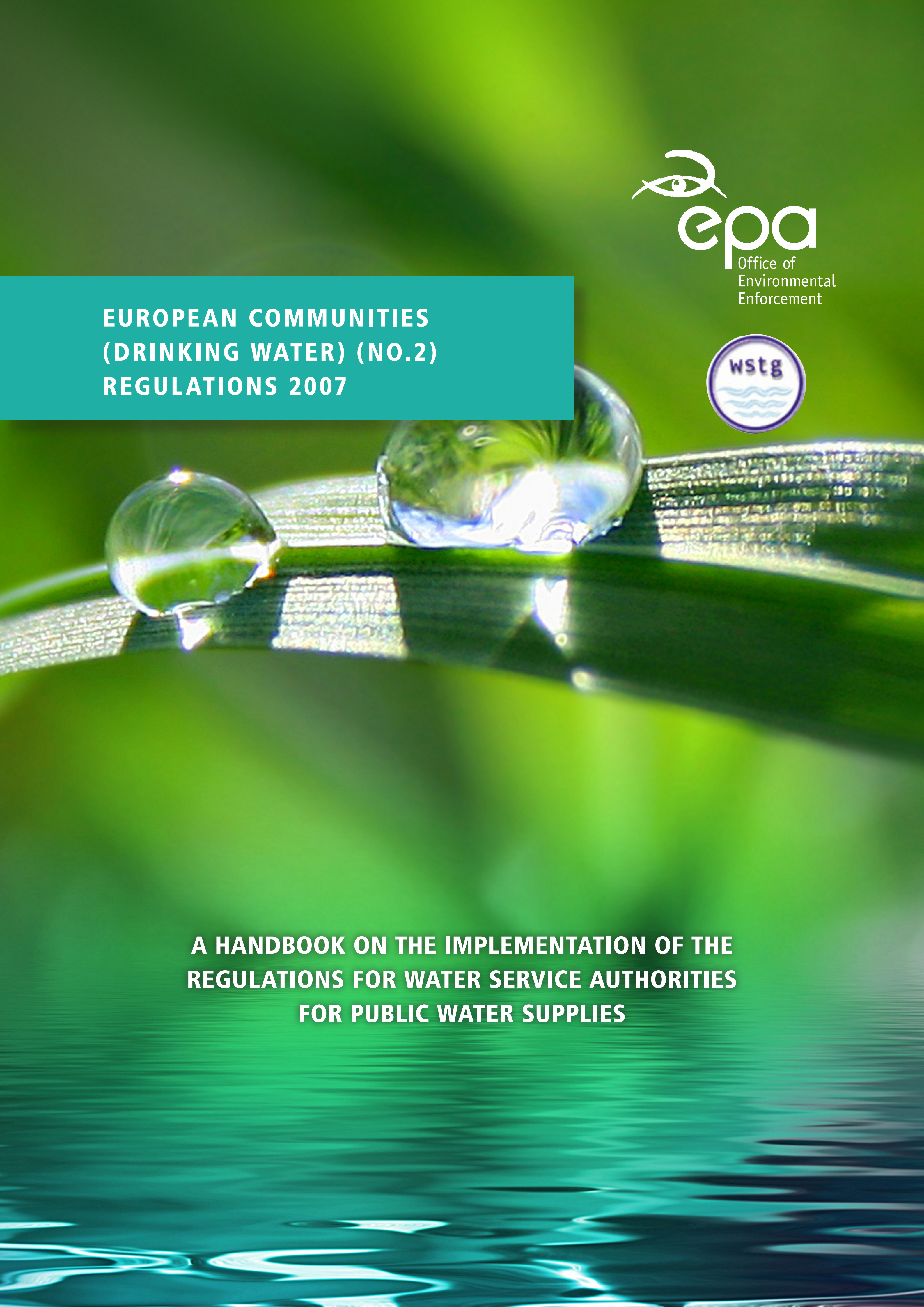

Office of Environmental Enforcement

EUROPEAN COMMUNITIES (DRINKING WATER) (NO.2) REGULATIONS 2007

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A HANDBOOK ON THE IMPLEMENTATION OF THE REGULATIONS FOR WATER SERVICE AUTHORITIES FOR PUBLIC WATER SUPPLIES

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Date:	12 April 2010

Office of
Environmental
Enforcement

European Communities (Drinking Water) (No.2)
Regulations 2007
(S.I. 278 of 2007)

A Handbook on the
Implementation of the Regulations
for Water Services Authorities
for Public Water Supplies

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(S.I. 278 of 2007)

A Handbook on the Implementation of the Regulations

for Water Services Authorities for Public Water Supplies

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Notice

This handbook has been compiled to provide guidance from the Environmental Protection Agency (the EPA) to the Water Services Authorities (WSAs) to assist the WSAs with the implementation of the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. 278 of 2007) in respect of public water supplies. It is not a legal document and it must not be taken to be an authoritative interpretation of these Regulations. The only definitive documents relating to the quality of drinking water are these Regulations and the European Communities Directive 98/83/EC on the quality of water intended for human consumption, which is given effect in Irish law by these Regulations. In all cases of doubt or possible ambiguity reference must be made to the Regulations.

