the work, and timing of any shut down in supply.

Unplanned disruption to the water supply: these are typically caused by a burst main. If it is likely to cause major disruption NI Water may need to contact the PHA and the local EHDs and District Councils.

Criteria for informing the PHA and District Councils would include some or all of the following: a significant supply disruption; size and vulnerability of the population affected; and high risk institutions involved e.g. hospitals, care homes.

NI Water will make arrangements for providing alternative supplies (refer section 10.4).

Adverse routine test result – single property: samples are taken at random from consumer taps on a daily basis. On receipt of adverse laboratory reports NI Water will undertake an initial risk assessment and arrange for further samples to be obtained and provide the householder with advice on precautions to be taken until the cause has been identified. This could be to flush the tap before drawing water, or boiling before use, or do not use the water. The laboratory results and any other relevant information, such as remedial actions and preliminary investigation findings are shared with the PHA, DWI and Environmental Health Departments via the notification proformas (see Annex 11.12).

Consumer water quality complaint – single property: this may be through Waterline or from local EHDs. NI Water will liaise with the householder and

see if it could be linked with any known operational problem in that locality. If necessary NI Water will visit the household and obtain samples.

8.2 **Investigating and reporting water quality exceedences**

Compliance with the drinking water standards is determined by comparing the results of laboratory analysis of water samples with the relevant Prescribed Concentrations or Values (PCV).

The NI Water Environmental Regulation Drinking Water Regulation team is responsible for ensuring that all drinking water parameter exceedences are investigated and reported to the DWI, PHA and District Council EHDs.

Where a standard has not been met, for any parameter, appropriate immediate investigation and remedial action is undertaken by Water Quality Scientists to ensure that the water supply does not present any public health risk. Sampling programmes are adjusted and increased testing may be scheduled in the water supply zone for the parameter involved.

All water quality exceedences are investigated and reported to the DWI. An Investigation Report detailing the cause of the problem and remedial action taken is completed by the Water Quality Scientists and subsequently provided to the DWI.

In the event that a parameter exceeds the Health Notification Value (HNV) the Water Quality Scientist will liaise with the PHA, the DWI and district council EHD to ensure customer safety. A proforma (annex 11.12 & 11.13) will be completed by the Water Quality Scientist to ensure that all the relevant information pertaining to the problem has been captured for discussion with the PHA. NI Water will take advice from the PHA on what course of action is required; this could involve issuing advice notices to customers (Annex 11.22).

Health Notification Values can be found in Annex 11.5

8.3 **Sampling undertaken by EHDs**

There are occasions when EHDs take samples of drinking water for analysis, as a result of planned work activities (e.g. food hygiene inspections) or following receipt of complaints (e.g. regarding concerns over the drinking water at a domestic property). These samples should be taken by appropriately trained staff (see 6.1.3). Where possible, chlorine readings should be taken at the time of sampling. In such circumstances, should unsatisfactory results regarding drinking water be obtained, Environmental Health Officers (EHOs) will investigate the underlying factors that may have contributed to the failure (e.g. contamination of an internal storage tank, existence of internal lead pipe work) while taking into account relevant guidance such as the document “Drinking Water Health Notification Values”

and work with the relevant duty holder (e.g. food business operator, employer, landlord, or owner-occupier of domestic property) to resolve the matter in line with relevant legislative requirements. This may be achieved through the use of informal or formal procedures including, where appropriate, advice and/or the use of statutory powers.

All water quality sample results should be forwarded by district councils to the DWI. Unsatisfactory results should also be forwarded to the PHA and NIW using an agreed reporting template indicating action taken/planned (see Annex 11.12). The PHA will liaise with the relevant council, discuss the risk assessment and actions required. Boil water notices or similar advice should only be issued on the advice of the PHA.

8.4 **Private Supplies**

All exceedences of the water quality standards are required to be investigated under the regulations, and where appropriate, remedial action must be taken to bring supplies into compliance. Under the regulations it is the responsibility of the Inspectorate to ensure appropriate investigation and follow-up actions have taken place (see Annex 11.11.8). The Inspectorate works closely with the environmental health staff within councils in ensuring that the requirements of the regulations are implemented.

The investigation process and any necessary resampling are mainly undertaken by environmental health staff who liaise closely with the Inspectorate during this process. The Inspectorate will also take part in the investigation by offering technical advice and assistance and, where necessary, undertaking site visits.

The Inspectorate will assess each failure to determine whether or not the failure could constitute a potential risk to health by applying the criteria within the Health Notification Values agreed for the public water supply. The Inspectorate would then initiate the process described in section 8.5, ‘Investigation and reporting of health notifications values (HNVs)’.

8.5 **Investigation and reporting of health notification values (HNVs)**

When investigating such failures an assessment must be made into whether a private water supply is a risk to human health. This takes into account the purpose for which the water is used. The Inspectorate will apply the Health Notification Values (refer Annex 11.5) which have been agreed for the public water supply to failures reported at private water supplies. Through the current triage reporting system, the PHA and the relevant district council would be informed of failures which have breached HNVs through the emailing of a history log to both PHA and district councils. The Inspectorate will then await advice from the PHA, on what course of action to take. This

could involve the PHA advising the Inspectorate to issue a boil water notice on the affected premises. EHDs may liaise with the Foods Standards Agency in Northern Ireland for further advise where there is a failure of the water supply at a food manufacturing or bottled water site. Similarly the Inspectorate will consult with DARD officers at meat/milk or vegetable processing sites which are under their remit. The DWI will liaise closely with PHA and district councils throughout the whole process until closure of the incident.

The Inspectorate have appropriate pre-prepared notices (see link in section 8.5.1) to issue to private water supply owners/users, on advice from PHA where there would be a requirement to restrict or prohibit the use of the water supply.

8.5.1 **Further technical information**

There is a UK wide resource in the Private Water Supplies Technical Manual which is freely available on-line at www.privatewatersupplies.gov.uk which provides advice and technical assistance to both owners and users of private water supplies as well as to professionals involved with private water supplies

9 Drinking water quality incidents and significant interruption to supply

9.1 Reporting Water Quality Exceedences

STOP! If you are reading this for the first time during an incident do not continue. Seek advice from an experienced colleague and/or refer to checklists contained in the appendices.

A water quality or supply issue may be detected through;

- routine monitoring by NI Water;
- customer complaints; and
- surveillance of reports of illness in the community by the PHA.

NI Water will undertake the initial investigation of any alerts detected through internal monitoring processes, consumer complaints or from information received from the PHA. If the water quality exceeds the relevant standard or Health Notification Value (HNV), or if there is likely to be a significant disruption to supply as defined in 8.1, NI Water will urgently contact the PHA (in hours through the Duty Room or after hours through the on call service). NI Water will complete a proforma Annex 11.17 to capture all relevant information pertaining to the problem for discussion with the consultant in health protection to enable the latter to undertake a risk assessment

This proforma will include:

- a description of the supply area (geographical and population coverage);
- water treatment processes;
- water transit time in the relevant distribution zone;
- water quality supply history;
- water sampling (when, where, quantity, outcome);
- chlorination levels;
- operational issues;
- suspected cause(s); and
- action taken to date including who has been informed.

9.2 Incident management

In the event of a major incident NI Water will establish a Major Incident Team which includes a Scientific Advisor. The Scientific Advisor is responsible for liaison with the PHA on specific public health issues. This role can be operated in conjunction with the role normally fulfilled by NI Water water quality scientists.

NI Water has a well established incident response and 'upward-reporting' mechanism that is regularly escalated to various levels of response, depending on prescribed incident category benchmarks. The procedure is set down in the NI Water Major Incident Plan. This plan forms the cornerstone of NI Water's emergency planning arrangements which includes a range of contingency plans for specific high risk events.

The NI Water Duty Officer rota provides formal standby arrangements which guarantee 24 hour senior management and emergency contact throughout the year.

The NI Water Telemetry Units, in Belfast and Londonderry (Altnagelvin), operate 24 hours a day / 365 days a year. Water quality and level alarms are monitored 24 hours a day and real-time storage, flow rate and chlorine levels can be read remotely by telemetry operators across Northern Ireland. The Telemetry Units also deal with out-of-hours emergency calls on dedicated hot-lines for the emergency services and other utility organisations.

A 'call-out' system is available for supervisors to deploy operational teams (generally first-line managers and industrial staff) to instigate urgent repairs outside normal working hours.

9.3 **PHA incident management**

Communication systems for NI Water to inform and alert the PHA, District Council Environmental Health departments and the DWI on water quality issues/events are outlined in 8.2, out of hour's contact details are detailed in Annex 11.1. These define how and under what circumstances NI Water will inform the PHA of HNV exceedences or issues of potential public health concern.

The response to these alerts will vary with the perceived public health effects of each event. These include:

1. Alert for information only
2. Alert for information and advice
3. Alert requiring the formation of a (multi-agency) Incident Management Team

The appropriate response for a given alert will usually be apparent following a risk assessment.

9.4 **Risk assessment**

The nature and extent of the public health response to an exceedence will vary according to the particular circumstances, and will be influenced by detailed knowledge of the history of the water quality in the supply and gastro-intestinal illness trends in the geographical area supplied by the water. Local knowledge will aid in the interpretation of trends in water quality indicators and determine a level for investigation and action, based on careful and thorough risk assessment. **Public health action is rarely required following a single exceedence**. Usually a repeat sample and further information are required. It is not always appropriate to specify exact levels where particular actions are required. Over emphasis on numerical guidelines can lead to compliance with the numbers becoming the primary focus.

When a water sample result exceeds a parametric value the first step is to consider whether the sample is valid and representative of the water supply, this is summarised in Fig. 8.

Figure 8: Valid sample result checklist summary

Sample issues

Is the result reliable?

- Sample taken by person familiar with sampling procedures, storage and transport?
- Any potential for mislabelling of sample?
- Consider reliability of sampling point (has it been used before?)
- Type of tap/abstraction point

Laboratory/test issues

- Accredited test method/accredited laboratory?
- Transcription error?
- Any pattern of abnormal results from other supplies on the same day?
- Availability of concurrent samples from other agencies/laboratories?

Other factors

- Does the result make sense i.e. is it plausible in view of profile of supply?
- Abnormally low free chlorine residual detected?
- Recent plumbing alterations at/near sampling point?
- Possibility of cross-connections or mixing of supplies?

If the sample is not considered valid then a repeat sample is required.

If the sample is considered to be a valid sample of the water supply at the sampling point, then there are a number of *supply issues* that should be considered (see Fig 10 below).

Figure 9: Supply issues

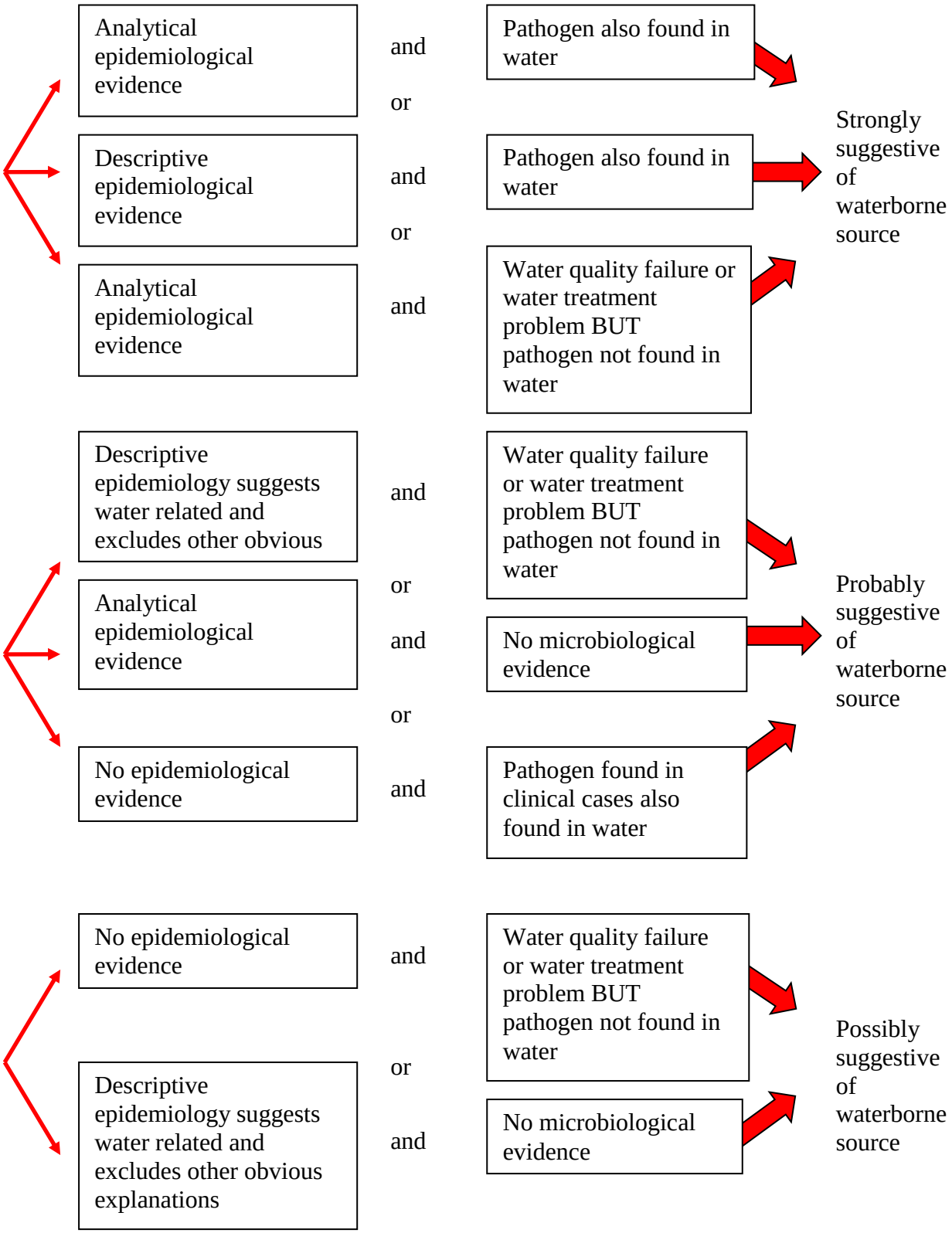
Supply issues

- Is the water at this point representative of the supply as a whole?
- Source of water – groundwater, surface water, natural well/spring
- Type of supply - public mains supply, private supply
- Water treatment process – type of treatment
- History of water quality of the supply
- Volume of water and number of hours from source to tap
- Geographical area of distribution and any sensitive populations in the area

Many exceedences will be managed entirely by NI Water in accordance with agreed protocols usually either by adjustment of disinfection or by flushing/scouring the pipe work.

A framework for assessing factors suggestive of a waterborne reason for an outbreak are outlined in Fig 10.

Figure 10: Factors suggestive of a waterborne source for an outbreak



10 Major incident involving potential public health risk.

Where an alert involves more than advising for information only, NI Water and PHA staff should liaise to determine whether there is a real or a potential public health risk related to the public water supply and/or human illness which may be related to the water supply. Sometimes it may be sufficient to agree further investigative or remedial action with appropriate follow-up. However such circumstances may trigger the formation an inter-agency Incident Management Team (IMT) to coordinate action.

Four complementary activities are required [Lead agencies]

- epidemiological investigation of persons at risk [PHA];
- microbiological investigation of patients [PHA], water treatment works [NI Water], animals [PHA/DARD] and the environment [PHA/NI Water & others];
- engineering investigations [NI Water]; and
- investigation for evidence of a contamination incident at the water treatment works [NI Water]

10.1 **The Interagency IMT**

The interagency IMT will be convened by the PHA and normally led by the Consultant in Health Protection (CHP). Depending on the issue it may be chaired by the Director/Assistant Director of Public Health. The core membership of the IMT will include:

- Consultant in Health Protection (CHP);
- NI Water technical and water quality staff;
- NIPHL Consultant Microbiologist;
- District Chief Environmental Health Officer;
- Director of Environmental Health;
- Head of Environmental Health Service;
- PHA information staff;
- PHA Public Relations Officer;

Depending on the circumstances additional representatives may be required from other Environmental Health departments, Health and Social Care Trusts, Health and Social Care Board, Food Standards Agency and Department of Agriculture and Rural Development.

The role of the interagency IMT is:

- to control the incident;
- prevent the distribution of contaminated water to the public and, where necessary, providing an alternative supply
- to identify factors contributing to the incident;
- to identify populations at risk;
- to ensure communication of public health advice. The latter may include the following warning notices:
  - boil water before use for drinking and food preparation
  - do not use for drinking or cooking
  - do not use for drinking, cooking or washing
- to evaluate the effectiveness of control measures; and
- to prepare and disseminate a report of the investigation to inform relevant stakeholders, to highlight lessons learned and issues for further investigation/research.

Each organisation may need to establish its own IMT to deal with specific operational matters relevant to that organisation. However it is important that each is represented on the inter-agency IMT to ensure appropriate co-ordination, liaison and communication.

The PHA will be responsible for convening the inter-agency IMT and providing secretarial support. All meetings of the inter-agency IMT must be fully documented including; names of attendees; key information; actions agreed with timescales and lead individual/organisation; and rationale behind decisions taken. The Chair is responsible for ensuring all inter-agency IMT members are aware of their role and responsibility. Members should keep a detailed log of their actions during the incident. Such material may be required at a later date should there be an inquiry into the incident.

Depending on the initial risk assessment where it is concluded there is an imminent and significant risk to public health early control measures may be necessary before the inter-agency IMT is formed. This may be before all laboratory information is available and should take place as a consequence of the initial liaison between organisations.

A sample agenda for the inter-agency IMT is provided in Annex 11.19.

10.2 **Communication of warning advice**

In a large scale event, potentially involving thousands of properties, the hazards posed by issuing a wide scale warning notice, for example to boil water prior to use, need to be carefully balanced against the nature of the water supply incident. Experience has shown that is often preferable to implement enhanced health surveillance of the affected community instead of issuing such a notice. Each situation has to be judged on its merits, taking

into account: local knowledge, whether or not water supplies can be quickly returned to normal or an alternate piped supply provided (by rezoning). If a decision is made to issue a warning notice the basis for lifting the notice should be agreed at the same time. Experience has again shown that significant problems can arise if the criteria for lifting a warning notice have not been considered and decided when it is first issued.

NI Water is responsible for issuing warning notices (see Annex 11.21) following advice from the PHA and providing alternative supplies (rezoning, tankers, bowsers and bottles). Do Not Drink / Do Not Use / Boil Water warning notifications apply to all users equally and no additional specific advice is required for commercial food business operators. The provision of an alternative supply (e.g. by tanker) would not negate against the need to boil water before use.

Methods for informing the public will include media alerts, social media, the NI Water Website and the NI Water Call Centre. A register of the major industrial food producers, by water supply zone, is held by NI Water's Key Account Officers, and food businesses will be notified regarding warning notices e.g. if there is a requirement to boil water before use.

NI Water can increase the capacity of its call centre by invoking the Mutual Aid Scheme – a scheme by which water companies can call on each other to provide support in times of adversity. Support can be in a number of forms, as stipulated in the Mutual Aid Agreement, for example provision of bottled water, equipment and/or personnel.

NI Water also has arrangements that leaflets can be distributed to households within 24 hours of such a decision. These alerts may need to be repeated should the incident last more than a few days. Similarly when the issue is resolved and the warning notices lifted this decision must also be communicated to the public. Consideration must also be given to ensuring that appropriate communication exists with those whose first language may not be English. This may require accessing interpreters at short notice.

District councils have responsibilities for decisions about the continued operation of premises manufacturing or serving food and drink, and for public buildings such as schools and leisure centres (see Annex 11.22 for private water supplies generic notices). The PHA is responsible for initiating contingency arrangements for hospitals and other health and social services. All responding agencies should ensure there is a consistent public health message with common information and joint statements including "frequently asked questions and answers" available for call handlers, the public, the media, and on relevant websites. Ensuring that this consistent message is received by the public through the media is the responsibility of the IMT. The IMT will agree who should be lead spokesperson(s) for the media.