Although every effort has been made to ensure the accuracy of the material contained in this publication, complete accuracy cannot be guaranteed. Neither the EPA nor the author accept any responsibility whatsoever for loss or damage occasioned or claimed to have been occasioned, in part or in full, as a consequence of any person acting, or refraining from acting, as a result of any material contained in this publication.

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The EPA also acknowledges the contribution of a Steering Group who supervised the preparation of this handbook and reviewed its contents. The members of the Steering Group were:

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- Mr Brendan Wall, the EPA
- Mr Tom Kirby, Water Services Training Group
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- Dr Patricia McDonald, Health Service Executive
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- Mr Sean Clerkin, National Federation of Group Water Schemes
- Mr Colm Brady, National Federation of Group Water Schemes

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Foreword

This handbook has been prepared by the Environmental Protection Agency (the EPA) to assist the Water Services Authorities (WSAs) to implement the provisions of the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. 278 of 2007) (the Regulations) in respect of public water supplies provided by the WSAs. A parallel handbook has been prepared to assist private water suppliers and WSAs to implement the Regulations in respect of private water supplies. This handbook and the parallel handbook together replace the previous handbook, published by the EPA in 2004, on the implementation of the European Communities (Drinking Water) Regulations 2000 (S.I. 439 of 2000).

The handbook is presented as a controlled document in loose leaf format in an A4 ring binder and consists of a list of contents and 13 separate sections dealing with the principal aspects of the Regulations and some related matters of good practice. Each section begins with a brief summary of the material covered in the section together with a contents list. This format will allow the EPA to readily up-date the handbook should there be a need for further guidance or if there are any amendments to the Regulations in the future.

The handbook begins with a comprehensive summary (section 1) of the Regulations for those personnel in WSAs that need an overview of the Regulatory requirements. This summary sets out the water supplies that are covered by the Regulations and the water supplies that are exempt. It outlines the supervisory role of the EPA over the WSAs including powers of direction to improve the quality of public water supplies. It explains the duty of WSAs to supply wholesome and clean water – defined by standards and the point at which these standards apply (mainly at consumers' taps). It outlines the monitoring requirements (sampling and analysis) that WSAs must meet and sets out what the WSAs must do when there is a failure to meet a standard or an indicator parameter value. These include investigations to establish the cause of the failure, actions to protect human health if the Health Service Executive (the HSE) considers the failure to be a potential danger to human health and remedial actions to ensure that the standards and indicator parameter values are met, including those associated with authorised departures from the standards. The handbook sets out the enforcement powers of the EPA to require WSAs to take action and the records about public water supplies that must be maintained by WSAs and the EPA. It explains the responsibilities of WSAs and owners of premises when a failure is caused by the condition of pipe work and fittings within premises (the domestic distribution system). It outlines the requirements on the use of treatment chemicals and materials of construction in the provision of public water supplies. It details the requirement on the EPA to audit WSAs to check whether they are meeting the regulatory requirements. Finally it explains the offences that WSAs can commit if they fail to meet particular regulatory requirements and the prosecution powers of the EPA. The full text of the Regulations is included as an appendix to section 1.

Sections 2 to 13 provide more detailed and specific guidance to WSAs on the principal requirements of the Regulations. Individual sections will be of interest to different groups of personnel within WSAs (and any contractors to the WSAs).

Section 2 describes and lists the standards that define a wholesome and clean water supply and the action that WSAs must take to restore compliance if there is a failure to meet an indicator parameter value. It also describes and lists the indicator parameter values that are not part of the definition of wholesomeness. If there is a failure to meet an indicator parameter value, the WSA is only required to take remedial action if the HSE considers the failure to be a potential danger to human health.

Section 3 describes and provides comprehensive guidance on the two types of "compliance monitoring" – "check monitoring" and "audit monitoring" that WSAs are required to carry out on each public water supply to determine whether the supply complies with the standards and indicator parameter values. It also expands the frequency tables in the Regulations for ease of reference. It also provides comprehensive guidance on the "operational monitoring" that WSAs should be carrying out to check that treatment works and distribution networks are operating effectively to deliver water that meets the standards.

It is very important that sampling and analysis for compliance monitoring is carried out properly so that there is confidence that the results obtained are accurate. Sections 4 and 5 provide comprehensive guidance on sampling and analysis. This guidance is not significantly different from the guidance in the 2004 Handbook because the regulatory requirements on sampling and analysis have not changed.