10.3 Effective communications with ethnic minorities and ethnic minority businesses

It is essential that proper consideration be given to communicating effectively with Ethnic Minorities/Ethnic Minority Businesses (EMB's) regarding any matters that pertain to drinking water safety especially with regard to an incident. Issues such as language barriers and cultural differences must be considered to ensure associated messages are fully understood by persons for whom English is not their first language (Derry City Council, 2010). (For further information see Annex 11.23).

10.4 Alternative supplies

When there is an extended loss of water supplies or a Do Not Drink /Do Not Use notice is issued, NI Water will provide alternative supplies by several methods depending on the nature and scale of the incident:

- Bottled water;
- Stand Pipes
- Static tanks – free standing tanks which require lifting and transport to move
- Mobile tanks (known as bowsers) – towable, trailer mounted tanks
- Tankers – used to replenish static tanks (must be clearly identified and must be food grade)
- Rezoning (introduction of water from a different source into the piped supply.

During an incident NI Water aims to provide 10 litres of drinking water per head per day within the first 24 hours.

NI Water has standing arrangements in place for the provision of alternative supplies by means of bottled water. The PHA will advise on the use of bottled water for babies and vulnerable individuals (see Annex 11.20)

Static and mobile tanks and tankers will be clearly marked with a permanent notice at the draw off point to warn users that the water must be boiled before use. While such water supplies will be from a safe source and NI Water has strict hygiene arrangements in place for the tanks and tankers themselves, there is no control over the hygienic status of the containers used by the public for collecting water from the draw off point or for storing it within the home. The standing boil water advice therefore safeguards against these hygiene risks. The PHA will issue guidance on the use of containers used to collect water from tankers/bowsers (see Annex 11.20).

When static and mobile tanks are deployed they will be refilled by NI Water using tankers on a regular basis. The tanks are designed to be as vandal proof as possible.

10.5 **Ending the incident**

Ideally, the criteria for lifting a control measure should be agreed by the IMT at the same time as the decision is taken to impose the measure(s). However, circumstances often make this difficult. In this situation, action to protect public health should not be delayed and the criteria for lifting control measures should be decided by the IMT as soon as practical thereafter. The decision to declare the incident over will be taken when the IMT is satisfied that the hazard is adequately controlled.

The criteria for standing down an incident will be set by the IMT on the basis of best available evidence and advice. These criteria should take into consideration the balance of risks associated with continuing any restrictions, against the health risk associated with the waterborne hazard. Criteria may include concentration and nature of the contaminant, remedial action, cases of human illness and timescale involved. In some instances, e.g. chemical and algal contamination, it may be necessary to flush storage tanks.

Criteria for standing down an incident

- Water monitoring results satisfactory;
- Treatment is effective; and
- Epidemiological evidence that the outbreak is over and/or return to baseline levels of human illness.

Closing an incident

The incident will be **closed** when: all necessary actions have been taken; there is the resumption of normal supplies and/or the water quality parameters have returned to normal; the IMT have reviewed the management of the incident; and prepared the IMT report.

10.6 **Interagency IMT report**

After an outbreak or incident the health protection led IMT will often, as a matter of good practice, publish an investigative report highlighting the epidemiological features of the incident and the lessons learned. Ideally this report should be completed within three months of the incident. It is important that where this is done, the report confines itself to the health study and does not include operational details about the water supply or its management unless relevant, because these matters will be investigated and reported upon by the DWI.

It is important that all agencies/organisations represented on the IMT contribute to the incident report and agree to its contents before it is published by the PHA. Exceptionally, if there is failure to agree the reasons should be noted in the report.

NI Water is required to provide a report to DWI (normally within 20 working days unless agreed with DWI) which will include copies of any report or advice provided to NI Water by its medical, scientific or technical advisers, any District Council or the PHA. The NI Water report will also include an assessment of the adequacy of the arrangements for liaison with District Councils and the PHA with respect to the event.

10.7 **Interagency plans**

Interagency plans for the management of a major incident involving the water supply should be tested on a regular basis and plans modified in accordance with the lessons learned from these exercises and relevant incidents (locally and nationally).

Good practice in emergency preparedness suggests the following regimes for testing major incident plans:

- Communications test every six months;
- Table-top exercise every year; and
- Live exercise every three years

The responsibility for organising such exercises lies with NI Water.

11 Annexes

11.1 Annex: Contact Details – NI Water, PHA & DWI

NI Water

Waterline **03457 440088** (24 hours)

Email: waterline@niwater.com

Northern Ireland Water
PO Box 1026
Belfast
BT1 9DJ

Public Health Agency

Health Protection Duty Room (Mon/Fri 0900-1700):
0300 555 0119 (professional use only).

After Hours/weekends duty doctor contactable through Ambulance Control:
02890 404045.

Email: pha.dutyroom@hscni.net

Public Health Agency
12-22 Linenhall St
Belfast BT2 8BS

Drinking Water Inspectorate

Klondyke Building
Cromac Avenue
Gasworks Business Park
Belfast BT7 2JA

Email: dwi@daera-ni.gov.uk

Tel: **028 9056 9282 (**Mon/Fri 09:00 to 17:00)

11.2 Annex: The Water Supply (Water Quality) Regulations (NI) 2017 Schedule 1 – prescribed concentrations and values

SCHEDULE 1

PRESCRIBED CONCENTRATIONS AND VALUES

TABLE A.

MICROBIOLOGICAL PARAMETERS

Part I: Directive requirements

Parameters	*Concentration or Value (maximum)*	*Units of Measurement*	*Point of compliance*
Enterococci	0	number/100ml	Customers' taps
Escherichia coli (E. coli)	0	number/100ml	Customers' taps
Coliform bacteria	0	number/100ml	Customers' taps **(i)**

TABLE B.

CHEMICAL PARAMETERS

Part I: Directive requirements

Parameters	*Concentration or Value (maximum)*	*Units of Measurement*	*Point of compliance*
Acrylamide	0.10	µg/l	**(ii)**
Antimony	5	µg Sb/l	Customers' taps
Arsenic	10	µg As/l	Customers' taps
Benzene	1	µg/l	Customers' taps
Benzo (a) pyrene	0.01	µg/l	Customers' taps
Boron	1	mg B/l	Customers' taps
Bromate	10	µg BrO_3/l	Customers' taps
Cadmium	5	µg Cd/l	Customers' taps
Chromium	50	µg Cr/l	Customers' taps
Copper	2	mg Cu/l	Customers' taps
Cyanide	50	µg CN/l	Customers' taps
1.2 Dichloroethane	3	µg/l	Customers' taps*****
Fluoride	1.5	mg F/l	Customers' taps
Lead	10	µg Pb/l	Customers' taps
Mercury	1	µg Hg/l	Customers' taps
Nickel	20	µg Ni/l	Customers' taps
Parameters	*Concentration or Value (maximum)*	*Units of Measurement*	*Point of compliance*

Nitrate	50	mg NO_3/l	Customers' taps
Nitrite	0.5	mg NO_2/l	Customers' taps
Aldrin	0.03	µg/l	Customers' taps*****
Dieldrin	0.03	µg/l	Customers' taps*****
Heptachlor	0.03	µg/l	Customers' taps*****
Heptachlor epoxide	0.03	µg/l	Customers' taps*****
Other pesticides	0.1	µg/l	Customers' taps*****
Total Pesticides **(iii)**	0.5	µg/l	Customers' taps*****
PAH - Sum of four substances **(iv)**	0.1	µg/l	Customers' taps
Selenium	10	µg Se/l	Customers' taps
Tetrachloroethene/Trichloroethene – Sum **(v)**	10	µg/l	Customers' taps*****
Total Trihalomethanes **(vi)**	100	µg/l	Customers' taps
Vinyl chloride	0.50	µg/l	**(ii)**

Notes:

(i) NI Water, with the agreement of the DWI, includes coliform bacteria within the Part I: Directive Requirements table for statistical purposes.

(ii) The parametric value refers to the residual monomer concentration in the water as calculated according to specifications of the maximum release from the corresponding polymer in contact with the water. This is controlled by product specification.

(iii) Total pesticides: means the sum of the concentrations of the individual pesticides detected and quantified in the monitoring procedure.

(iv) The specified compounds are:

- benzo(b)fluoranthene
- benzo(k)fluoranthene
- benzo(ghi)perylene
- indeno (1,2,3-cd) pyrene.

(v) The parametric value applies to the sum of the concentrations of the individual compounds detected and quantified in the monitoring process.

(vi) The specified compounds are:

- chloroform
- bromoform
- dibromochloromethane
- bromodichloromethane

* May be monitored from samples of water leaving treatment works or other supply point, as no significant change during distribution.

Part II: National requirements

Parameters	*Concentration or value (maximum unless otherwise stated)*	*Units of measurement*	*Point of compliance*
Aluminium	200	µg Al/l	Customers' taps
Colour	20	mg/l Pt/Co	Customers' taps
Iron	200	µg Fe/l	Customers' taps
Manganese	50	µg Mn/l	Customers' taps
Odour	3 at 25°C	Dilution number	Customers' taps
Sodium	200	mg Na/l	Customers' taps
Taste	3 at 25°C	Dilution number	Customers' taps
Tetrachloromethane	3	µg/l	Customers' taps
Turbidity	4	NTU	Customers' taps

11.3 Annex: The Water Supply (Water Quality) Regulations (NI) 2017 Schedule 2 – indicator parameters

SCHEDULE 2

INDICATOR PARAMETERS

Parameters	*Specification concentration or value (maximum) or state*	*Units of Measurement*	*Point of monitoring*
Ammonium	0.5	mg NH_4/l	Customers' taps
Chloride **(1)(2)**	250	mg Cl/l	Supply point
Clostridium perfringens (including spores)**(1)**	0	Number/100ml	Supply point
Coliform bacteria	0	Number/100ml	Customers' taps
Colony counts	No abnormal change	Number/1ml at 22°C Number/1ml at 37°C	Customers' taps, service reservoirs and treatment works
Conductivity **(1)(2)**	2500	µS/cm at 20°C	Supply point*****
Hydrogen ion**(2)**	9.5	pH units	Customers' taps
	6.5 (minimum)	pH units value	
Radon (for radioactivity) **(1) (3) (6)**	100	Bq/l	Supply point
Sulphate **(1)(2)**	250	mg	Supply point
Notes:			
(1) May be monitored from samples of water leaving treatment works or other supply point, as no significant change during distribution.			
(2) The water should not be aggressive. (refers to pH and alkalinity of the water)			
(3) Where radon concentrations exceed 1000Bq/l, remedial action must be carried out on radiological protection grounds without further consideration			
(4) Excluding tritium, potassium-40, radon and radon decay products.			
(5) Elevated levels of tritium may indicate the presence of other artificial radionuclides. If the tritium concentration exceeds its parametric value, an analysis of the presence of other radionuclides is required.			
(6) Where treatment to reduce the level of radionuclides in water intended for human consumption has been taken, monitoring must be carried out to ensure the continued efficacy of the treatment			
(7) If the gross alpha activity exceeds 0.1Bq/l or gross beta activity exceeds 1.0Bq/l, analysis for specific radionuclides is required.			

11.4 Annex: Health notification values

Statutory water quality standards are contained within the Water Supply (Water Quality) Regulations (Northern Ireland) 2017 and the Private Water Supplies Regulations (Northern Ireland) 2017.

These regulations require water to be 'wholesome' where water is used for domestic purposes such as for drinking, cooking, food preparation or washing, or where water is supplied to premises in which food is produced.

Within the regulations Schedule 1 parameters are specified in the definition of 'wholesomeness'. Schedule 1 parameters are health based mandatory parameters – their presence or level may be associated with an immediate significant health risk e.g. *E.coli.*

Schedule 2 parameters which are listed in the regulations are indicator parameters - an immediate health risk from an indicator parameter is unlikely.

The Drinking Water and Health Liaison Group (DW&HLG) has agreed an additional prioritised reporting protocol using agreed health notification values (HNVs). If a HNV is exceeded for any sample, compliance, operational or complaint, it is reported to the Public Health Agency and the relevant district council(s). This enables a dialogue on the significance of the exceedence to take place and consideration to be given to the need for appropriate health advice.

If a parameter is not listed in the HNV document, the notification value is an exceedence of the regulatory concentration, specification or value as contained in the regulations referred to above.

Review of Health Notification Values (HNVs)
The HNV document is regularly reviewed by DW&HLG talking into account, for example, legislative changes, changes to standards and guidelines and lessons learned from operational practice and experience. The date of last amendment appears in the footnote at the bottom of each page. From December 2012, the latest version of the HNV document will be appended to the DW&HLG guidance document: '*Drinking water and health: a guide for public and environmental health professionals and for those in the water industry in Northern Ireland*'. The guidance document is available on-line at:

http://www.niwater.com/drinking-water-guidance/

11.4.1 **Microbiological criteria**

Parameter	**Units**	**HNV**
Clostridium perfringens (incl. spores)	No./100ml	1 Recurrence [(1)]
Coliforms (SRs, WSZs, Complaints, Operational)	No./100ml	1 Recurrence [(1)]
Coliforms (WTWs)	No./100ml	1 Any occurrence
Cryptosporidium	No. of oocysts/10 litres	Any oocysts
E. coli (WTWs, SRs, WSZs) (Audit)	No./100ml	1 Any occurrence
E. coli (Complaints, Operational)	No./100ml	1 Recurrence [(1)]
Enterococci	No./100ml	1 Any occurrence

(1) Recurrence after investigation and follow-up sampling.

11.4.2 **Chemical Criteria**

Health Notification Values are listed below. Notification is required if the result exceeds the value. If a parameter is not listed, the notification value is an exceedence of the regulatory concentration, specification or value as contained in the Water Supply (Water Quality) Regulations (Northern Ireland) 2017 and the Private Water Supplies Regulations (Northern Ireland) 2017.

Parameter	**Units**	**HNV (*=Regulatory limit)**
Aluminium	μg Al/l	500
Arsenic	μg As/l	10*
Colour	mg/l Pt/Co Scale	100
Iron	μg Fe/l	2000
Lead	μg Pb/l	10
Manganese	μg Mn/l	400
Nitrate	mg NO_3/l	50*
Nitrite (WSZs)	mg NO_2/l	0.50*
Nitrite (WTWs)	mg NO_2/l	0.10*
Turbidity (WTWs) **(2)**	FTU	1*
Turbidity (WSZs) **(2)**	FTU	4*
THMs	WHO Index**(3)**	>1.0
Chlorate	mg/l	0.7
Chlorite	mg/l	0.7
Odour	Dilution No.	3
Taste	Dilution No.	3
Total indicative dose (for radioactivity)**(4)**	mSv/year	0.10*
Radon	Bq/l	100

(1) reports for turbidity should be accompanied by relevant additional information e.g; chlorine residuals; presence/absence of coliform bacteria or E.coli; iron, manganese &, aluminium results; pertinent process operation and sampling issues.

(2) chloroform + bromoform + dibromochloromethane + bromodichloromethane
300 μg/l 100 μg/l 100 μg/l 60μg/l

(3)Excluding tritium, potassium-40 and radon decay products

11.4.3 **Pesticides**

Pesticides are reported if the regulatory limit is exceeded (all pesticides detected in recent years are listed below):

Where a reporting value is exceeded for a pesticide not previously detected, or at a level higher than previously detected, NI Water will seek toxicological opinion from the National Centre for Environmental Toxicology: WRc-NSF Ltd (Tel: +44 (0) 14 9523 6260; or e-mail info@wrcnsf.com)

HEALTH NOTIFICATION VALUES FOR PESTICIDES

Parameter	HNV (µg/l)
Aldrin	0.03(1&2)
Dieldrin	0.03(1&2)
Glyphosate	1000(3)
Heptachlor	0.03(1&2)
Heptachlor Epoxide	0.03(1&2)
Isoproturon	9(2)
Linuron	10(3)
MCPA	2(2)
Mecoprop	10(2)
Metoxuron	10(4)

Health Notification Values References

1) *The Water Supply (Water Quality) Regulations (Northern Ireland) 2007 (S.R.No. 147)*

2) *World Health Organisation (WHO) Guidelines for Drinking Water Quality – Fourth Edition, 2011 and First, Second & Third Addendums*

3) *Guidance on Safeguarding the Quality of Public water Supplies – DoE Welsh Office, 1989*

4) *Based on HNV for Linuron in absence of better information being available.*

Abbreviations:
SRs: Service Reservoirs
WSZs: Water Supply Zones
WTWs: Water Treatment Works

11.5 Annex: NI Water customer care (including critical care) information leaflet.

Loss of water supply

You should always be prepared for an interruption to your water supply. We recommend that you:

- Find out how your medical equipment operates. If you are unsure ask your health professional.
- Have adequate water storage.
- Consider the possibility of staying somewhere else during a prolonged interruption to your supply.

If you are on our Register and you don't have water, we will prioritise you to get bottled water.

Flooding

We understand the distress and inconvenience caused when homes are flooded.

If you have mobility or eyesight problems you may find it difficult to get out of your home safely if flooding occurs. We therefore recommend that you have a planned way out of your home which you are familiar with.

If you are on our register and flooding occurs, we will prioritise our response to ensure that we are with you as quickly as possible.

Customer Care Register

If you wish to register, please call Waterline

How to contact us
08457 440088
(calls charged at local rate)
Text Relay Service:
08457 440088
E-mail: waterline@niwater.com
Website: www.niwater.com
PO BOX 1026, Belfast, BT1 9DJ

Confidentiality

Our Customer Care Register is confidential. Your details will be kept private and will only be used by members of our staff and contractors to provide the services you need.

www.niwater.com

northern ireland water

Customer Care Register

NI Water provides essential services for all our customers throughout Northern Ireland.

We offer a range of free additional services if you have a disability, are an older consumer, have a serious medical condition or need extra help for any other reason.

You need to join our Customer Care Register to get the extra free services you or anyone in your household would like to receive.

Doorstep Password scheme

You can ask for a password to help you identify our staff. Please arrange a password with us. Our staff will always use this password when they visit you.

If someone claims to work for us but does not know your password, do not let them in.

Instead, please get in touch with us and we will check if the caller is a genuine NI Water employee.

Carers Contact Service

You can name a carer or relative who:

- can contact us on your behalf.
- we can contact if we need to reach you at anytime.
- we can post information directly to.

Staying in Touch

NI Water will write to you on an annual basis to confirm your details, however should your circumstances change or contact details need updated, please contact us on Waterline,
08457 440088

Information leaflets

All our information leaflets and letters are available in Braille; in large print; and on CD and audio tape.

If you wish to register, please call

Waterline 08457 440088

www.niwater.com

11.6 **Annex: Microbiological standards**

To protect public health there are microbiological standards which have to be met at each treatment works and treated water service reservoir or water tower. Microbiological tests are also undertaken on consumer tap samples. The significance of individual test results for each microbiological parameter at each location varies and a single positive result does not necessarily mean that water is unsafe to drink. Other information is required to assess water safety. Each of the standards is listed below:

***Escherichia coli* and enterococci** are bacteria present in the gut of warm-blooded animals. They should not be present in drinking water and, if found, immediate action is required to identify and remove any source of faecal contamination that is found. The standard is 0 per 100ml.

Clostridium perfringens is a spore-forming bacterium that is present in the gut of warm-blooded animals. The spores can survive disinfection. The presence of spores in drinking water in the absence of *E.coli* and enterococci indicates historic or remote faecal contamination that requires investigation. The standard is 0 per 100ml.

Coliform bacteria are widely distributed in the environment often as a result of human or animal activity, but some grow on plant matter. Their presence in a water supply indicates a need to investigate the integrity of the water supply system. The standard is 0 per 100ml.

Colony counts are general techniques for detecting a wide range of bacteria, the types and numbers being dependent on the conditions of the test. These counts, if done regularly, can help to inform water management, but they have no direct health significance. The standard is ‘no abnormal change’.

11.7 **Annex: Health based chemical standards**

Health-based standards for chemical parameters are set using a precautionary approach and on the basis of a lifetime's consumption of water and taking into account other exposure through routes other than drinking water (e.g. food). Just because a standard has been set for a substance does not mean that it is present in drinking water. The vast majority of the regulated chemicals are never found in drinking water in Northern Ireland at levels approaching or exceeding the standards. Others may occur only in very specific or local circumstances which are described below. A common situation is leaching from fixtures and fittings or pipework within a specific building water system. The chemical parameters for which prescribed concentrations or values are specified in the Drinking Water Regulations are:

Acrylamide monomer is not normally found in drinking water. It is produced in the manufacture of polyacrylamides occasionally used in water treatment. Its presence in drinking water is limited by control of the product specification. The standard is 0.1 µg/l.

Antimony is rarely found in drinking water. Trace amounts can be derived from brass tap fittings and solders. The standard is 5 µg Sb/l.

Arsenic occurs naturally in only a few sources of groundwater. Specific water treatment is required to remove it. The standard is 10 µg As/l.

Benzene is present in petrol. It is not found in drinking water, but it can migrate through underground plastic water pipes if petrol is spilt in the vicinity. Some bottled waters and soft drinks which include sodium benzoate as an ingredient have been reported as containing benzene. The standard is 1 µg/l.

Benzo (a) pyrene is one of several compounds known as polycyclic aromatic hydrocarbons (PAHs). Their source in drinking water is as a result of deterioration of coal tar which was used to line water pipes up until the early 1970s. Due to extensive water mains refurbishment and renewal it is now rare to detect this substance in drinking water. The standard is 0.01 µg/l.

Boron in surface water sources comes from industrial discharges or from detergents in treated sewage effluents. It can be present in partially desalinated seawater when this is used to supplement drinking water supplies. Concentrations found in drinking waters are generally very low. The standard is 1 mg B/l.

Bromate can be formed during disinfection of drinking water as a result of a reaction between naturally occurring bromide and strong oxidants (usually ozone). It may be generated in the manufacture of sodium hypochlorite disinfectant. Exceptionally, groundwater beneath an industrial site can become contaminated with bromate. The standard is 10 µg BrO_3/l.

Cadmium is rarely detected in drinking water and trace amounts are usually due to dissolution of impurities from plumbing fittings. The standard is 5 µg Cd/l.

Chromium in drinking water comes from the coatings on some taps and plumbing fittings. The standard is 50 µg Cr/l.

Chlorate and Chlorate produced as a by-product when chlorine dioxide is used for disinfection. Guidance states that in using chlorine dioxide the level of total oxidants (chlorine dioxide, chlorite and chlorate) should not exceed 0.5mg/l

Copper in drinking water comes mostly from copper pipes and fittings in households. In general, water sources are not aggressive towards copper, but problems very occasionally occur on new housing estates or in new installations. These 'blue water' events can be avoided by good plumbing practices. The standard is 2 mg Cu/l.

Cyanide is not normally present in drinking water, but could be present in surface water as a result of a specific industrial contamination incident. The standard is 50 µg CN/l.

1,2-Dicholoroethane is a solvent that may be found in groundwater in the vicinity of industrial sites. Where necessary it can be removed by special water treatment. The standard is 3 µg/l.

Epichlorhydrin can be found in trace amounts in polyamine water treatment chemicals. Its presence in drinking water is limited by control of the product specification. The standard is 0.1 µg/l.

Fluoride occurs naturally in many water sources, especially groundwater. It cannot be removed by conventional water treatment, so high levels must be reduced by blending with another low fluoride water source. No adverse health effects are anticipated at levels of fluoride at, or below, the drinking water standard. The standard is 1.5 mg F/l.

Lead very occasionally occurs naturally in raw waters, but the usual reason for its presence in drinking water is lead plumbing in older properties. If the water supply has a tendency to dissolve lead then water companies treat the water to reduce consumer exposure. The permanent remedy is for householders to remove lead pipes and fittings. The standard is currently 10 µg Pb/l

Mercury is not normally found in sources of drinking water in the UK. The standard is 1 µg Hg/l.

Nickel occurs naturally in some groundwater and, where necessary, special treatment can be installed to remove it. Another source of nickel in drinking water is the coatings on modern taps and other plumbing fittings. The standard is 20 µg Ni/l.

Nitrate occurs naturally in all source waters although higher concentrations tend to occur where fertilisers are used on the land. Nitrate can be removed by ion exchange water treatment or through blending with other low nitrate sources. The standard is 50 mg NO_3/l.

Nitrite is sometimes produced as a by-product when chloramine (a mixture of chlorine and ammonia) is used as the essential residual disinfectant in a public water supply. NI Water does not currently use chloramine as a disinfectant. The standard is 0.1 mg NO_2/l in water leaving water treatment works and 0.5 mg NO_2/l at consumers' taps.

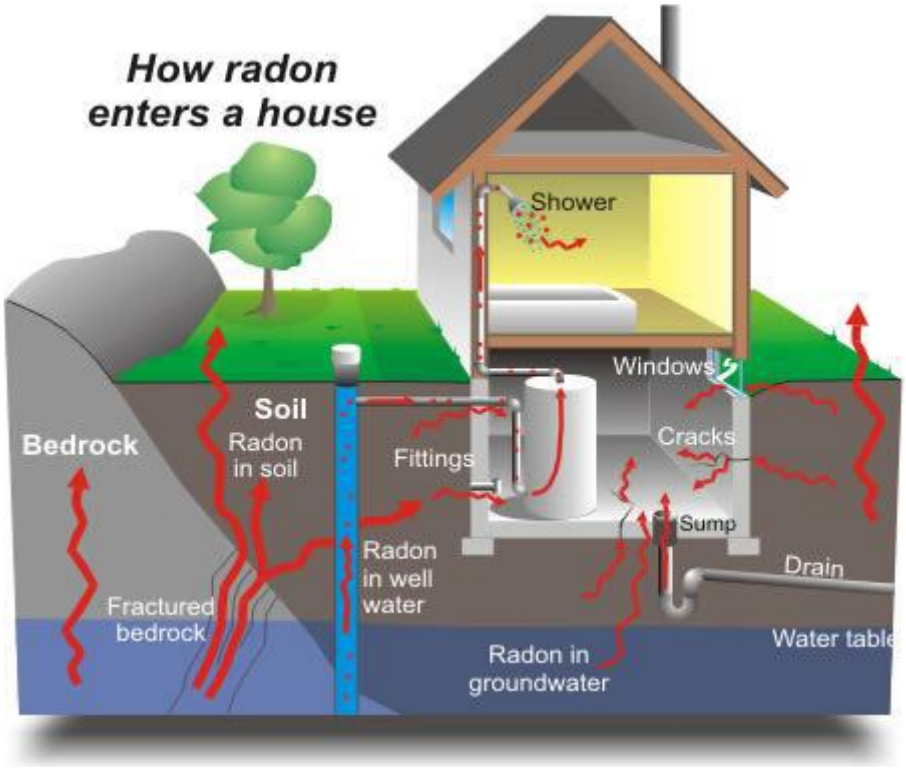
Pesticides – organochlorine compounds (aldrin, dieldrin, heptachlor, heptachlor epoxide) are no longer used in the UK because they are persistent in the environment. They are very unlikely to be found in drinking water. The standard for each compound is 0.03 µg/l.

Pesticides – other than organochlorine compounds are a diverse and large group of organic compounds used as weed-killers, insecticides and fungicides. Many water sources contain traces of one or more pesticides as a result of both agricultural uses mainly on crops and non-agricultural uses, mainly for weed control on highways and in gardens. Where needed, water companies have installed water treatment (activated carbon and ozone) so that pesticides are not found in drinking water. The standard is 0.1 µg/l for each individual substance and 0.5 µg/l for the total of all pesticides. NI Water must test for those pesticides used widely in their areas of supply. Pesticide monitoring thus varies according to the probability and anticipated nature of contamination.

Polycyclic aromatic hydrocarbons is a group name for several substances present in petroleum-based products such as coal tar. The standard is 0.1 µg/l for the sum of all the substances (see Benzo (a) pyrene listed above for more information).

Radon is a radioactive gas that emanates from rocks and soils and tends to concentrate in enclosed spaces like underground mines or houses. The European Directive, Euratom 2013/51, introduced requirements in relation to public health protection with regard to radioactive substances in water intended for human consumption. The Water Supply (Water Quality) Regulations (Northern Ireland) 2017 for public water supplies, and The Private Water Supplies Regulations (Northern Ireland) 2017 for private water supplies, both set a standard for radon in drinking water of 100 Bq/l.

Figure 11: How Radon enters a house



Selenium is an essential element and a necessary dietary component. Amounts in drinking water are usually well below the standard of 10 µg Se/l.

Tetrachloroethene and trichloroethene are solvents that may occur in groundwater in the vicinity of industrial sites. Where necessary they are removed by specialist treatment. The standard is 10 µg/l for the sum of both substances.

Trihalomethanes (THMs) are formed during disinfection of water by a reaction between chlorine and naturally occurring organic substances. Their production is minimised by good operational practice. The standard is 100 µg/l.

Vinyl chloride may be present in plastic pipes as a residual of the manufacturing process of polyvinyl chloride (PVC) water pipes. Its presence in drinking water is controlled by product specification. The standard is 0.5 µg/l.

11.8 **Annex: National chemical and physical standards**

The European Drinking Water Directive (DWD) recognises that Member States can set additional standards and the UK has decided to retain national mandatory standards for several parameters set in the original 1980 DWD that have become additional monitoring parameters in the 1998 DWD. Most of the standards are set on the basis that higher levels may make the water unacceptable to consumers on the grounds of taste, odour or appearance.

Aluminium occurs naturally in some source waters. It is removed from drinking water by conventional water treatment (coagulation and filtration). Aluminium sulphate may be used as water treatment chemicals at some water treatment works. The standard is 200 µg Al/l.

Colour occurs naturally in upland water sources and is caused by natural organics which are characteristic of these catchments. It is removed by conventional water treatment. The standard is 20 mg/l on the Pt/Co scale.

Iron is present naturally in many water sources. It is removed by water treatment. Some iron compounds are used as water treatment chemicals. However, the most common source of iron in drinking water is corrosion of iron water mains. The standard is 200 µg Fe/l.

Odour and Taste can arise as a consequence of natural substances in surface waters, particularly between late spring through to early autumn. Water treatment with activated carbon or ozone will remove these natural substances. The standard is described as acceptable to consumers and no abnormal change in odour or taste.

Sodium is a component of common salt (sodium chloride). It is present in seawater and brackish groundwater. Some water treatment chemicals contain sodium. Concentrations in drinking water are extremely low, but some water softeners can add significant amounts where they are installed in homes or factories. The standard is 200 mg Na/l.

Tetrachloromethane is a solvent that may occur in groundwater in the vicinity of industrial sites. Where necessary it is removed by specialist water treatment. The standard is 3 µg/l.

Turbidity is a measure of the cloudiness of water. It can arise from disturbance of sediment within water mains. The standard at consumers' taps is 4 NTU (see also turbidity at treatment works below).

Additional monitoring parameters

In addition to the drinking water standards, water companies are required to test for additional indicator parameters to assist them with good water supply management and the control of drinking water quality. Some of these parameters have a European standard set for the purpose of triggering an investigation of the water supply.

Ammonium salts are naturally present in trace amounts in most waters. Their presence might indicate contamination of sanitary significance and they interfere with the operation of the disinfection process. The standard is 0.5 mg NH_4/l.

Chloride is a component of common salt. It may occur in water naturally, but it may also be present due to local use of de-icing salt or saline intrusion. The standard is 250 mg Cl/l.

Conductivity is a non-specific measure of the amount of natural dissolved inorganic substances in source waters. The standard is 2,500 µS/cm.

Hydrogen Ion (pH) gives an indication of the degree of acidity of the water. A pH of 7 is neutral; values below 7 are acidic and values above 7 are alkaline. A low pH water may result in pipe corrosion. This is corrected by adding an alkali during water treatment. The standard is a range between 6.5 and 9.5.

Manganese is present naturally in many source waters. It is removed by treatment. Specific treatment is required for manganese removal. Concentrations may vary seasonally and may be due to ”turnover” in impounding reservoirs. The standard is 50ugMn/l.

Sulphate occurs naturally in all waters and cannot be removed by treatment. The standard is 250 mg SO_4/l.

Total indicative dose is a measure of the effective dose of radiation the body will receive from consumption of the water. It is calculated only when screening values for gross alpha or gross beta (radiation) are exceeded. The standard is 0.10 mSv/year.

Total organic carbon represents the total amount of organic matter present in water. The standard is ‘no abnormal change’.

Tritium is a radioactive isotope of hydrogen. Discharges to the environment are strictly controlled and there is a national programme of monitoring surface waters. The standard for drinking water sources is 100 Bq/l.

Turbidity measurement is an important non-specific water quality control parameter at WTWs because it can be monitored continuously on line and alarms set to alert operators to deterioration in raw water quality or the need to optimise water treatment. The standard at treatment works is 1 NTU.

11.9 **Annex: Epidemiological investigation**

High quality epidemiological information is vital in the investigation of possible outbreaks of waterborne disease associated with mains water consumption because microbiological evidence of water contamination by pathogenic organisms is usually difficult to obtain. Epidemiological investigations of such outbreaks are often complex and expert assistance from the Health Protection Agency (through its Memorandum of Understanding with PHA) may be required.

Microbiological results can often provide the strongest evidence of a chain of causation between a possible vehicle of infection and cases of human disease. The greater the degree of definitive identification of the isolate obtained from the vehicle and from the patient, the greater the degree of certainty that the vehicle was responsible for the human illness.

Even in the absence of definitive microbiological evidence it is possible, using descriptive and analytical epidemiological techniques, to demonstrate an epidemiological association between mains water consumption and the likelihood of development of disease. In most outbreaks, while it is often fairly straightforward to isolate pathogens responsible for the human illness, isolation of pathogens from environmental samples (including food and water) is often much more difficult given the lag period between exposure and investigation. In such cases, epidemiological evidence becomes crucial in demonstrating an association between the suspect vehicle and likelihood of disease. Analytical studies will often allow this association to be quantified.

Key points in the epidemiological investigation include:

- ***definition of the population at risk***. Definitions such as those involving a potential risk factor such as “those living in a given water supply area” should be avoided as that could pre-empt the investigation. A better alternative is “those on the lists of GPs in which cases have occurred”. Cases and controls to be included in an epidemiological study must be recruited in such a way to ensure they are members of this population.

- ***Definition of cases*** e.g.
  - Probable: any person resident in the area (defined) who became ill with symptoms of (defined) with date of onset on or after (defined).
  - Confirmed: as probable case with stool specimen positive for (defined)

- ***Case finding.*** Cases should be actively sought through enhanced surveillance. GPs, hospitals and microbiology laboratories should be alerted. Symptomatic cases may report via telephone helplines. This may include liaising with health authorities in the Republic of Ireland in the context of cross border incidents.

- ***Descriptive epidemiology***. The cases should be described by: age; occupation; time, place or residence and work/school; relevant known exposures obtained from initial case histories which will also depend on the causative organisms (e.g. farm visits, recreational water contact, drinking water supply zones, food consumed and milk supply).

An epidemic curve of the number of cases plotted against onset of symptoms should be maintained and this will indicate whether the incident originated from a point source, continuing source or as a result of person to person spread. Attack rates by area (district council/Trust/water supply zone) should be calculated with the denominator being the population at risk in the relevant area. The proportion of cases exposed to each suspected risk factor should be calculated.

Cases should be plotted by water supply zones to determine whether distribution of cases matches the distribution of water supplies. Water from different WTWs is often blended and NI Water will be able to provide information on the percentage of water from each treatment works supplied to each Zone. Statistical tests can then estimate the association between infection rates and the percentage from each treatment works and the probability that differences in rates of illness in the different water supply zones occurred by chance.

- ***Analytical study.*** The descriptive epidemiology from early cases should be reviewed in conjunction with the results of the microbiological investigations, information on water quality and treatment and on any possible contamination of water sources prior to proceeding with an analytical study. Should it be decided to proceed with an analytical study the hypotheses to be tested should be clearly stated and the statistical power described.

11.10 **Annex: Algorithms**

11.10.1 **Annex: Algorithm for total coliform bacteria**

Total coliform bacteria are an indicator parameter in the drinking water legislation with a parametric value of 0 coliforms per 100mls of water.

Coliform Bacteria

- Include a wide range of genera not specific to faecal contamination
- Not necessarily useful as an indicator of faecal contamination
- Can be used as an indicator of treatment effectiveness, to assess cleanliness and integrity of distribution system, and to assess potential presence of biofilms.

Coliform Bacteria belong within the family Enterobacteriaceae. They contain various species of the genera *Escherichia*, *Klebsiella*, *Enterobacter*, *Citrobacter*, *Serratia* and many others. While *E. coli* is the only member of the total coliform group that is found exclusively in faeces, other members of the group are found naturally in water, soil and vegetation, as well as in faeces.

Although the presence of total coliform bacteria is not a reliable indicator of the presence of faecal contamination, the cause of their presence should be investigated and further action taken if necessary (see algorithm for coliform exceedence).

As operational indicators, total coliform bacteria provide information on the adequacy of drinking water treatment and on the microbial condition of the distribution system.

Total coliform bacteria are easily destroyed during disinfection. Effective treatment including disinfection should yield water free of any coliform organisms, no matter how polluted the source water may have been. The presence of any total coliform bacteria in treated water leaving a plant therefore suggests inadequate treatment and disinfection, is unacceptable and should be corrected immediately

If total coliform bacteria are found in the distribution system, but water tested immediately post-treatment is free of coliform bacteria, this suggests that regrowth or post-treatment contamination has occurred. Post-treatment contamination could result from numerous problems such as pipe leaks with negative pressure events, pipe breaks, inadequate cleaning and disinfection after repairs, and cross-connections (including backflow) with non-potable water. In addition, surges in water mains from activities such as hydrant tests and fire-fighting may result in the sloughing of biofilm and a subsequent rise in total coliform bacterial counts. Microbiological parameters, such as *E. coli* or coliform bacteria, may also be influenced by the design and hygienic status of the consumer's tap.

In a distribution system, public health decisions should not be based solely on the presence of coliform bacteria, in the absence of *E. coli*, unless the investigation indicates a problem that results in a threat to public health.

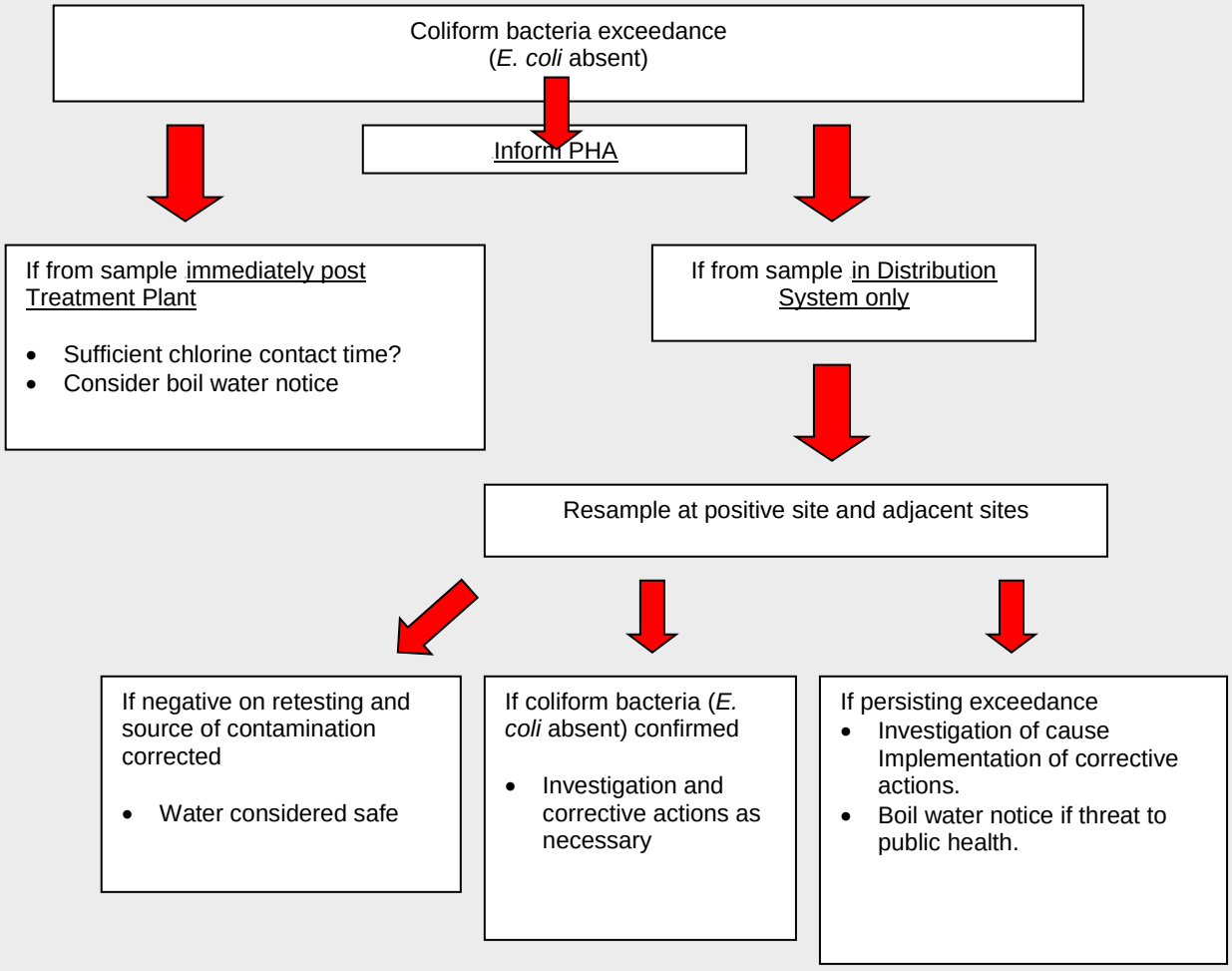
If enhanced health surveillance indicates that a waterborne outbreak may be occurring, or if conditions exist that could result in a waterborne outbreak, then the necessity of issuing a boil water notice should be immediately discussed. In the event that an incident that may have contaminated the distribution system or interfered with treatment is known, consumers may be notified immediately to boil the drinking water.