Section 6 deals with the very important procedures when there is a failure to meet a standard or indicator parameter value. It describes, and gives examples of, the investigations that WSAs must carry out to determine the cause of the failure (deterioration of raw water quality, a failure of a treatment process, a problem in the distribution network or the condition of the domestic distribution system). It sets out

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how the WSA must consult with the HSE on whether a failure is a potential danger to human health and if it is the WSA must take action with the agreement of the HSE to prohibit or restrict the use of the supply (such as advice to boil water) in order to protect human health. It also describes the requirement, under a direction from the EPA if necessary, upon the WSA to prepare a programme of remedial action to bring a failing supply back into compliance and gives guidance on the actions for important parameters. Much of the guidance in this section is issued by the EPA pursuant to powers in the Regulations and is legally binding on the WSAs. This section also describes the process whereby WSAs can apply to the EPA for a departure from the standards – that is permission to carry on supplying non-compliant water whilst remedial action is being taken.

Section 7 provides guidance for WSAs on the handling of consumers' complaints about drinking water quality. Section 8 defines incidents and emergencies affecting drinking water quality and provides guidance to WSAs on the management of such events including the use of Drinking Water Incident Response Plans (DWIRPs).

Section 9 sets out the information on drinking water quality and other information about public water supplies that WSAs are required to provide annually to the EPA to enable the EPA to compile its Annual Report on Drinking Water Quality in Ireland.

The EPA has adopted a drinking water safety plan (DWSP) approach to ensuring drinking water is both "safe" and "secure". Section 10 provides guidance to WSAs on preparing DWSPs based on the approach adopted by the World Health Organisation (WHO). The appendix to this section provides comprehensive guidance as part of a DWSP on carrying out risk assessments for *Cryptosporidium*, an important water borne parasite which if present can cause outbreaks of Cryptosporidiosis.

It is vital to ensure that in ensuring drinking water quality that water treatment works and distribution networks are designed, operated and maintained properly. Sections 11 and 12 provide guidance on matters related to the operation of water treatment works and distribution networks including the importance of quality management systems and standard operating procedures and the training of operators.

Finally section 13 describes the EPA's audit policy in respect of WSAs and public water supplies and sets out the format of audits and the reporting mechanism.

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SECTION 1: THE 2007 REGULATIONS

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Section 1: The 2007 Regulations

Summary of Section 1

- Describes the requirements of the Regulations for public water supplies in terms of standards of wholesomeness, monitoring (sampling and analysis), protection of human health, investigations of failures and remedial action, record keeping and other matters.
- Sets out the duties and roles of the Water Service Authorities (WSAs) as the water suppliers.
- Sets out the duties and roles of the Environment Protection Agency (the EPA) as the supervisory authority.
- Sets out the role of the Health Service Executive (HSE) in protecting human health.

Contents of Section 1

1. Introduction and brief summary of the Regulations
2. Application of the Regulations
3. Role of the EPA as the Supervisory Authority
4. Duties of WSAs to supply wholesome water
5. Point of compliance with the standards
6. Monitoring of drinking water quality
7. Protection of human health
8. Investigation of failures and remedial action
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10. Enforcement by the EPA
11. Records to be maintained by WSAs and the EPA
12. Duties in relation to water on premises
13. Treatment, equipment and materials
14. Audit of WSAs by EPA
15. Offences, prosecutions and penalties

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1. Introduction and brief summary of the Regulations

1.1 Introduction

1.1.1 | The European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. 278 of 2007) (the Regulations) fully transpose and implement the EU Council Directive 98/83/EC on the quality of water intended for human consumption. These Regulations came into effect on 12 June 2007 when the previous Regulations were repealed.

1.1.2 | This section describes the requirements of the Regulations for public water supplies supplied by, or on behalf of, the Water Services Authorities (WSAs). While it paraphrases many of the provisions of the Regulations, it should be read in conjunction with the text of the Regulations. For ease of understanding, the sub-sections follow a logical order rather than following the order of the Regulations.

1.2 Brief summary of the Regulations

1.2.1 | Briefly the Regulations:

- define the water supplies covered and exempted;
- specify the Environment Protection Agency (the EPA) as the supervisory authority for WSAs in respect of public supplies;
- require WSAs to supply wholesome and clean water and define such water by reference to standards and other requirements;
- define the points at which the standards apply;
- require WSAs to monitor (sample and analyse) public supplies with their monitoring programmes subject to approval and enforcement by the EPA;
- require WSAs, in consultation, and agreement, with the Health Service Executive (the HSE), to take action to protect consumers whenever public water supplies are considered to be a risk to human health;
- require WSAs to investigate immediately failures to comply with the standards and other requirements and to prepare and implement action programmes to secure compliance which are enforceable by the EPA;