If total coliform bacteria (in the absence of *E. coli*) are confirmed, some or all of the corrective actions listed below may be necessary. The degree of response will depend on the history of the quality of raw water supply, the historical effectiveness of treatment process and integrity of distribution system, and an assessment of the significance and extent of the problem.

If corrective actions are deemed necessary, they may include:

- Verification of integrity of treatment process and distribution system
- Verification of required disinfectant residual throughout the distribution system
- Increase in chlorine dosage, flushing of water mains, cleaning of treated water storage tanks and checking for presence of cross-connections and pressure losses
- Sample and test sites adjacent to the site(s) of the positive sample(s). Tests performed should include coliform bacteria, *E. coli*, disinfectant residual and turbidity
- Investigation to identify the problem and prevent recurrence
- Continue selected sampling and testing (e.g. bacteriological, disinfectant residual and turbidity) of all identified sites during the investigative phase to confirm the extent of the problem and to verify the success of the corrective actions.

Algorithm for Coliform exceedance



Considerations include

Sampling/Supply Issues?

Other parameters, including …
E. coli, turbidity, residual chlorine

Coliforms where?
Presence of coliforms immediately post treatment plant, or in distribution system only?
If in distribution system only, is this at a single site or multiple sites?

Persisting exceedance?
With biofilm sloughing, coliforms may persist for weeks.

Boil water notice
- Incident that interfered with treatment or contaminated distribution system?
- Coliforms present immediately post treatment plant?
- Coliforms present in multiple sites in distribution system?
- Persisting exceedance(s)?
- Investigation indicates a problem that results in a threat to public health?
- Evidence of human illness?
- Immunocompromised on supply?*

Is there any public health significance of persisting exceedance?
- Any evidence of faecal contamination?
- Speciation of coliforms?
  * *There may be coliforms in distribution system that are not enteric but associated with infection in compromised patients especially in hospital setting (same as water sample isolates)*
- Review of surveillance data (e.g. Salmonella, Shigella, Hepatitis A notifications)
- If no evidence of adverse health effects due to coliforms of types isolated from water distribution system, and no other relevant findings from surveillance data – no indication of a threat to public health
- Evidence of associated adverse health effects → convene Major Incident Team
  → recommend boil water notice or alternative supply

11.10.2 **Annex: Algorithm for *Escherichia coli***

Escherichia coli is a microbiological parameter in the drinking water legislation with a parametric value of 0 per 100mls of water.

E. coli

- The use of pointer bacteria, in particular *E. coli* and coliform bacteria, as a means of assessing the potential presence of waterborne pathogens, has been paramount to protecting public health.
- *E. coli* is a coliform bacterium that has historically been regarded as the primary indicator of the presence of human or animal faeces. It is sensitive to disinfection and therefore not a good indicator of presence of more resistant organisms.
- There is no absolute correlation between the number of pointer organisms and (a) the actual presence or numbers of enteric pathogens or (b) the risk of illness occurring.

E. coli is a member of the coliform group, part of the family Enterobacteriaceae, and is described as a facultative anaerobic, Gram-negative, non-spore forming, rod-shaped bacterium that possesses the enzyme ß-glucuronidase. It is the only member of the coliform group that is found exclusively in the faeces of humans and other animals. Of the coliforms, *E. coli* is generally the most sensitive to environmental stresses. It rarely grows outside the human or animal gut. Its presence in water indicates not only recent faecal contamination but also the possible presence of intestinal disease-causing bacteria, viruses and protozoa.

The detection of *E. coli* in any drinking water system is unacceptable. Conversely, the absence of *E. coli* in drinking water generally indicates that the water is free of intestinal disease-causing bacteria. However, because *E. coli* is not as resistant to disinfection as intestinal viruses and protozoa, its absence does not necessarily indicate that intestinal viruses and protozoa are also absent.

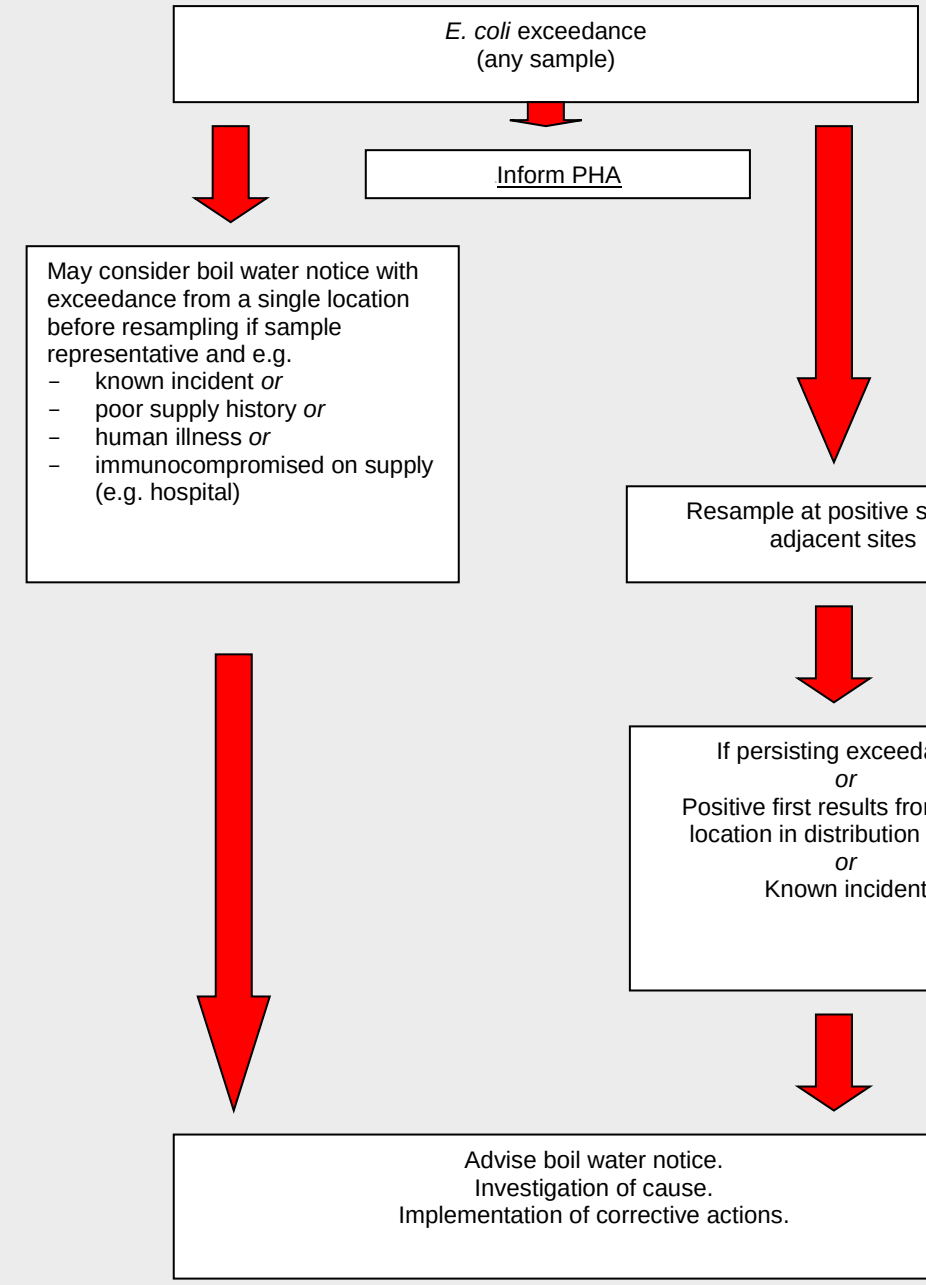
If *E. coli* is detected in a public drinking water system, and if resampling and testing of the positive site(s) confirm the presence of *E. coli*, a boil water notice should be advised and corrective actions carried out by NI Water as necessary. Surveillance for possible waterborne disease cases should be conducted (see algorithm for *E. coli* exceedence).

Depending on the extent of *E. coli* contamination in the first sampling *e.g.* positive sample results from more than one location in the distribution system, a boil water notice may be advised immediately and corrective actions initiated without waiting for confirmation.

If the presence of *E. coli* in drinking water is confirmed, corrective actions may include the following:

- Verification of integrity of treatment process and distribution system
- Verification of required disinfectant residual throughout distribution system
- Increase in chlorine dosage, flushing of water mains, cleaning of treated water storage tanks and checking for presence of cross-connections and pressure losses
- Sample and test sites adjacent to the site(s) of the positive sample(s). Tests performed should include *E. coli*, coliform bacteria, disinfectant residual and turbidity
- Investigation to identify problem and prevent recurrence
- Continue selected sampling and testing (e.g. bacteriological, disinfectant residual and turbidity) of all identified sites during the investigative phase to confirm the extent of the problem and to verify the success of the corrective actions.

Algorithm for *E. coli* exceedance



Considerations include

Sampling/Supply Issues?

Other parameters, including …
Coliforms, turbidity, residual chlorine

***E. coli* where?**
Single site? Multiple sites?

Persisting exceedance?

Boil water notice
- Human illness?
- Incident that interfered with treatment or contaminated distribution system?
- Persisting exceedance?
- Exceedance in multiple sites in distribution system?

Human disease surveillance
- If evidence of cases → Incident Management Team

11.10.3 **Annex: Algorithm for *Cryptosporidia***

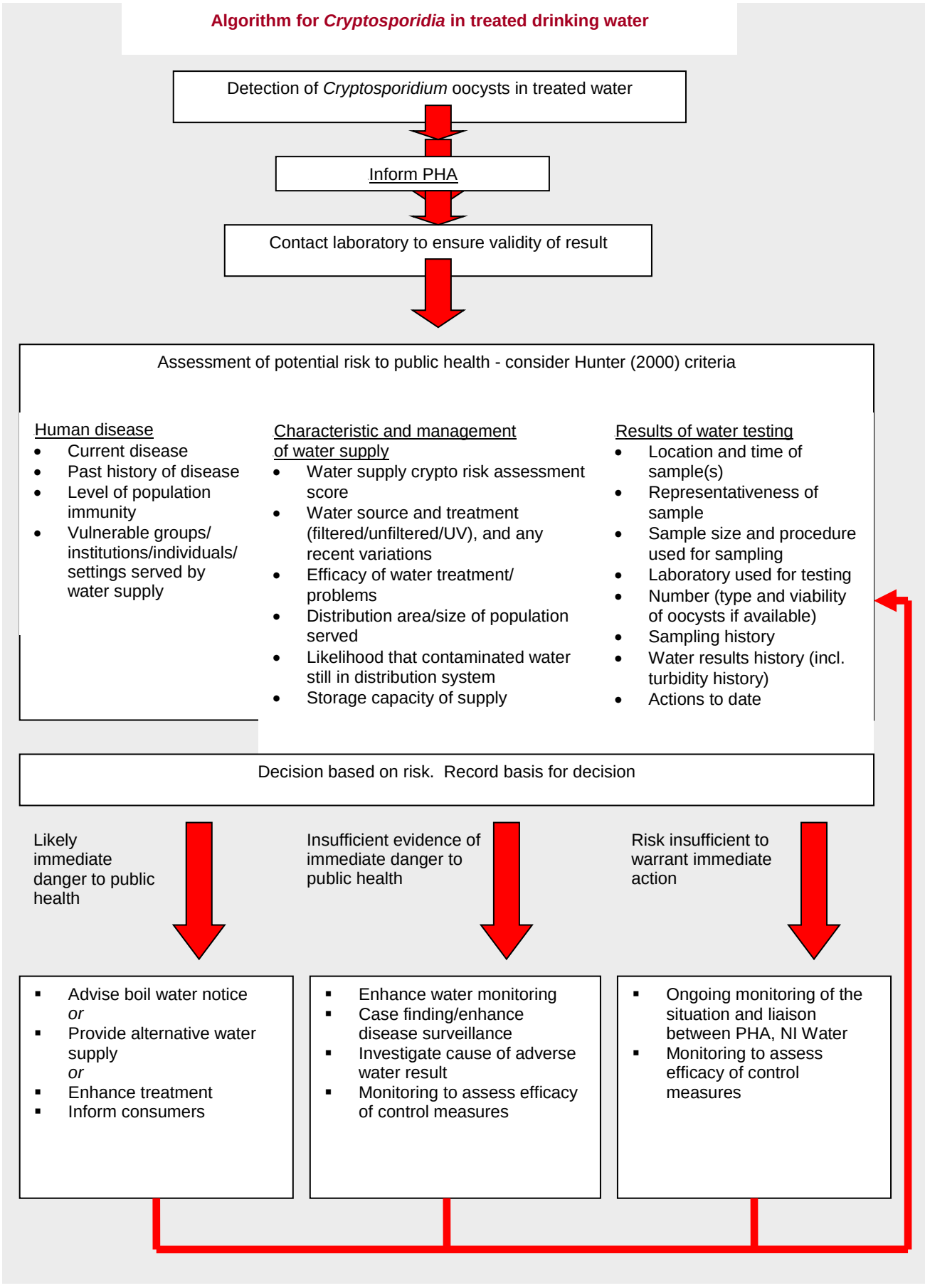
There is no direct relationship between levels of *Cryptosporidium* detected in drinking water and human illness. Outbreaks of human illness have occurred in the absence of *Cryptosporidium* identified in a water supply and conversely *Cryptosporidium* has been detected in water supplies in the absence of associated human illness. Therefore, interpretation of *Cryptosporidium* monitoring results and implications for human health depend on a number of factors including adequacy of sample, pathogenicity of species, viability of oocysts, vulnerability of individuals on the supply and the level of community immunity. Other factors to be considered are the source of the water, the treatment process and the history of monitoring results on the supply (see "Algorithm for *Cryptosporidia* in treated drinking water".

As cryptosporidiosis may be a severe illness specific advice may be required for particularly vulnerable groups e.g. infants, immunocompromised, and the elderly.

11.10.4 **Annex*: Cryptosporidia* and immunocompromised patients**

Some groups of immunocompromised patients are at particular risk of cryptosporidiosis infection and should boil their drinking water. This includes those whose T-cell function is compromised (this includes people with HIV infection who are immunosuppressed, children with severe combined immunodeficiency (SCID) and those with specific T-cell deficiencies, such as CD40 ligand deficiency, also known as Hyper IgM Syndrome), should be advised to boil and cool their drinking water **from whatever source**. This includes tap or bottled water, and ice cubes should also be produced from boiled and cooled water.

Algorithm for *Cryptosporidia* in treated drinking water



11.10.5 Annex: *Clostridium* perfringens

Clostridium perfringens is an indicator parameter. The legislation requires that in the event of non-compliance with this parametric value, the supply shall be investigated to ensure that there is no potential danger to human health arising from the presence of pathogenic micro-organisms.

Clostridium perfringens is normally present in faeces. They are not recommended for routine monitoring of distribution systems because they can survive a long time after (and far from) a pollution event, leading to possible alarms. The presence of *Clostridium perfringens* in ground waters in the absence of *E. coli* and enterococci points to pollution at some time in the past and suggests the source may be liable to intermittent contamination. The spores are relatively resistant to disinfection and must be removed by some form of filtration. Their presence in treated water suggests deficiencies in treatment filtration processes.

When *C. perfringens* is detected NI Water will assess the treatment process for the preceding 3 weeks, as a precaution. NI Water will also inform the PHA of the detection of *C. perfringens*.

This parameter may be examined as part of the revision of the EC Drinking Water Directive. Although *Clostridium perfringens* is a useful indicator of faecal pollution (particularly groundwater) it should not be relied upon as an indicator for *Cryptosporidium*.

11.10.6 Annex: Cyanobacteria – Drinking Water Implications

Background

Cyanobacteria, commonly referred to as blue-green algae, are found in soils, inland waters, estuaries and the sea. Whilst blue-green is the dominant colour variant many Cyanobacteria range in colour from blue-green to yellow-brown to red.

In inland waters they occur as separate cells, multi-cellular filaments or as colonies throughout the water column – some Cyanobacteria can also regulate their buoyancy to determine their position in the water column. Their growth is determined by available sunlight, nutrient levels and water temperature / turbulence.

In general terms the public only become aware of Cyanobacteria when they observe a surface bloom or scum formation at the edge of a water body. Such blooms may lead to high toxin concentrations in the water body and in terms of public health this is the most notable feature of Cyanobacteria.

It should be noted that the presence of a bloom or scum does not necessarily mean that there will be toxins in the water body.

Cyanobacteria Toxins – General Health Concerns

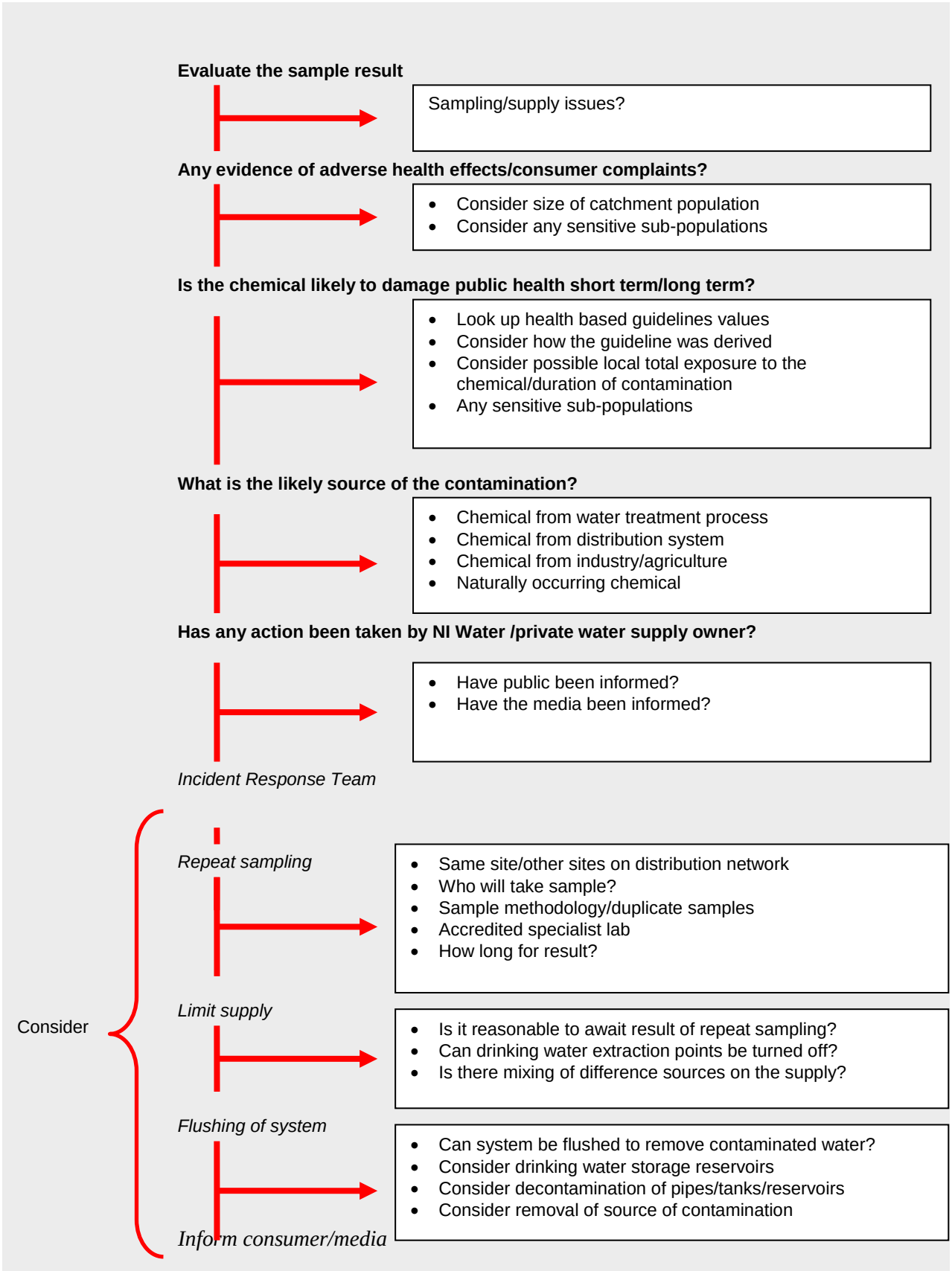
The main health concerns are associated with either contact or ingestion of water containing Cyanobacteria toxins. The toxins produced by Cyanobacteria are of varying degrees of toxicity ranging from skin / eye irritation to liver damage or neurotoxicity. Cyanobacteria toxins have the deaths of farm animals and dogs in the UK in 1989. Repeated or chronic exposure is of primary concern whilst in some cases acute toxicity can be more important e.g. presence of Anatoxins.

Cyanobacteria Toxins – Drinking Water

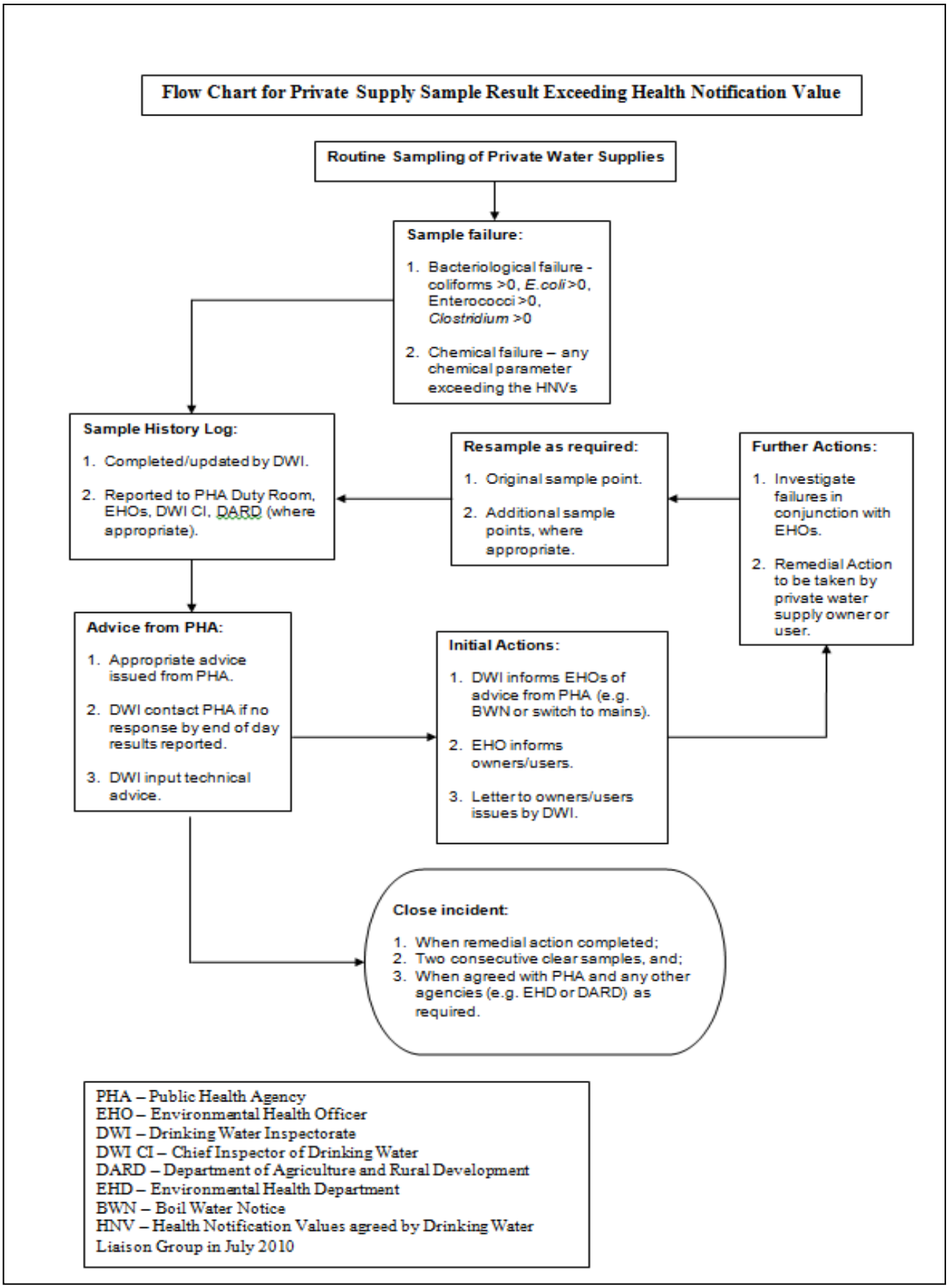
Water Treatment Works are designed to treat the wide range of raw water quality from a particular impounding reservoir, lake, underground aquifer or river. This includes the removal of algae and Cyanobacteria and their by-products through the use of oxidation and Carbon filtration methodologies.

In addition to these treatment processes there may be control measures to reduce the potential for blooms within the raw water source. These include catchment management policies to minimise nutrient inputs to raw water sources as well as strategies to minimise stratification and nutrient release from sediments in these sources. The aim of these control mechanisms is to reduce the nutrients, light and conditions that contribute to algal / Cyanobacteria growth.

11.10.7 Annex: Algorithm for exceedence of chemical parameter or chemical contamination of water



11.10.8 Annex: Algorithm for Private Supply sample result exceeding the health notification value



11.11 **Annex: NI Water proforma for notification of a bacteriological exceedence to the PHA & DWI**

Initial Sample Details: Sample/resample number:			Chlorine Residual		Bacteriological Results				
					Presumptive		Confirmed		
Date	Site Code	Sample Address	Free	Total	Coliforms	Faecal Coliforms	Coliforms	Faecal Coliforms	Action To Be Taken
REASON FOR ORIGINAL SAMPLE:									
WATER SUPPLIED FROM:			"RESAMPLE SHEET" SUPPLIED TO						

Notification to:

Name		Location	Date	Type of Communication			Comments
				Phone	Fax	E-mail	

Signed: _____ Name in Capitals: ___ _____

Date:

11.12 **Annex: NI Water proforma for notification of a chemical exceedence to the PHA & the Inspectorate**

INITIAL SAMPLE DETAILS						
SAMPLE			CHEMICAL CODES			ACTION TO BE TAKEN
DATE	CODE	LOCATION	PARAMETER	RESULT	PCV	
ID Numeric :			Sampled ID :			
Comments:						

NOTIFICATION DETAILS							
NAME		LOCATION	DATE	TYPE OF COMMUNICATION			COMMENTS
				PHONE	FAX	E-MAIL	

COMPLETED BY:- _____ (SIGN) DATE:

11.13 Annex: District council proforma for notification of bacteriological exceedence to PHA, NIW & the Inspectorate

* DISTRICT/BOROUGH/CITY COUNCIL* - insert council name

Details of Samples of Drinking Water Taken by the Environmental Health Department for Bacteriological Examination
Reporting of Results to the Public Health Agency, Northern Ireland Water and the Drinking Water Inspectorate

Council Contact: _____ Telephone and Email: _____

Ref No	Date of Sample	Name and type of Supply (eg mains, spring, well, borehole etc)	Address of sampling point including post code	Routine, Complaint or Resample	Was Tap Sterilized? Record chlorine reading below	Laboratory Results Most Probable Number (MPN) per 100 ml Coliforms	E. coli	Description of the issue and action (s) taken with date
			BT _____	Routine ☐ Complaint ☐ Resample ☐	Tap sterilized? Yes ☐ No ☐ Cl ……mg/l			

Note: All Unsatisfactory results should be emailed to the PHA, NIW and the Inspectorate using the email addresses listed below within 24 Hours / next working day. Relevant Group EH staff may also need to be informed. Please refer to the latest version of the Health Notification Value document – copies available from DWLG at nigel.mcmahon@health-ni.gov.uk

Agency	Email address	Date Forwarded
Public Health Agency – Duty Room	pha.dutyroom@hscni.net	
Northern Ireland Water	NIW_EHO_SampleReports@niwater.com	
Drinking Water Inspectorate	dwi@daera-ni.gov.uk	

11.14 Annex: Chemical incident checklist: water incidents

(From Public Health Emergency Planning. Guidance for Departments of Public Health Medicine. 2005. Appendix 8. Chemical Incident Emergencies. Guidance for Public Health Physicians.)

Which water supply has been affected?

- Description of the supply network, reservoirs, treatment plants etc
- Is water from different sources mixed in the supply?
- Any other relevant information regarding facilities with vulnerable population or industry on the supply network e.g. pre-schools/crèches, hospitals, nursing homes, food processing, food premises, home dialysis patients' homes etc.

What is the contaminant involved?

How much contaminant is involved?

When did contamination occur?

- Description of the contamination
- How long did the contamination last?
- How was the incident discovered?
- Was remediation undertaken?
- What is the nature of remediation?
- What testing has been done?
- What was and is the pH of the water?

What population was exposed?

Have the public been notified? If yes how have they been notified?

Have there been public complaints or queries?

- Describe complaints - number, nature and location

Has there been a response by the NI Water to these complaints?

- Do you anticipate further communication with the public?

Are there plans to set up an Incident Management Team?

Expertise that the PHA might offer

- Determination of the human health effects of the contamination
- Risk communication

(NB: Other sources of expertise may be consulted e. g. The National Centre for Environmental toxicology – WRC, for information on potential effects and exposure limits)

Adapted from: HPA Checklist: Water Incidents.
Consult the HPA Checklist for more information to aid risk assessment in A-Z at www.hpa.org.uk

11.15 Annex: Other pathogenic organisms

There are a wide range of pathogenic organisms capable of causing adverse human health effects if they are introduced into drinking water supplies. Contaminated waste can be the source of large outbreaks of disease, however, for the majority of waterborne pathogens there are other equally important sources of infection, such as person to person contact and food. The human health effects caused by waterborne transmission vary in severity from mild gastroenteritis to severe and sometimes fatal diarrhoea.

Most waterborne pathogens are introduced into drinking water supplies in human or animal faeces. They do not grow in water and infection is initiated in the gastrointestinal tract. However, some are environmental organisms that grow in water and soil, and can cause opportunistic infections through other routes of transmission, such as inhalation leading to respiratory infections (legionellosis) or infections at sites as diverse as skin and brain *(Naegleria fowleri).*

The following is a summary of the subset of pathogenic organisms of direct relevance to waterborne transmission in the context of UK private and public water supplies.

Bacterial pathogens

Aeromonas species

These occur widely in water, soil and food, and are capable of growth in water distribution systems. They are capable of infecting open wounds and septicaemia can occur in immunocompromised persons. The presence of aeromonads in drinking water is generally considered a nuisance rather than a health hazard. The organisms are detected by colony counts and controlled by good water supply distribution management and hygiene practices.

Campylobacter species

These are one of the most important causes of acute gastroenteritis worldwide. It is the most common bacterial cause of food poisoning in the UK and approximately 1,000 cases are reported annually in Northern Ireland. The vast majority are sporadic cases and unlike salmonella, outbreaks of campylobacter are uncommon. As few as 1000 organisms can cause infection and most infections occur in infants and young children. Wild and domestic animals, especially poultry, wild birds and cattle, are important sources, with other sources including domestic pets and contaminated food and drinking water, including meat and unpasteurised milk. Control of drinking water transmission relies on the protection of raw water sources from animal and human waste, adequate disinfection and protection of stored water from animal and bird faeces.

Escherichia coli pathogenic strains

Most *E. coli* strains are present in large numbers in the normal gut flora of humans and animals. A few strains can cause serious disease and some cause acute bloody diarrhoea. These enteropathogenic *E. coli* are identified on the basis of virulence factors and the most well known in the context of waterborne transmission are the enterohaemorrhagic *E. coli (EHEC*), particularly serotypes O157:H7 and O111. On average there are about 50 reports of *E. coli* 0157 infection annually in Northern Ireland with rates of infection highest in young children. The infective dose is particularly low with as few as 100 organisms causing infection. Up to seven per cent of cases develop a potentially fatal haemolytic uraemic syndrome (HUS) characterised by acute renal failure. Control of drinking water transmission of pathogenic *E. coli* is the same as that for other *E. coli*, namely raw water protection from faecal waste, adequate disinfection and protection of stored water.

Legionella

Although all Legionella species are potentially pathogenic for humans, *Legionalla pneumophila* is the major species responsible for legionellosis which occurs in two clinical forms; Legionnaire's disease, a pneumonia, and Pontiac fever, a milder respiratory infection. Legionnaire's disease is an uncommon form of pneumonia in Northern Ireland with 5-10 reports annually with the majority associated with travel outside the UK. Legionella spp. Are common in surface waters and moist soils, and grow in warm conditions in the range of 25 – 50 degrees C. Transmission is via inhalation. Control focuses on building water system design and maintenance through minimising the production of water aerosols and limiting growth conditions by keeping cold water cold and hot water hot. Most large waterborne outbreaks have been linked to cooling towers which are poorly maintained, whereas sporadic infections are more commonly linked to hot water systems in large buildings.

Mycobacteria

The non tuberculous or atypical strains are natural inhabitants of water environments. They can give rise to a range of diseases involving the skeleton, lymph nodes, skin and soft tissue as well as respiratory, gastrointestinal and genitourinary tracts. They are a major cause of disseminated infections in immunocompromised patients and a common cause of death in HIV positive persons. Only two species have been reported in tap water, *M.kansasii* and *M.avium* complex. Water-related infections due to the latter have been attributed to unfiltered water supplies and *M.kansasii* has been found in domestic showers and hospital water systems in the Netherlands and UK respectively. The organisms are more resistant to disinfection with chlorine than other bacteria as coliforms, therefore control relies on treatment by filtration and effective management of distribution systems to minimise growth conditions and maintenance of a persistent level of residual chlorine.

Pseudomonads

These are common environmental organisms with similar characteristics to Aeromonads (see above). *Pseudomonas aerugionsa* is capable of growing on specific construction materials used in building plumbing systems, swimming pools and spas. Exposure to high numbers in water in the latter settings can cause folliculitis (rashes) and ear infections, and the organism can infect wounds and give rise to septicaemia and meningitis in the immunocompromised patient. Control is through the use of suitable approved materials in the design of pools, spas, plumbing systems and water mains. Incidences of high numbers of the organism in packaged waters has been associated with complaints of taste and odour, and this has resulted in a monitoring standard of <1 per 250ml being set for bottled waters. Bottled water regulations can be found at:

http://www.food.gov.uk/foodindustry/guidancenotes/foodguid/waterguidance

There is no equivalent standard for public water supplies due to the fact they are not normally in packaged form.

Salmonella spp

All salmonella species cause either gastroenteritis, septicaemia, enteric/typhoid fever and a carrier state in previously infected persons. Typically diarrhoea is accompanied by fever and abdominal pain which is self-limiting, but infection with *S. typhi* and *S. paratyphi* (typhoid strains) is more serious and can be fatal. Waterborne typhoid fever outbreaks have devastating public health implications. The typhoid strains are restricted to humans and in Northern Ireland tend to be associated with foreign travel, but others such as *S. typhimurium* and *S. enteritidis* occur in a wide range of livestock, including poultry. Contamination has been detected in many foods and milk, and these pathogens gain access to water sources from sewage discharges, livestock and wild animals. Control measures involve protection of raw water from animal and human waste, adequate disinfection and protection of stored water from animal and bird faeces.

Shigella spp

These, including bacillary dysentery, cause serious intestinal diseases mostly in young children. Only 10 – 100 organisms are required to cause infection resulting in severe watery diarrhoea, abdominal pain and fever. A milder self-limiting disease is caused by the *S. sonnei* strain. The organisms are restricted to humans and higher primates with most cases of shigellosis occurring in the institutional setting due to poor sanitation. Prevention of waterborne outbreaks is important due to the severity of the illness caused and control is by protection of raw and treated water from human waste combined with adequate disinfection.

Toxic cyanobacteria

These are photosynthetic bacteria that share some properties in common with algae, hence they are commonly known as blue green algae. However, there are many which are not blue green and can range in colour from yellow to brown and red. Cyanobacteria are common in the environment occurring in soil, sea water and freshwater. Sunlight and warm weather stimulate growth especially in stagnant waters or low flow conditions and in the presence of high nutrient levels (eutrophic waters). Some will form floating surface blooms or scums, others stay mixed in the water column or are bottom dwelling (benthic). Their public health significance derives from the ability of some species to form toxins. At least 13 toxin producing species have been identified and each toxin has specific properties with distinct concerns, including liver damage, neurotoxicity and tumour production. Acute symptoms after exposure include gastric disorders, fever and irritations of the skin, ears, eyes, nose and throat. Cyanobacteria do not multiply in the body and hence they are not infectious. Control relates to source water abstraction management and the minimisation of algal blooms together with prevention of direct recreational contact with algal blooms and by excluding light from stored water tanks.

Vibrio spp

Non-toxigenic strains are widely distributed in water environments, but toxigenic strains occur in water less often because they are generally limited to humans, although they have been found inside aquatic organisms like crustaceans and algae. The prevalence of *V. cholerae* declines notably in colder waters (< 20 degrees C). Illness symptoms are due to the production of the cholera enterotoxin. The majority of those infected do not develop illness; however those who do will experience characteristic ‘rice water stools’ and suffer severe dehydration and loss of electrolytes which is fatal without treatment. Vibrio human infections are very uncommon in Northern Ireland. High numbers of organisms are required to cause infection, therefore person to person contact is not the main cause of spread and serious outbreaks are due to poor sanitation and ingestion of faecally contaminated food and water. Control is by protection of raw water from human waste, adequate disinfection and protection of stored water.

Viral pathogens

Viruses associated with waterborne transmission are predominantly those that infect the gastrointestinal tract and are excreted in human faeces (enteric viruses). As a group, viruses can cause a wide variety of infections and symptoms involving different routes of transmission, sites of infection and routes of excretion. Viruses responsible for respiratory infection can be discharged in faeces and contaminated water may therefore be a route of transmission through aerosols and droplets. It is also thought that polyomaviruses excreted in urine and linked to long-term health effects have the potential for waterborne transmission. An important issue for control of water borne transmission is that viruses generally survive better in water

particularly in cold climates, than bacterial indicator organisms. Consequently, satisfactory indicator test results do not preclude the presence of viruses. Another important factor to be considered is the greater resistance of viruses to disinfection compared to bacteria.

Adenoviruses

Infections by adenoviruses have been linked to consumption of contaminated food and drinking water, although person to person spread through shared utensils and contaminated surfaces in the institutional setting is the more common source of outbreaks of gastroenteritis. Eye infections have been linked to the sharing of towels and goggles when swimming. These viruses consist of double stranded DNA and generally do not grow in cell culture, therefore detection relies on polymerase chain reaction (PCR) techniques. Control is made problematic because human adenoviruses are exceptionally resistant to disinfection, especially UV light irradiation. Protection of raw and treated water is therefore very important to control risks from drinking water supplies.