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- provide for the EPA, in consultation, and agreement, with the HSE, to grant departures from the some of the standards pending completion of action programmes;
- require WSAs to inform consumers of the remedial action taken;
- require the EPA to keep a register of each water supply supplied by WSAs;
- require WSAs to keep up-to-date records of the results of monitoring and make them available to the public;
- require WSAs to maintain records of any incidents of failures affecting their operations and to make the records available to the EPA;
- require WSAs to ensure that the efficiency of disinfection is verified, that concentrations of disinfection by-products are minimised without compromising disinfection and that substances and materials used in water supplies do not compromise human health;
- require the EPA to audit water supplies supplied by WSAs;
- a person authorised by the WSA or the EPA (may be a member of the WSA or EPA staff or from another organisation) may at all reasonable times enter any premises (the public water supply or premises served by the supply) for carrying out duties under the Regulations (such as sampling and investigation of failures);
- make it an offence for WSAs to fail to meet certain requirements (such as to comply with Directions from the EPA or to notify the EPA of incidents); and
- provide for prosecution of offences either summarily or on indictment.

1.3 General matters

1.3.1 | Regulation 1 cites that the Regulations are called 'the European Communities (Drinking Water) (No. 2) Regulations 2007' (S.I. 278 of 2007). Regulation 2 states that the Regulations come into immediate effect which means they applied from 12 June 2007. Regulation 3 defines and interprets various terms used in the Regulations.

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2. Application of the Regulations

2.1 Supplies covered

2.1.1 | The supplies covered by the Regulations are defined in regulation 3(1) by the meaning of the term 'water intended for human consumption'. Thus the Regulations apply to all public water supplies and many private water supplies as follows:

- public water supplies supplied by WSAs through a distribution network; and
- private water supplies including:
  - public group water schemes (PuGWS – where the treated water is provided by a WSA but the responsibility for distribution of the treated water to the users rests with a privately managed group scheme, such as a Management Committee or Board. These schemes usually take water from the larger public water supplies;
  - private group water schemes (PrGWS) – where the water is privately sourced, treated and distributed to the members (users) by a Management Committee or Board. Many of these schemes have their water treated under a Design, Build and Operate (DBO) contract arrangement;
  - individual private water supplies that supply 10 m^3/d or more on average (50 or more persons); and
- individual private water supplies that supply less than 10 m^3/d on average (less than 50 persons) and are part of a commercial or public activity, such as bed and breakfast establishments;
- water supplied from a tanker (or similar container) for example when the normal distributed supply is not available or prohibited (a do not drink water notice is in force); and
- all water used in food production (whether in manufacturing, processing, preserving or marketing) unless the EPA for public water supplies or WSAs for private water supplies is satisfied that the quality of that water cannot affect the wholesomeness of the foodstuff in its finished form (see paragraph 2.1.4).

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2.1.2 | **This handbook applies to all public water supplies supplied by WSAs and water supplied in tankers or similar containers by WSAs when the public water supply is not available from the distribution network or a do not drink water notice is in force.**

2.1.3 | **A similar 'Handbook on Implementation for Private Water Suppliers' applies to all the above private water supplies and water supplied in tankers or similar containers by private water suppliers when water is not available from a private supply or a do not drink water notice is in force.**

2.1.4 | The EPA is not aware of any public water supplies that supply water only to premises used in food production – the water is supplied to other premises for domestic purposes or as part of a public or commercial activity. Therefore the EPA has not made any recommendations on the exclusion of water supplies to food production undertakings on grounds that the quality of the water does not affect the wholesomeness of the foodstuff in its finished.

2.2 Supplies exempted

2.2.1 | The exempted supplies are defined in regulation 3(1) partly under the meaning of 'water intended for human consumption' and partly under the meaning of 'exempted supply'. Thus the following supplies are exempted from the provisions of the Regulations:

- natural mineral water as defined in the European Communities (Natural Mineral Waters, Spring Waters and Other Waters in Bottles or Containers Regulations 2007) (S.I. No. 225 of 2007);
- water, other than natural mineral water supplied in bottles or other similar containers (Natural Mineral Waters, Spring Waters and Other Waters in Bottles or Containers) Regulations 2007 (S.I. No. 225 of 2007);
- waters which are medicinal products (within the meaning of EU Council Directive 65/65/EEC of 26 January 1965);
- individual supplies of less than 10 m^3/d on average or serving fewer than 50 persons, provided that those supplies are not used in a commercial or public activity (such as a hotel or similar commercial outlet);

- supplies used solely for purposes in respect of which (in the view of the relevant supervisory authority) the quality of the water could have no influence whatsoever on the health of consumers; and

- supplies used in food production (whether in manufacturing, processing, preserving or marketing) which the EPA for public water supplies or WSAs for private water supplies is satisfied that the quality of that water cannot affect the wholesomeness of the foodstuff in its finished form.

2.2.2 | For the exempted supplies specified in the last three bullets of 2.2.1, the Regulations require WSAs to notify those supplied that the Regulations do not apply. WSAs must also indicate to those consumers the action that can be taken to protect their health from the adverse effects of any contamination of the supply. And when a potential danger to human health comes to light from an exempted supply, the relevant WSA must provide appropriate advice promptly to the consumers of that supply.