Astroviruses

These are single stranded RNA viruses detected in environmental samples by PCR techniques. They cause self-limiting gastroenteritis in young children and infected individuals excrete large numbers of the virus in faeces, hence the viruses will be present in sewage. Person to person spread in day care, home settings and institutions is common. Contaminated food and water may be an important route of transmission. Control measures are the same as for adenoviruses although UV maybe more effective.

Caliciviruses

Caliciviruses are single stranded RNA viruses which include the genera Norovirus (Norwalk like viruses). The human caliciviruses are a major cause of acute viral gastroenteritis in all age groups. Symptoms include nausea, vomiting and abdominal cramps. Less than half of those infected present with diarrhoea and some have fever. Known as winter vomiting disease the symptoms are relatively mild and self-limiting, however the high attack rate denotes a low infectious dose. Since the virus is excreted in faeces it will occur in domestic waste water as well as contaminated food and drinking water. Numerous water-related outbreaks have been documented in relation to recreational water, ice, water on cruise ships, other drinking waters and shellfish harvested in polluted estuarine waters. Control measures relate to the protection of raw and treated water from faecal contamination and adequate disinfection.

Enteroviruses

These are a wide group of viruses which include poliovirus, coxsackievirus and echovirus. They are the smallest viruses and consist of a single stranded RNA genome. Many can be detected in environmental samples by cell culture. Enteroviruses are all excreted in the faeces of infected individuals and are therefore the most numerous viruses in sewage and sewage polluted waters, however the predominant route of transmission is by person to person contact and inhalation. Control measures relate to the protection of raw and treated water from faecal contamination and adequate disinfection.

Hepatitis A

This is highly infectious and the infecting dose is low. Like other enteric viruses, Hepatitis A virus enters the gastrointestinal tract by ingestion and then enters the bloodstream to reach the liver where it can cause severe damage in around ten per cent of adult cases. There is a long incubation phase of around 30 days followed by a characteristic onset of symptoms, such as fever, malaise, nausea, anorexia, and eventually jaundice. The evidence for waterborne transmission of Hepatitis A is well documented and stronger than it is for all other viruses. Food borne outbreaks are also relatively common. Travel of people from areas with good sanitation to those with poor sanitation is associated with a high risk of infection, as is drug abuse. Control measures relate to the protection of raw and treated water from faecal contamination and adequate disinfection.

Hepatitis E

This is similar in its effects to Hepatitis A, however, the incubation period for infection is longer and there is a high mortality rate in pregnant women. Currently cases and outbreaks are rare in the UK. Control measures are the same as Hepatitis A.

Rotavirus

These are double stranded RNA viruses some of which infect humans while others are specific to animals. They are not grown readily in cell culture, but can be detected in environmental samples by PCR techniques. Human rotaviruses are the most important single cause of infant death in the world. The virus infects cells in the villi of the small intestine and disrupts sodium and glucose transport. Person to person transmission and inhalation are the important routes of spread, however, both water and food borne outbreaks are documented. Rotavirus may be more resistant to conventional disinfection techniques than other viruses. Control measures are the protection of source and treated water from contamination by human faecal wastes, and careful attention to adequate treatment and disinfection of drinking water prior to supply to consumers.

Protozoan pathogens

Protozoa and helminths are common causes of human and animal infection which present real challenges for control because most produce cysts, oocysts or eggs that are extremely resistant to disinfection and survive for long periods in the environment.

Ancanthamoeba

This is a free living amoebae common in water and soil. Under unfavourable conditions it develops a dormant cyst capable of withstanding extremes of temperature (-26 to 56 degrees C). Cases of acanthameobic keratitis, a painful infection of the cornea, have been associated with the use of tap water in preparing solutions for washing contact lenses. It is a rare disease but may lead to impaired vision, blindness and loss of the eye. Since the cleaning of contact lenses is not considered to be a normal domestic use of tap water, control is through the purchase and use of proprietary, sterile, lens cleaning solutions.

Cryptosporidium

This parasite has a complex life cycle which causes a self-limiting, but unpleasant, diarrhoeal illness in humans and animals. It forms oocysts which are shed in faeces in very high numbers. The main route of infection is by person to person spread and by direct contact with farm animals, pets and their environments. However, outbreaks due to faecally contaminated drinking water are now widely documented and several have occurred in Northern Ireland in the past decade. Approximately 120-140 human cases are reported annually in Northern Ireland. As few as ten oocysts can lead to infection. The oocysts are very resistant to chlorine; therefore control is achieved by source protection, filtration and disinfection with UV irradiation.
For information on Cryptosporidium in drinking water see http://dwi.defra.gov.uk/research/bouchier/index.htm

Giardia

Giardia is a protozoa which colonises the human gastrointestinal tract and some animals forming a thick walled cyst which is shed intermittently in faeces. It causes diarrhoea and malabsorption in the small intestine. Illness is generally self-limiting, but can be chronic, lasting over one year, in otherwise healthy people. As few as ten cysts are required for infection. The cysts survive for months in water. Person to person contact is the commonest route of transmission between children. Although more resistant to disinfection with chlorine than bacterial pathogens, unlike cryptosporidium, chlorination can be used as a control measure together with filtration and source water protection.

Naegleria fowleri

This is a free living amoboflagellate distributed widely in the environment which forms resistant cysts under unfavourable conditions. It causes primary amoebic meningocephalitis in healthy people by entering the brain through penetration of the olfactory mucosa. The disease is acute and patients often die within ten days before diagnosis. Cases are rare. *Naegleria* are thermotolerant and found in warmer waters such as hot springs, swimming pools and spas. Infection is contracted by exposure of the nasal passages to contaminated water and thus predominantly associated with recreational water uses. Control is by means of water temperature (< 25 degrees C) and the maintenance of a stable and effective residual chlorine level of at least 0.5 mg/l.

11.16 **Annex: NI Water PHA risk assessment template**

Date & Time of Notification:	
Sample Date:	
Sample ID:	
Water Quality Scientist:	
Consultant in Health Protection (CHP):	

Basic Details

Details	**Information Provided to CHP**	**Initialled / Date & Time**
Location details / address • WTW • SR • Customer property		
Sample result details (Microbiological – Presumptive result) Including: • PCV / HNV level • Sample history information • Source of potential contamination – if known		
Results of any other samples in the supply area		
Sample point / tap information		

Details	**Information Provided to CHP**	**Initialled / Date & Time**
Source of supply		
Awareness of increased customer complaints/contacts from potentially affected area		
Details of all action taken to date		

Details	**Information Provided to CHP**	**Initialled / Date & Time**
Details on next steps / action to be taken		

WTW

Details	Comments / Information	Initialled / Date & Time
Water treatment process		
Type of treatment		
Plant operation / known Treatment difficulties		
Onsite telemetry readings e.g. turbidity, chlorine residuals		
Volume of water into distribution		
Potential population affected		
Area of distribution		
Residence time in the distribution		

Service Reservoir

Details	Comments / Information	Initialled / Date & Time
Onsite telemetry readings e.g. chlorine residuals		
WTW details		
Volume of water into distribution		
Potential population affected		
Area of distribution		
Residence time in the distribution		
Does SR have chlorination		

Customer Property

Details	Comments / Information	Initialled / Date & Time
Type of sample / reason for sample		
Operational activity in the area		
SR supply details		
Customer complaints – awareness of increased level of complaints		

Public health advice to NI Water (CHP)

Details	Advice Received / Given	Initialled / Date & Time
Action recommended		
Timescales for required NIW action based on risk assessment		
Advice on notice type required		
Agreed criteria for incident closure		
Requirement for updated information to customer during incident		

11.17 Annex: Advice for incident management teams

Draft meeting agenda for Incident Management Teams

Minutes

The Chairman should ensure that minutes of each meeting are taken by a person not directly involved and that these are circulated with action points to all members as soon as possible after the meeting.

Agenda

1 Chairman's introduction including terms of reference

2 Minutes of last meeting (if applicable)

3 Review membership (are there lines of contact to all appropriate organisations?)

4 Incident resumeè and update

- 4.1 General situation report
- 4.2 Case report
- 4.3 Water utility report
- 4.4 Microbiological report
- 4.5 Environmental health report
- 4.6 Other relevant reports

5 Management of Incident

- 5.1 Control measures
- 5.2 Implications for public health
- 5.3 Advice to boil water
- 5.4 Provision of alternative water supplies
- 5.5 Care of patients (hospital and community)
- 5.6 Microbiological aspects (specimens, analysis and resources)

6 Issuing advice

- 6.1 Advice to the public (need for press release)
- 6.2 Advice to professionals (GPs, hospital, dentists etc)

7 Agree content of press release and press arrangements

8 Nominate others to assist Chairman in press conferences and interviews (if required)

9 Consider arrangements for enquiries from the public (the need for a Helpline)

10 Obtain all relevant telephone and fax numbers/email and other contact details for all key personnel

11 Agree action points and timetable, identify individuals responsible for the agreed actions

12 Date, time and location of next meeting

11.18 Annex: Checklist for Incident Management Teams

The following is a suggested prompt list for actions by the Chair of an Incident Management Team (IMT) for dealing with microbiological incidents affecting drinking water supplies. It is not meant to imply that each action must follow the one preceding it or that all steps are needed on every occasion. In practice some steps will be carried out simultaneously and others will be required throughout the outbreak.

1 Ongoing routine surveillance

1.1 Analysis of routine data

1.2 Is there a mechanism for early identification of change in the data?

2 Recognition of a possible outbreak/potential for an outbreak

2.1 Notification of an incident by NI Water

2.2 Investigation of the potential for the incident to cause an outbreak

2.3 Change in background level of cases

2.4 Determine if there is an outbreak

2.5 Consider whether or not cases have the same illness

3 Assessing the public health significance of the incident

3.1 Obtain as much information as possible about:

3.1.1 the nature of the incident;

3.1.2 the exact area affected in terms of water supply zone(s) and geographical distribution;

3.1.3 the action being taken by NI Water;

3.2 Decide from the available evidence whether the incident may result in an outbreak

4 If no potential for an outbreak – no further investigation, resume ongoing surveillance.

5 If potential for an outbreak, or outbreak recognised

5.1 When convening the outbreak control team, consider:

5.1.1 membership

5.1.2 optimum size

5.1.3 lines of communication to all organisations not represented directly

5.1.4 accommodation, communications and catering

5.1.5 deputies to provide cover for long hours

5.1.6 accurate records of meetings

5.2 Start a log book noting the time and date of the first notification of the incident and maintain this record throughout the incident

5.3 Assess the seriousness of the incident from details provided by

NI Water

5.4 Seek advice from professionals including national experts from HPA/elsewhere,

5.5 Liaison with the Inspectorate and DoH (and other government departments as appropriate)

6 Decide on control measures and determine the necessary commitment of personnel and resources

6.1 Initiate immediate control measures

6.2 Consider the need for the issue of 'Advice to boil water' or other appropriate advice notices and the special provisions needed if this action is carried out

6.3 Liaise with and advise NI Water who ultimately issue the notice of advice, appropriately

6.4 Consider with NI Water the provision of alternative water supplies

6.5 Ensure high risk premises e.g. businesses concerned with food production, hospitals, schools and residential homes have been contacted

6.6 Ensure water sampling regimen covers appropriate geographical area and samples are analysed for appropriate parameters

6.7 Consider if there is an ongoing public health risk

7 Communications with the media and the public

7.1 Consider best routes of communication for informing the media and the public

7.2 Ensure accuracy and timeliness

7.3 Use the media constructively

7.4 Nominate one or more spokespersons

8 Decide when the incident/outbreak is over

8.1 Decide at an early stage the criteria for lifting 'Advice to boil water'

9 Prepare and issue the IMT report as soon after the event as practicable.

9.1 Include a review of lessons learnt for the future

11.19 Annex: Draft outline for Incident Management Team report

The following is a list of suggested headings which is not exhaustive. Each report should be tailored to the circumstances of the individual incident.

1 Executive Summary

2 Introduction

3 Background to the incident

- 3.1 Population demographics
- 3.2 Background rates of human illness
- 3.3 Water treatment and distribution
- 3.4 Water quality monitoring

4 Incident/outbreak control

- 4.1 Co-ordination and management
- 4.2 Action taken by NI Water
- 4.3 Advice to boil water
- 4.4 Media
- 4.5 Advice to the public and to business

5 Epidemiology

- 5.1 Surveillance
- 5.2 Descriptive epidemiology
- 5.3 Analytic epidemiology

6 Other investigations

- 6.1 Water microbiology
- 6.2 Catchment area studies
- 6.3 Climatic conditions
- 6.4 Hydrogeology

7 Discussion

- 7.1 Epidemiology
- 7.2 Water treatment and distribution
- 7.3 Control measures
- 7.4 Other recent incidents/outbreaks (where relevant)

8 Lessons learned, recommendations and conclusions

9 References

10 Appendices

- 10.1 Chronology of events

10.2 General background on cryptosporidiosis/relevant pathogen
10.3 Incident Management Team – membership and terms of reference
10.4 Press releases
10.5 Detailed epidemiology
10.6 Maps

11.20 Annex: Public health advice when water supply is low.

Published on *HSC Public Health Agency* (http://www.publichealth.hscni.net)
Home > Public health advice when water supply is low

Updated: 31 December 2010. 3.00pm.

The Public Health Agency has issued the following advice to the public in relation to keeping healthy when mains water is unavailable.

How do I keep my hands clean without mains water?
It is still very important to ensure that your hands are clean before cooking food and eating as many gastrointestinal illnesses are transmitted through dirty hands. The very young and the elderly are especially vulnerable. For this reason you should:
• use any water you have for hand hygiene first before you use it for showering and bathing;
• use antibacterial hand gels or wipes if you have them;
• be extra vigilant in supervising small children to keep their hands clean.

Can I drink the water I get from the bowser at the distribution points?
Preferably you should use bottled water for drinking when your water is in short supply. The water in the bowser or tanker is drinkable but the container that you use to collect the water from the bowser, while looking clean, may contain bacteria. Therefore the following steps should be taken:

- ensure you use a clean container to collect the water and preferably one that can be covered or has a cap or top;
- it is advised that you boil the water and cool it before using it for drinking, brushing teeth and making ice;
- bowser water can be used for making tea or coffee, provided you boil it;
- bowser water can be used for cooking.

Can I brush my teeth with water from a bowser?
The water you use to brush your teeth should be of the same quality as the water you drink. Preferably use bottled water or water that has been boiled and allowed to cool.

My baby is on formula feed so how do I feed my baby?
• use boiled water and make up feed in the usual way;
• ready-made preparations are available and can be used as an alternative;
• it should be noted that some types of bottled water may not be suitable for making up infant formula because of high salt levels (sodium concentrations of less than 20mg/l are preferable and not more than 200mg/l). There may be

labelling on the bottle that will indicate if it is not suitable for making up infant formula.

How do I maintain personal hygiene when water is in short supply?
A small amount of water can be used to fill a bathroom sink and sponges or facecloths used for personal washing with soap. Separate cloths/sponges should be used for the face and genital areas. Each person in the household should have their own designated cloth/sponge and towel. Alternatives to this include using sanitary wipes or alcohol-based gels. You should note that alcohol-based gels cannot be used on the face or genital areas.

How do I maintain a clean environment at home without mains water?
The most important places to keep clean are the surfaces where food is prepared or eaten, the toilet and wash hand basins in bathrooms. Surfaces and sinks can be cleaned with disinfectant wipes or if a small amount of water is available use a clean cloth and the usual cleaning solutions. Toilet cleaner and domestic bleach can be used to clean toilets.

How do I flush my toilet without mains water?
Flushing a toilet uses three to seven litres of water so it is important that unnecessary flushing does not take place.
• toilets do not require sterile water for flushing;
• water from distribution points can be used if you have enough to drink;
• waste water can be used to flush the toilet such as dish water. You can fill the cistern with that water or pour it down the toilet until the toilet is cleared;
• rain water can be collected in buckets and used for this purpose.

How do I keep my house warm without mains water?
Most houses have central heating systems that are based on radiators filled with water that are heated by an oil or gas boiler. There is a chance that these systems will be affected by the shortage of mains water supplies. It is important if your heating is not working to take the following steps:
• consult a plumber to assess the cause of the non-functioning boiler;
• if using an alternative heating appliance ensure it has been adequately maintained and the manufacturer's instructions followed.

How can hygiene be maintained in schools?
Hand washing is one of the most important ways of controlling the spread of diseases, particularly in environments such as schools. The recommended method for washing hands is to use liquid soap, water and paper towels. Hands should be washed after using the toilet and before eating or handling food.

If flowing hot and cold water is not available for a prolonged period of time it will not be possible to maintain adequate hand hygiene. Sanitising wipes and hand gels, although useful at sterilising, are not an alternative to adequate hand washing.

Children/students with diarrhoea and vomiting should not attend school or should be sent home immediately if these symptoms are identified. A school should not open in the absence of hot and cold running water.

To prevent scalding
Care should be taken when boiling water and pouring it into containers to cool as there is a risk of scalding. The boiled water should be poured into a clean container that can be covered and allowed to cool. This should be kept away from children.

The important message is to keep warm by:
• wearing several thin layers of clothing as they will keep you warmer than one thick layer – wear a hat, gloves and scarf if necessary;
• when inside, keep moving and try not to sit still for more than one hour at a time as activity generates body heat;
• have frequent warm healthy meals and drinks – but avoid alcoholic drinks as these can lower body temperature.

Vulnerable and elderly neighbours
Finally, the PHA advises that people should check on their vulnerable and elderly neighbours who may not be able to get water from distribution points and make sure they have everything they need to keep warm, watered and fed.

Advice for food handlers and operators
An adequate supply of drinkable water is essential to operate a safe food business, particularly if you are preparing or handling open high risk foods.

During the current water shortages, which may last for up to one week, all food businesses must maintain good standards of hygiene, restrict their operations, or where necessary, even close.

Any food business operator who is unsure or requires specific advice should contact the Food Safety Team on 028 9027 0428.

See Belfast City Council's website for further information at www.belfastcity.gov.uk/bigfreeze/water.asp (Scroll to the bottom of the page for the appropriate information.)

Notes to the editor:
Further information:

Additional information is available on the following websites:

- NI Water:www.niwater.com [1]
- nidirect: www.nidirect.gov.uk/news-dec10-health-advice-during-interruption-to-water-supply[2]

- Belfast City Council: www.belfastcity.gov.uk/bigfreeze/water.asp
- Advice for food handlers and operators - see Belfast City
- Council: www.belfastcity.gov.uk/bigfreeze/water.asp [3]

(Scroll to bottom of the page for the appropriate information.)

Source URL: http://www.publichealth.hscni.net/news/public-health-advice-when-water-supply-low

Links:
[1] http://www.niwater.com
[2] http://www.nidirect.gov.uk/news-dec10-health-advice-during-interruption-to-water-supply
[3] http://www.belfastcity.gov.uk/bigfreeze/water.asp

11.21 Annex: NI Water Notices

11.21.1 Annex: Boil Water before use

Mr A B Sample
Sample House Number
Sample Road
Sample Town
Sample County
AB1 2CD
Date 14/10/11

ROYAL MAIL
POSTAGE PAID
RMNI 206

Dear Customer

BOIL YOUR WATER BEFORE USE UNTIL FURTHER NOTICE

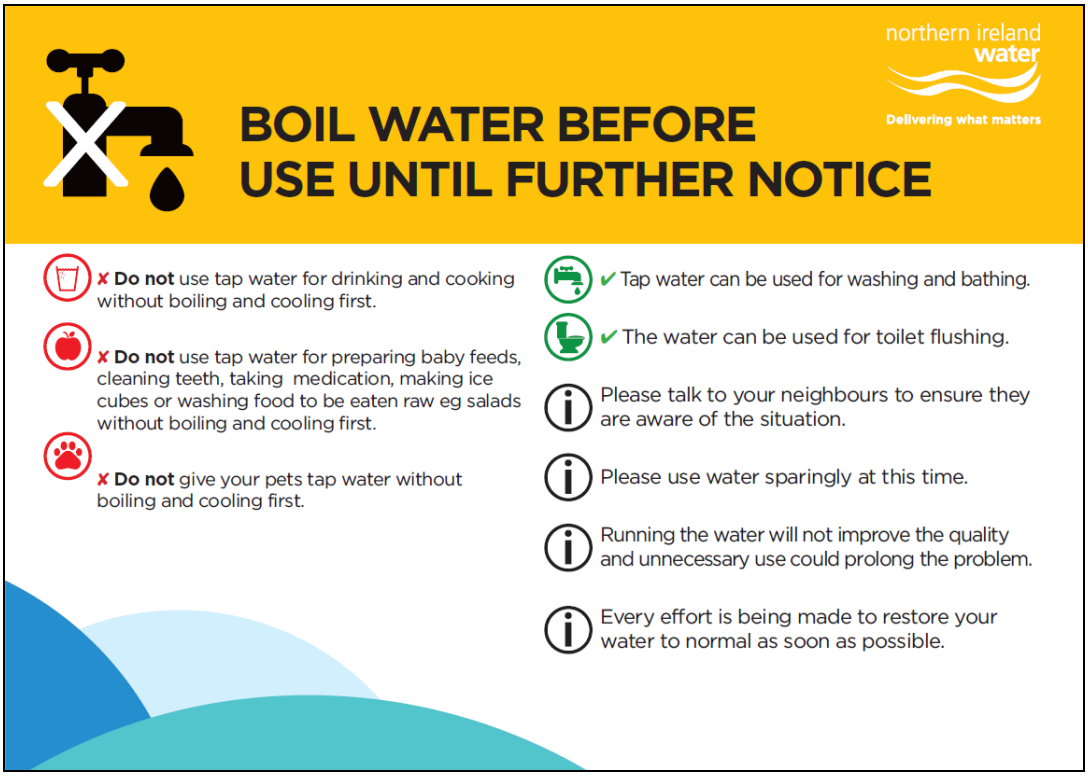
Owing to a temporary deterioration in water quality, Northern Ireland Water and The Public Health Agency are advising all customers in your area to boil tap water. Please follow the advice on the front of this card about how your water can be used.

We apologise for any inconvenience this may cause and thank you for your co-operation.
We will notify you when your water supply is back to normal.

For further information and latest updates, please visit our website or telephone us.

www.niwater.com
Waterline: 03457 440088
Text Relay Service: 03457 440088
If undelivered please return to: NI Water, PO Box 1026, Belfast, BT1 9DJ

northern ireland water
Delivering what matters



northern ireland water
Delivering what matters

BOIL WATER BEFORE USE UNTIL FURTHER NOTICE

✘ **Do not** use tap water for drinking and cooking without boiling and cooling first.

✘ **Do not** use tap water for preparing baby feeds, cleaning teeth, taking medication, making ice cubes or washing food to be eaten raw eg salads without boiling and cooling first.

✘ **Do not** give your pets tap water without boiling and cooling first.

✔ Tap water can be used for washing and bathing.

✔ The water can be used for toilet flushing.

Please talk to your neighbours to ensure they are aware of the situation.

Please use water sparingly at this time.

Running the water will not improve the quality and unnecessary use could prolong the problem.

Every effort is being made to restore your water to normal as soon as possible.

11.21.2 **Annex: Do Not drink/ Do not cook**

Mr A B Sample
Sample House Number
Sample Road
Sample Town
Sample County
AB1 2CD
Date 14/10/11

ROYAL MAIL
POSTAGE PAID
RMNI 206

Dear Customer

DO NOT USE TAP WATER FOR DRINKING OR COOKING

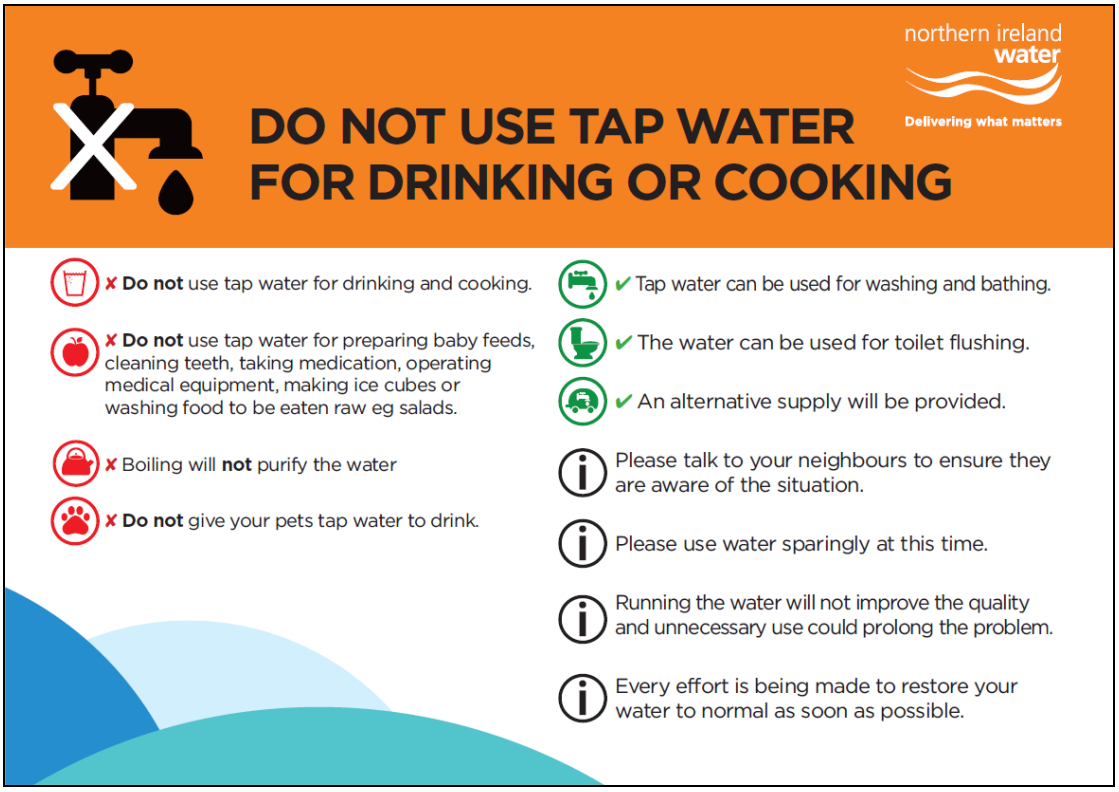
There is a possibility that your water supply may be contaminated, Northern Ireland Water and The Public Health Agency are advising all customers in your area to avoid using tap water for drinking and cooking. Please follow the advice on the front of this card about how your water can be used.

We apologise for any inconvenience this may cause and thank you for your co-operation.
We will notify you when your water supply is back to normal.

For further information and latest updates, please visit our website or telephone us.

www.niwater.com
Waterline: 03457 440088
Text Relay Service: 03457 440088
If undelivered please return to: NI Water, PO Box 1026, Belfast, BT1 9DJ

northern ireland water
Delivering what matters



11.21.3 **Annex: Do not Use**

Mr A B Sample
Sample House Number
Sample Road
Sample Town
Sample County
AB1 2CD
Date 14/10/11

ROYAL MAIL
POSTAGE PAID
RMNI 206

Dear Customer

DO NOT USE THE WATER FROM YOUR TAPS

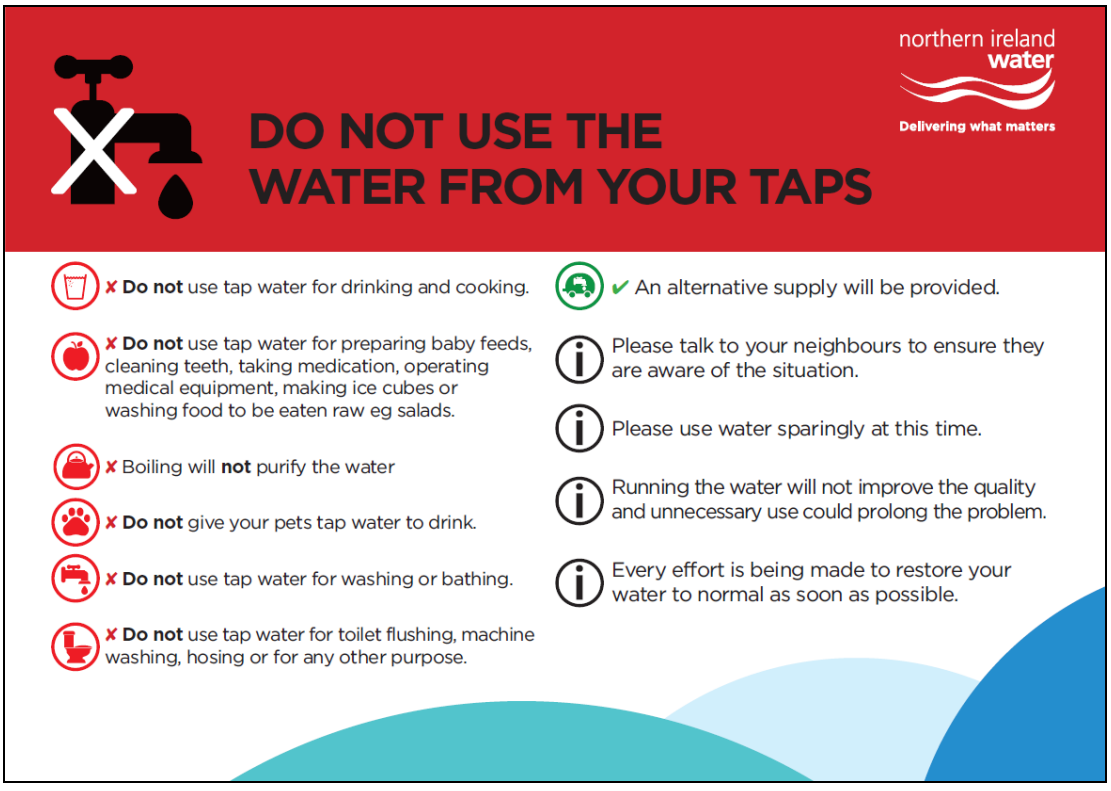
There is a possibility that your water supply may be contaminated, Northern Ireland Water and The Public Health Agency are advising all customers in your area to completely avoid using the water from your taps. Please follow the advice on the front of this card.

We apologise for any inconvenience this may cause and thank you for your co-operation. We will notify you when your water supply is back to normal.

For further information and latest updates, please visit our website or telephone us.

www.niwater.com
Waterline: 03457 440088
Text Relay Service: 03457 440088
If undelivered please return to: NI Water, PO Box 1026, Belfast, BT1 9DJ

northern ireland water
Delivering what matters



DO NOT USE THE WATER FROM YOUR TAPS

northern ireland water
Delivering what matters

✘ **Do not** use tap water for drinking and cooking.

✘ **Do not** use tap water for preparing baby feeds, cleaning teeth, taking medication, operating medical equipment, making ice cubes or washing food to be eaten raw eg salads.

✘ Boiling will **not** purify the water

✘ **Do not** give your pets tap water to drink.

✘ **Do not** use tap water for washing or bathing.

✘ **Do not** use tap water for toilet flushing, machine washing, hosing or for any other purpose.

✔ An alternative supply will be provided.

Please talk to your neighbours to ensure they are aware of the situation.

Please use water sparingly at this time.

Running the water will not improve the quality and unnecessary use could prolong the problem.

Every effort is being made to restore your water to normal as soon as possible.

11.21.4 **Annex: Your Taps can now be used in the normal way.**

Mr A B Sample
Sample House Number
Sample Road
Sample Town
Sample County
AB1 2CD
Date 14/10/11

ROYAL MAIL
POSTAGE PAID
RMNI 206

Dear Customer

YOUR TAP WATER CAN NOW BE USED IN THE NORMAL WAY

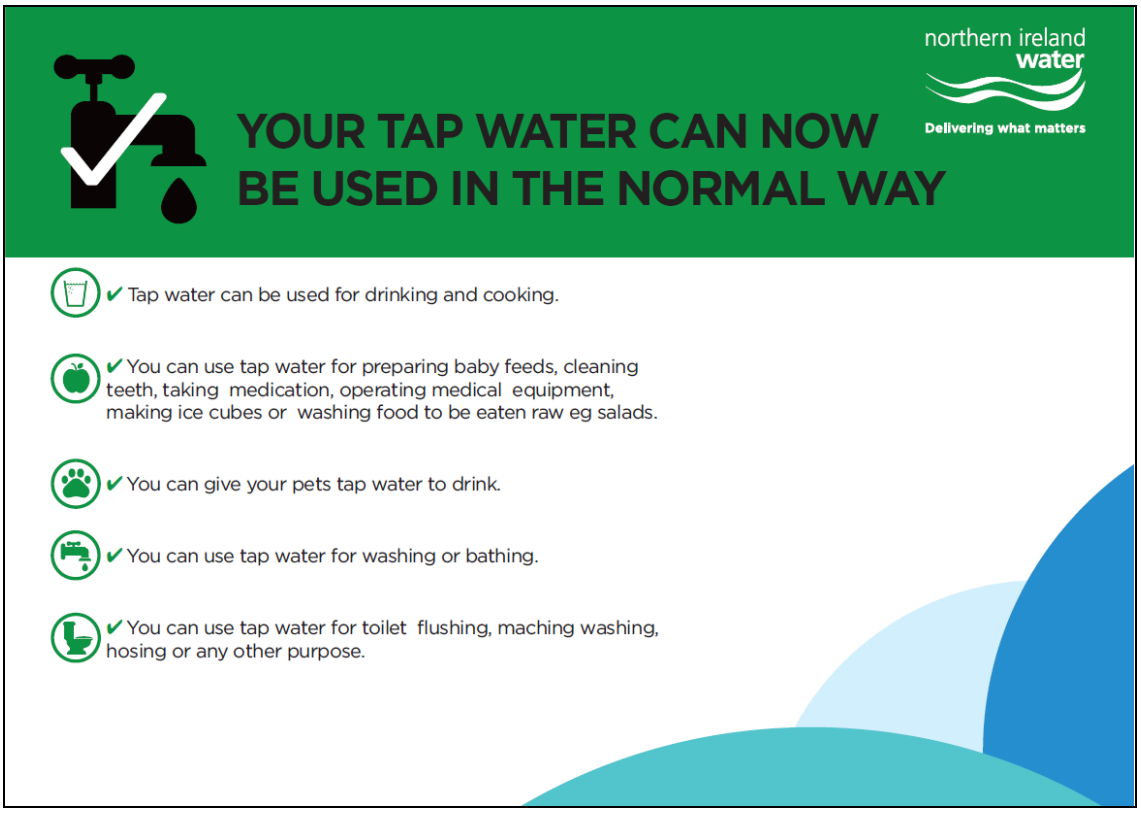
Tests have shown that your water supply is free from any contamination. The Public Health Agency have now agreed that the recent precautions are no longer necessary and your tap water can be used in the normal way.

We apologise for any inconvenience.

For further information and latest updates, please visit our website or telephone us.

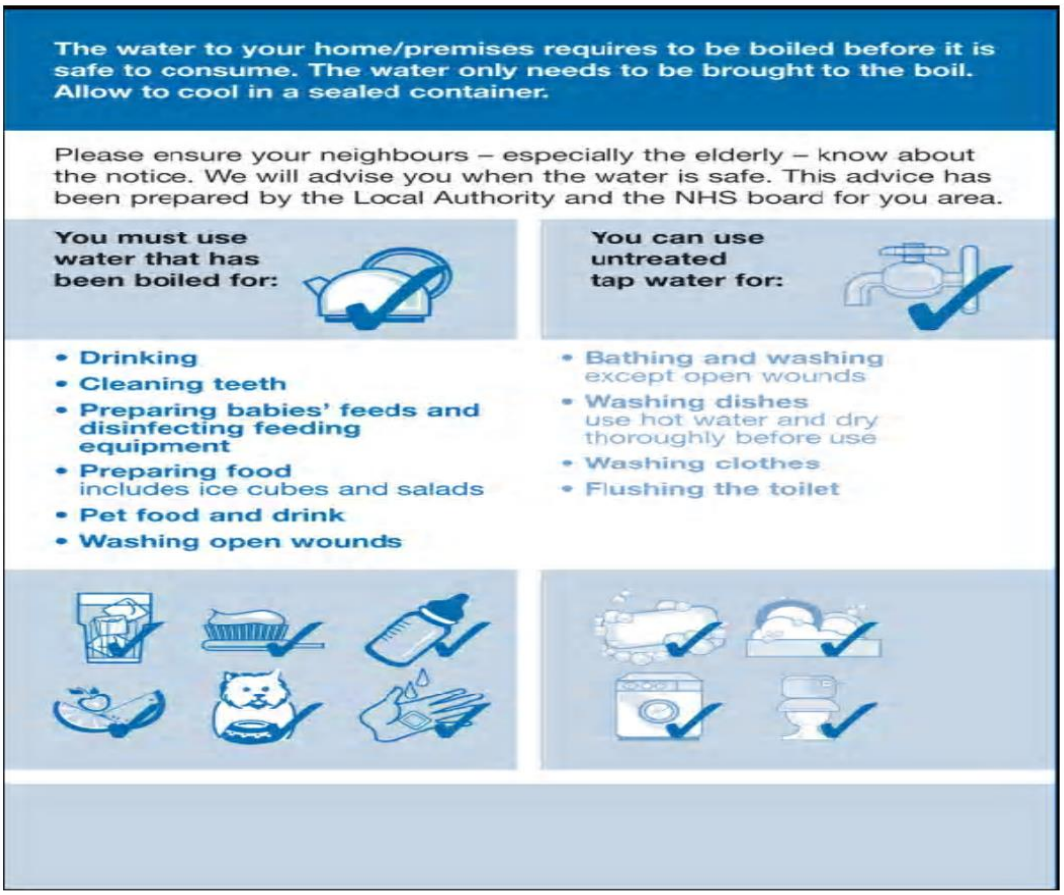
www.niwater.com
Waterline: 03457 440088
Text Relay Service: 03457 440088
If undelivered please return to: NI Water, PO Box 1026, Belfast, BT1 9DJ