3. Role of the EPA as the Supervisory Authority

3.2.1 | Under regulation 3(1) the EPA is defined as the supervisory authority for all public water supplies supplied by WSAs. Thus the EPA is responsible for enforcement of compliance by WSAs with the monitoring provisions, the standards for drinking water quality and other requirements of the Regulations. The Regulations specifically provide for the EPA:

- to verify compliance of water supplied by WSAs with the standards (tables A and B of part 1 of the schedule) and indicator parameter values (table C of part 1 of the schedule) specified in the Regulations (regulation 7(1));

- to review WSAs monitoring programmes (regulation 7(5)(b)), to direct WSAs to amend their monitoring programmes (regulation 7(6)), to issue guidelines on the manner, frequency and method of monitoring (regulation 7(11)) and apply to the High Court for an order when a WSA has failed to comply with a Direction on monitoring (regulation 7(15));

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- to direct WSAs to keep such records as it may specify on the management, treatment, monitoring and remedial action in relation to public water supplies (regulation 8(1)), to maintain a register of all supplies made by WSAs (regulation 8(3)) and to require WSAs to provide specified information to enable it to maintain the register (regulation 8(5));

- to issue guidelines to assist WSAs to fulfil their obligations about protecting human health when there is potential danger to health (regulation 9(5));

- to issue guidelines for WSAs to notify it of any failures to meet the standards and indicator parameter values (regulation 10(2)) and on the nature and timing of remedial and enforcement action (regulation 10(8)), to ensure that remedial action is taken by WSAs to restore the quality of water and issue Directions for that purpose (regulation 10(4)(a)), to amend and approve remedial action programmes submitted to it by WSAs (regulation 10(4)(c)) and to consider (in consultation and agreement with the HSE) whether any failure of an indicator parameter value is a risk to human health and if so to require the WSA to submit a remedial action programme (regulation 10(5)). **In practice the WSA consults the HSE under regulation 10(5) and if the HSE agrees that there is a risk to human health, the WSA informs the EPA**. If EPA requires further advice it will consult the HSE directly;

- with the agreement of the HSE, to grant (regulation 11(1)) and review (regulation 11(4)(d)) departures from the standards on applications by WSAs and to specify the information to be included in the applications (regulation 11(3));

- to issue such directions to WSAs as it considers necessary to achieve compliance with the standards and indicator parameter values and if a WSA fails to comply to carry out, or arrange to carry out, any action needed to comply and to recover the costs from the WSA (regulation 12);

- to direct WSAs to undertake specific measures to comply with the requirement on the quality of treatment (including disinfection), equipment and materials (regulation 13(3));

- to give such directions to WSAs as it considers appropriate for its function under the Regulations (regulation 16(1));

- to undertake an audit of water supplies to ensure that the Regulations are complied with by WSAs (regulation 17(1));
- to apply to the High Court for an order when a person fails to comply with a direction issued by it or fails to comply with a requirement of the Regulations (regulation 18(1)); and
- to take a prosecution against a WSA for any of the summary offences specified in the Regulations (regulation 22(1)).

4. Duties of WSAs to supply wholesome water

4.1 | Regulation 4 requires WSAs to ensure that their water supplies are wholesome and clean, and that it meets the requirements of the Regulations. Water that is "wholesome and clean" is defined as water which:

- is free from any micro-organisms and parasites and from any substances which in numbers or concentrations, constitute a potential danger to human health; and
- meets the quality standards specified in Tables A (microbiological) and B (chemical) in part 1 of the schedule to the Regulations.

4.2 | The indicator parameter values in Table C of part 1 of the schedule to the Regulations are not part of the definition of a wholesome and clean water. However if there is a breach of one of these values, the EPA is required to consider whether the breach poses a risk to human health and if it does to require the relevant WSA to take action to restore the quality of water (regulation 10(5)). In practice, the WSA will consult the HSE and inform the EPA if the HSE agrees that there is a risk to human health.

4.3 | Under regulation 6(1), a WSA is not in breach of its obligations under the Regulations where any non-compliance with the standards or indicator parameter values is due to the domestic distribution system in premises or the maintenance of that system (see paragraph 12 of this section).

4.4 | WSAs determine whether their water supplies are wholesome by carrying out the monitoring (sampling and analysis) required by regulation 7 and parts 2 and 3 of the schedule to the Regulations (see paragraph 6 of this section). Where this monitoring shows that a water supply does not meet the requirements and standards in paragraph

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4.1 and the values in paragraph 4.2, the WSA is required to investigate the failure to determine the cause and to take appropriate remedial action (see paragraph 8 of this Section). When a failure is considered to be a potential danger to human health, the WSA is required, in agreement with the HSE, to take action to protect consumers (see paragraph 7 of this section). WSAs are also required to keep records of all their supplies including the results of monitoring to determine compliance with the standards, the results of investigation of failures and details of remedial action taken.

4.5 | WSAs in taking measures under the Regulations must ensure that there is no deterioration in the existing quality of water supplies so far as that is relevant for the protection of human health or an increase in the pollution of waters used in the production of water supplies (regulation 15).

4.6 | Where a public water supply is made within the functional areas of two or more WSAs, the WSAs concerned may agree that one of the WSAs shall perform the functions required by the Regulations in respect of that public water supply (regulation 7(3)(a)). It would be reasonable for the WSA with the largest part of the public water supply in its area or the WSA that owns the water treatment works to agree to perform these functions. The Minister at the Department of Environment Heritage and Local Government (DoEHLG) may direct those WSAs to nominate a WSA to perform these functions and if those WSAs fail to comply the Minister may direct one of the WSAs to perform these functions (regulation 7(3)(b)). It is likely that the Minister will only use these powers when the WSAs fail to agree amongst themselves which WSA shall perform the functions.

5. Point of compliance with the standards

5.1 | The standards and other requirements of wholesomeness in paragraph 4.1 and the indicator parameter values in paragraph 4.2 are required to be met as follows:

- at the taps normally used for human consumption (such as kitchen taps – consumers' taps) in the case of water supplied by WSAs through a distribution network;
- at the point where it emerges from a tanker or similar container provided by a WSA when the normal distributed supply is not available or is prohibited; and
- at the point where water is used in a food undertaking.

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5.2 | WSAs are required to monitor compliance with the standards and other requirements by taking and analysing samples from consumers' taps in premises in the distribution network. However, WSAs may take samples from other points within the distribution network (such as service reservoirs) or from treatment works for particular parameters if WSAs can demonstrate that there will be no adverse change in the concentrations or values of those parameters between those points and consumers' taps.

6. Monitoring of drinking water quality

6.1 Role of WSAs

6.1.1 | Each WSA is required under regulation 7(2) to monitor all its supplies to determine whether they comply with the standards and other requirements of the Regulations. To achieve this each WSA is required by regulation 7(5) to establish an annual monitoring programme that accords with the detailed provisions (frequency and parameters for check and audit monitoring) in part 2 of the schedule to the Regulations and which specifies the points at which samples will be taken for analysis. The DoEHLG has already issued each WSA with an interactive database under the Drinking Water National Monitoring Programme (DWNMP) which enables WSAs to generate the monitoring programmes. Each WSA is also required to carry out on a case by case basis under regulation 7(10) additional monitoring for substances and micro-organisms for which no standard is set in the Regulations, but where there is reason to suspect that they may be present and they may pose a potential danger to human health (these could include for example *Cryptosporidium*, uranium, molybdenum).

6.1.2 | Regulation 7(3) deals with the situation where a water supply provided by a WSA straddles the areas of one or more WSAs. In this situation those WSAs may decide that one of them shall carry out the monitoring function for that supply. The Minister of DoEHLG has the power to direct one of the WSAs to carry out the monitoring function for that supply.

6.1.3 | Each WSA has to ensure that the samples it takes are representative of the quality of drinking water consumed throughout the year and are equally distributed through the supply (regulation 7(7)). It also has to ensure (regulation 7(8)) that it

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complies with the specifications for the analysis of parameters specified in part 3 of the schedule to the Regulations. Detailed advice on analysis is provided in section 5 of this handbook.

6.2 Role of the EPA

6.2.1 | Regulation 7(1) requires the EPA to verify that WSAs comply with the standards in the Regulations and regulation 7(12) requires the EPA to supervise the performance of WSAs in respect of their monitoring functions and permits the EPA to issue directions if necessary. Each WSA is required to submit its monitoring programme to the EPA whenever EPA directs it to do so (regulation 7(5)). The EPA may issue a legally binding direction (regulation 7(6)) to a WSA requiring it to amend its monitoring programme. The EPA may also issue guidelines under regulation 7(11) on various matters relating to monitoring and it has done so in Section 3 of this handbook. A WSA must comply with directions from the EPA and it commits an offence if it fails to comply (Regulations 7(13) and (14). When there is such a failure, the EPA may apply to the High Court for an order (Regulations 7(15) and 18(1) and it may bring a prosecution under regulation 22(1).

7. Protection of human health

7.1 | Regulation 9 provides that where a supply of water is considered to be a risk to human health a WSA must take follow-up action in consultation, and agreement, with the HSE. The Regulation obliges a WSA, subject to the agreement of the HSE, to ensure that use of the relevant supply is prohibited or restricted, that consumers are informed promptly and given any necessary advice and that the EPA is notified promptly. Therefore each WSA must establish, and keep under review, appropriate contact arrangements with the HSE and the EPA regarding the protection of human health. In addition when there is or could be a risk to human health (including inefficiency of disinfection), the EPA, subject to agreement with the HSE, must as it considers necessary, issue a legally binding direction to a WSA requiring it to take measures necessary to prevent, limit, eliminate or abate the risk. Further guidance from the EPA in relation to regulation 9(5) on the protection of human health is given in section 6 of this handbook.