northern ireland water
Delivering what matters

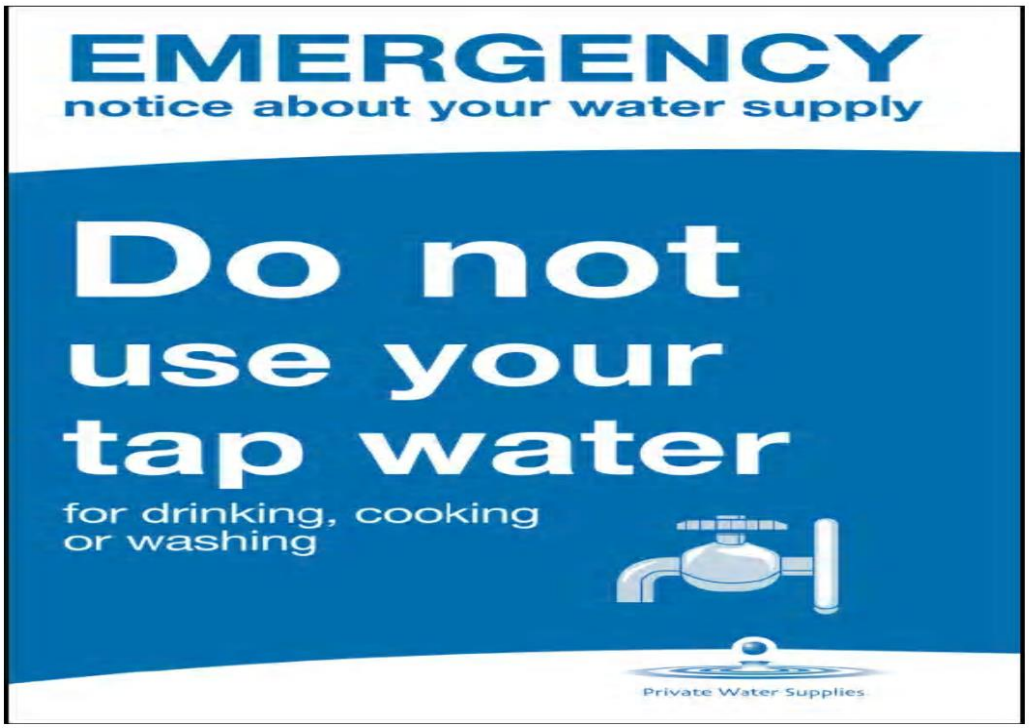


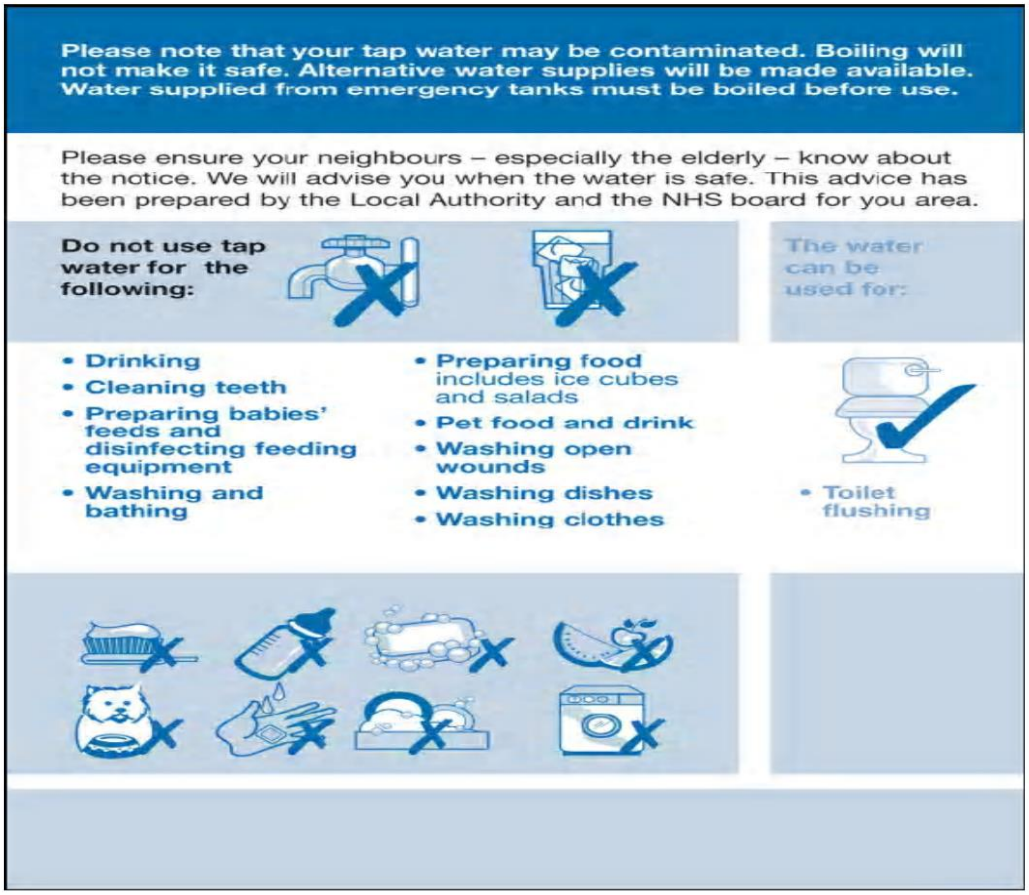
11.22 Annex: Private Water Supplies – Generic Notices

11.22.1 Annex: Boil water before use

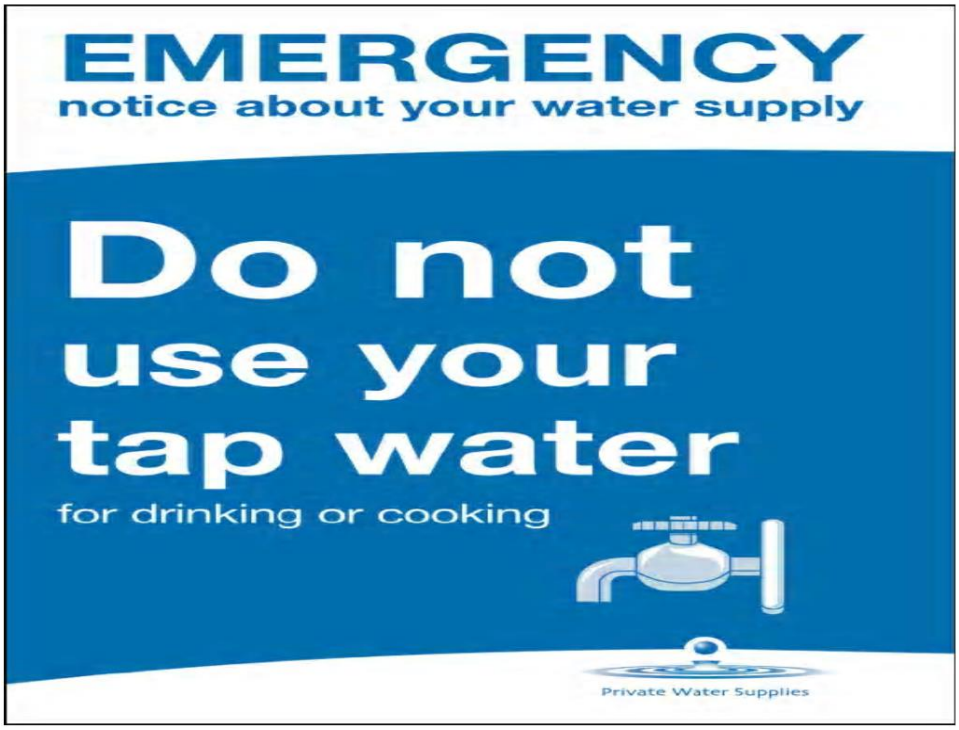


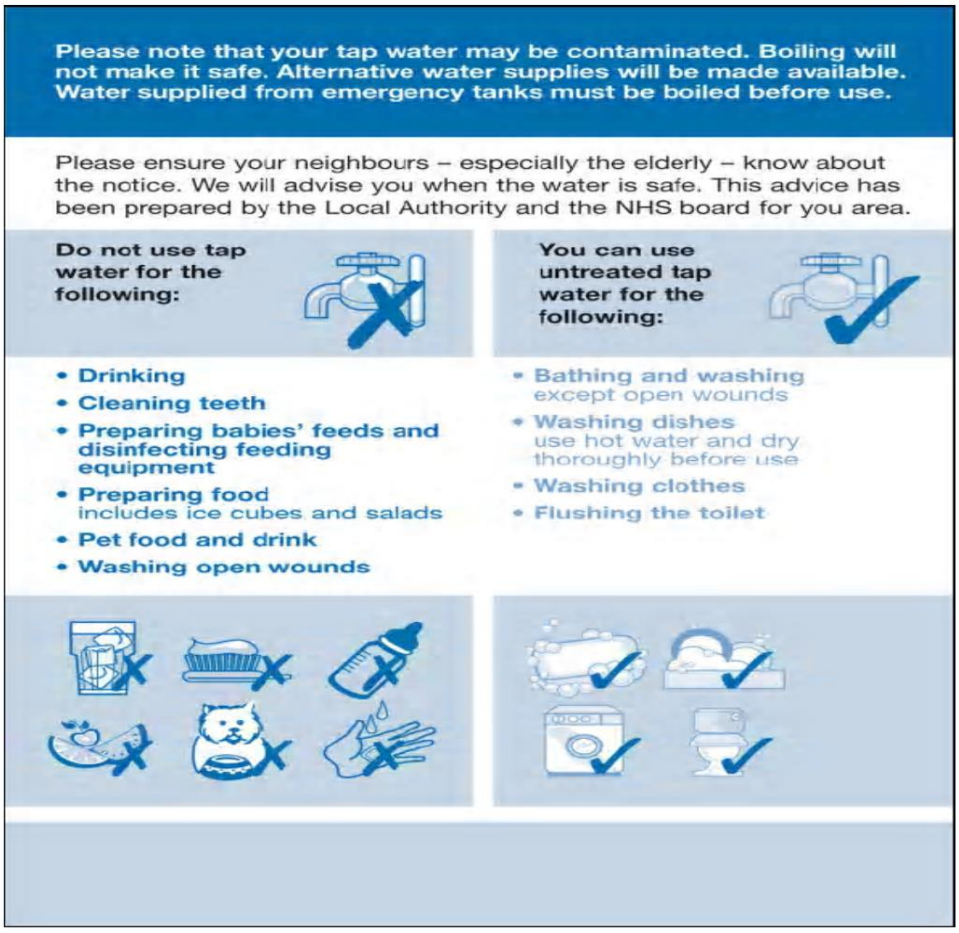
11.22.2 **Annex: Do not use for drinking or cooking**



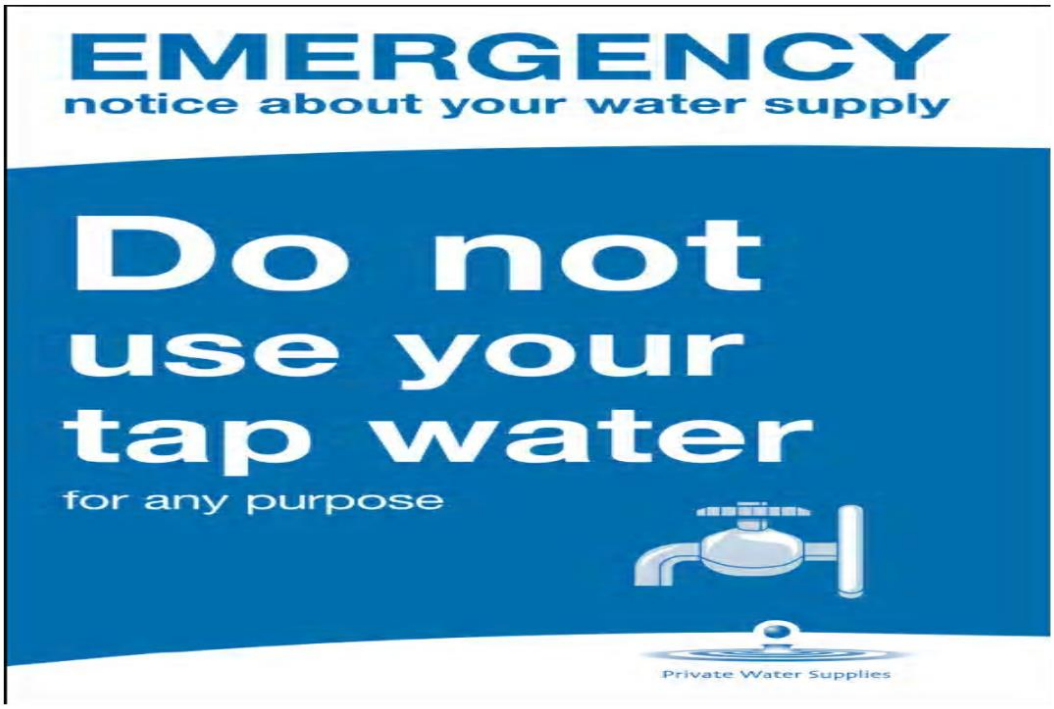


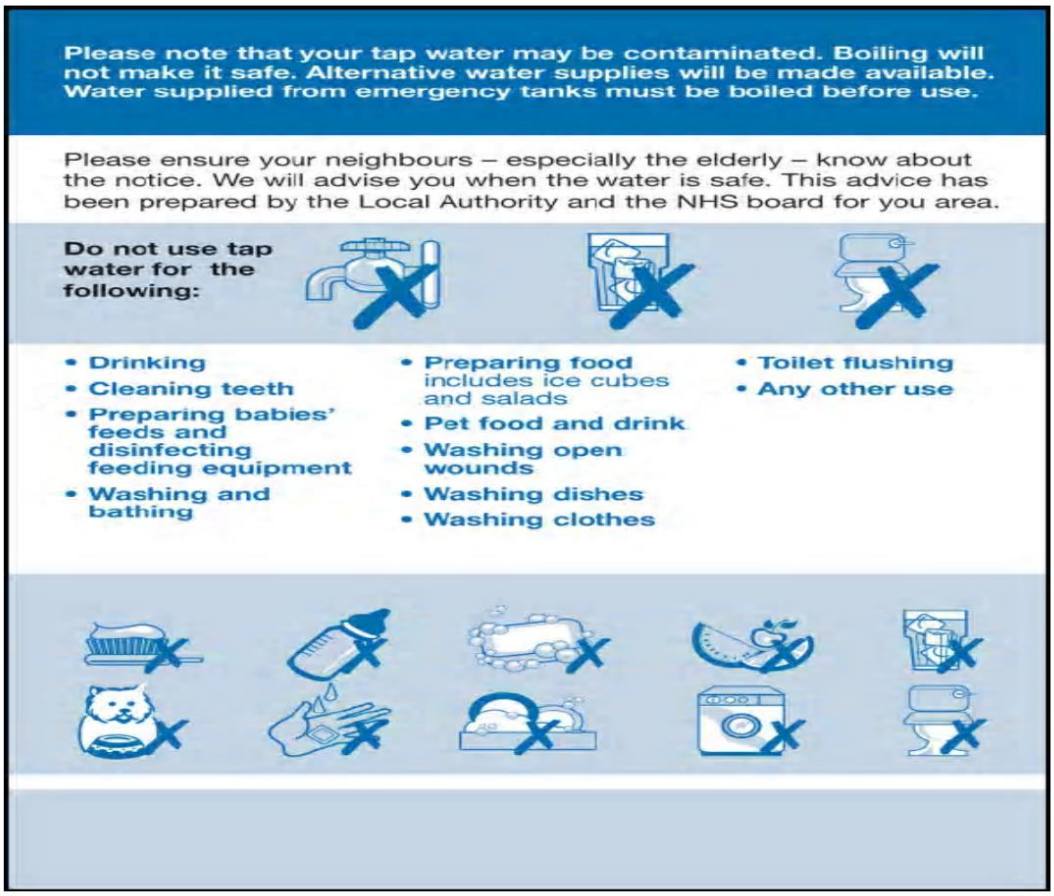
11.22.3 **Annex: Do not use for drinking cooking or washing**



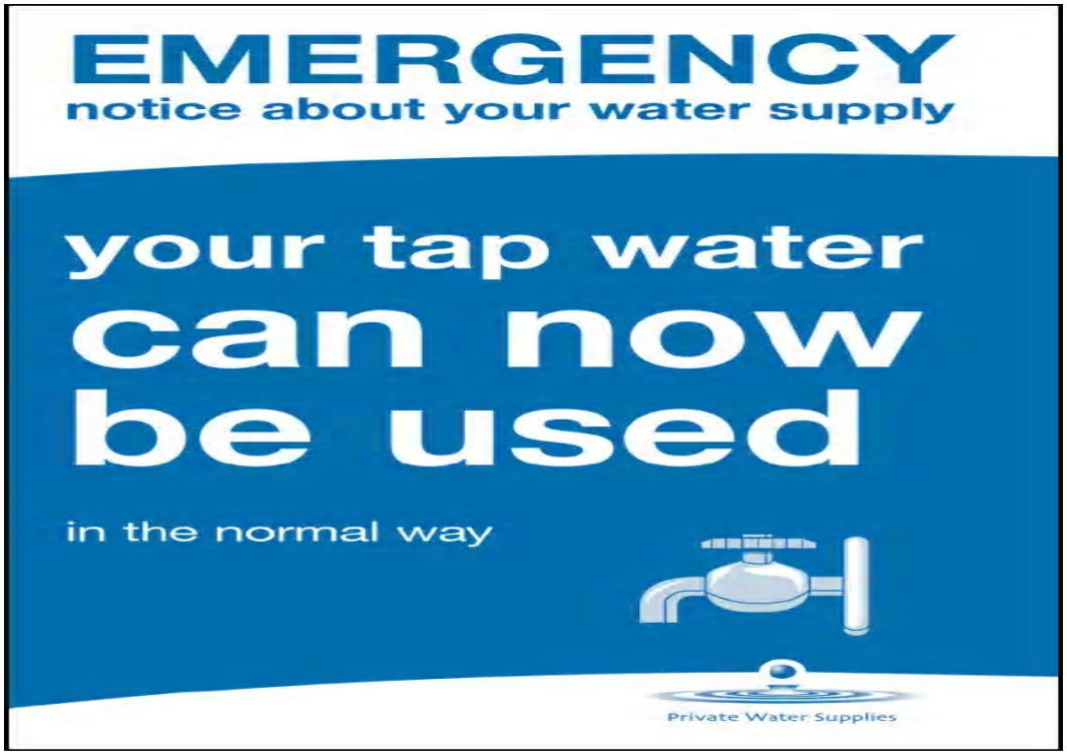


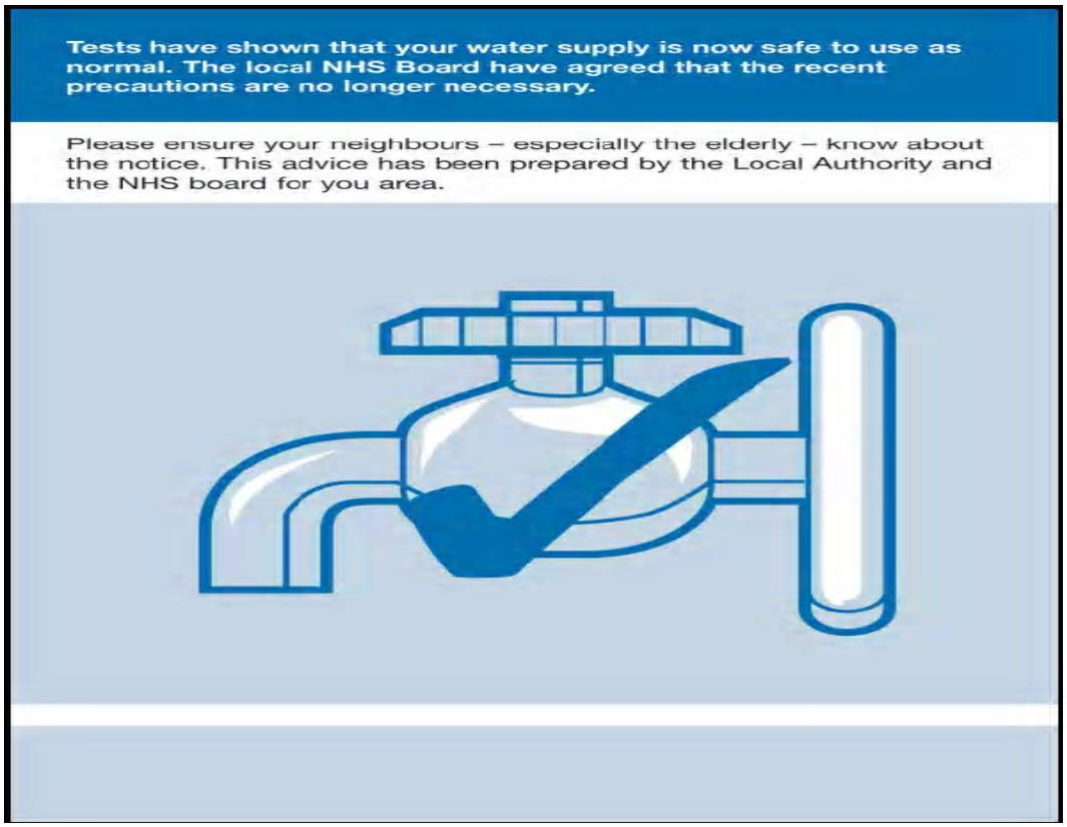
11.22.4 **Annex: Do not use for any purpose**





11.22.5 **Annex: Water can now be used**





11.23 Annex: Effective communications with ethnic minorities and ethnic minority businesses

Consideration of the following seven points advised by Sills and Desai (1996), while having no formal status in law, may assist in helping to improve the effectiveness of communications shared with ethnic minorities/EMBs regarding drinking water:

These are:

- **Level of Awareness**
  (Written communications can often assume too high a level of awareness);

- **Message**
  (If communications are to be effective the message needs to be of interest to the intended audience);

- **Level of Literacy**
  (The level of literacy of the ethnic minority audience targeted by the communication must be considered);

- **Language**
  (Simply translating information may not always be the solution);

- **Medium**
  (One form of communication does not suit all groups in society);

- **Delivery**
  (Careful consideration needs to be given to how the target audience is reached); and

- **Monitoring**
  (It is essential to monitor all stages of the communication process to ensure rapid and appropriate responses that are effective).

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