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8. Investigation of failures and remedial action

8.1 | Regulation 10(1) requires each WSA to ensure that each non-compliance with quality standards and indicator parameter values in the Regulations is immediately investigated to determine the cause of the failure. This investigation should establish whether the non-compliance was due to the domestic distribution system or the maintenance of that system (see paragraph 12 of this section). Regulation 10(2) requires a WSA to inform the EPA as soon as it discovers a non-compliance (whether through routine monitoring or otherwise) in accordance with any guidelines issues by the EPA (see section 6 of this handbook). Failure to notify the EPA is an offence under regulation 10(3).

8.2 | Regulation 10(4) specifies the intervention necessary for the purposes of remedial action. The EPA is required to ensure that remedial action is taken by the relevant WSA as soon as possible. However, the EPA must prioritise its interventions having regard to the extent to which the standards have been breached and human health put at risk. Regulation 10(4)(c) requires that within 14 days of receiving notification of a breach of a standard (not an indicator parameter value), the EPA must, subject to any departures in force (see paragraph 9 of this section), ensure that the WSA:

- takes the necessary remedial action to restore water quality and secure compliance with the standards in the Regulations; **the EPA may issue a direction if it considers it necessary**,
- prepare and submit a remedial action programme to the EPA for approval within 60 days, and
- implement it as soon as possible but not later than:
    - one year from the date of its approval by the EPA in relation to quality standards specified in Tables A (microbiological) and B (chemical) in part 1 of the schedule to the Regulations where a risk to human health arises; or
    - two years from the date of its approval by the EPA in relation to quality standards specified in Table B (chemical) in part 1 of the schedule to the Regulations, where a risk to human health does not arise.

8.3 | When there is a breach of an indicator parameter value, the EPA must consider whether the breach poses a risk to human heath. The EPA must consult the HSE in making this assessment. **In practice the WSA consults the HSE under regulation**

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10(5) and if the HSE agrees that there is a risk to human health, the WSA informs the EPA. If a risk to human health exists the EPA must, as it considers necessary, require the relevant WSA to take remedial action to restore water quality and to submit and implement a remedial action programme within the time frame specified in paragraph 8.2.

8.4 | Under regulation 10(6), the EPA may amend a WSA's action programme and under regulation 10(7), the programme must include such interim measures as are appropriate taking into account any strategic water supply plan of the WSA. Regulation 10(8) provides for the EPA to issue guidelines about the nature and timing of remedial, enforcement and other relevant action under this regulation. WSAs are obliged under regulation 10(9) to inform consumers about the remedial action, unless the EPA considers the breach to be trivial in nature and extent. It is unlikely that the EPA will issue a direction regarding remedial action when the EPA regards a breach to be trivial.

8.5 | WSAs are required to maintain, and make available on request to the EPA, a record of each incidence of failure to meet the standards and indicator parameter values which includes details of (Regulations 10(10) and (11)):

- the date of the incident;
- the extent and duration of the failure;
- the cause of the failure; and
- any complaint received arising from the failure.

8.6 | Regulation 10(12) makes it an offence for a WSA to fail to:

- comply with a direction from the EPA under regulation 10(4);
- inform consumers in accordance with regulation 10(9);
- maintain records for the purposes of regulation 10(10); and
- make a record available to the EPA on request under regulation 10(11).

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9. Departures from the standards

9.1 | Regulation 11 provides for departures from the standards in table B (chemical parameters) in part 1 of the schedule to the Regulations. A departure is permission for a WSA to continue supplying water which breaches a standard whilst remedial action is being taken. The EPA may grant a departure on application by a WSA up to a maximum value determined by the EPA, and subject to agreement with the HSE, provided that the departure does not constitute a potential danger to human health and the water supply to the area cannot be maintained by other reasonable means.

9.2 | Regulation 11(3) specifies that the application for a departure shall contain the information specified by the EPA (see section 6 of this handbook). Regulation 11(4) requires that a departure granted by the EPA shall:

- be subject to such conditions as may be specified by the EPA;
- be for as short a period of time as possible and not exceed 3 years;
- specify the matters set out in part 4 of the schedule to the Regulations, unless the EPA has determined that the non-compliance is trivial and the remedial action is completed within 30 days (but not if the failure occurred on more than 30 days during the previous 12 months); and
- be reviewed by the EPA before the end of the period to determine whether sufficient progress has been made.

9.3 | Regulations 11(6) and (7) provide for the EPA under specified circumstances and conditions to grant second and third departures each for a period not exceeding three years. Regulation 11(8) requires the EPA to notify the granting of all departures involving supplies exceeding 1,000 m^3/d (more than 5,000 people) to the Minister at the DoEHLG, who in turn has to notify the European Commission.

9.4 | Regulation 11(9) requires a WSA which is granted a departure (other than one for a trivial breach) to:

- promptly inform the population supplied of the departure and its conditions; and

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- advise particular population groups for which the departure could present a special risk (for example for a departure from the nitrate standard, advising mothers bottle feeding infants to use low nitrate bottled water instead of the water supply because of the risk of methaemoglobinaemia).

10. Enforcement by the EPA

10.1 | In addition to the functions outlined previously the EPA now has significantly enhanced enforcement powers to ensure that WSAs comply with the requirements of the Regulations:

- regulation 16 enables the EPA to give legally binding directions to WSAs (the EPA issues directions to the County Manager or equivalent person in the WSA) as are appropriate for fulfilling its functions and failure to comply with a direction is a prosecutable offence under regulation 22;
- regulation 18 provides for the EPA to obtain injunctive relief in the High Court when a WSA has failed to comply with a direction or other requirement – in effect an order from the Court to the WSA to comply;
- regulation 19 provides for an authorised person from the EPA or a WSA to enter premises for the purpose of their functions under the Regulations and to bring on to the premises other persons and equipment to carry out such work as the authorised person considers necessary. Any person from the EPA entering premises of the WSA would need to comply with all health and safety measures and would not interfere with the safe operation of any plant and equipment at the premises;
- regulation 12 provides for intervention by the EPA, after consultation with a WSA to give such assistance or support to that WSA in order to achieve satisfactory compliance with the standards and other requirements of the Regulations. Regulation 12 (2) also provides for direct intervention by the EPA where a WSA fails to comply with a direction. It is likely that the EPA would only use this as a last resort where direct and urgent intervention is necessary in the interests of human health. If the EPA uses this power it can recover its costs from the WSA as a simple contract debt; and

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- regulation 13 enables the EPA to issue a legally binding direction to a WSA to ensure that the WSA undertakes specific measures in relation to the substances or materials used in the treatment or distribution of drinking water and also in relation to the efficiency of disinfection systems.

11. Records to be maintained by WSAs and the EPA

11.1 | Regulations 8(1) and 10(10) place specific **record keeping obligations on WSAs**. Regulation 8(1) provides for the EPA to direct a WSA to keep, and submit to the EPA, such records as the EPA may specify in relation to:

- the management and treatment of water supplies;
- the monitoring (sampling and analysis) of compliance with the standards and indicator parameter values specified in part 1 of the schedule to the Regulations. The WSA must maintain up to date records of the monitoring results for each of its water supplies under regulation 8(4);
- the corrective action, and the other information required by regulation 10(10), taken following a non-compliance with the standards and values in part 1 of the schedule to the Regulations;
    - the date of the incident of failure to comply;
    - the extent and duration of the failure;
    - the cause of the failure;
    - the remedial action taken; and
    - any complaint received arising from the failure; and
- verification of the efficiency of disinfection in accordance with regulation 13(2).

11.2 | Regulation 8(2) requires the EPA to carry out, or arrange to carry out, such monitoring as it considers necessary to verify the information in the WSA's record. Under regulation 8(3), **EPA is required to maintain a register of each water supply provided by each WSA** which must include as a minimum (the EPA can direct a WSA to provide the information):

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- the name and address of the WSA;
- the volume of water supplied in m^3/d (or population);
- the type of water treatment;
- the source of the water supply; and
- the supply code allocated under the DWNMP, or any subsequently allocated code.

The EPA is required to keep the register at its principal office for inspection by any person during office hours and to provide a copy of an entry in the register to a person for which it may charge the reasonable cost of that copy (Regulations 8(7) and (8). Regulation 8(9) enables this register to be in electronic form provided a person can obtain a legible copy from it.

11.3 | Each WSA is required to keep the record of its monitoring of public water supplies (and private water supplies) at its principal office for inspection by any person during office hours and to provide a copy of an entry in the record to a person for which it may make a reasonable charge. The Minister of the DoEHLG has issued guidelines under regulation (9) (Circular letter WSP 6/09) requesting **WSAs to start putting their monitoring results on their websites** from July 2009. Access to the information should be from a prominent position of the home page on the website and the information should be presented in a simple user friendly way with a minimum of technical language. The information should be put on the website within one month of the results being available from the laboratory except that when the result indicates a failure to meet a standard or indicator parameter that result should be put on the website as soon as possible after the HSE has confirmed whether or not there is a potential risk to human health.

12. Duties in relation to water on premises

12.1 | Under regulation 6(1), a WSA is not in breach of its obligations under Regulation 4(1) where any non-compliance with the standards or indicator parameter values is due to the domestic distribution system in premises or the maintenance of that system. It follows that when there is non-compliance in a sample taken from a consumer's tap, the WSA's investigation has to determine whether the failure was due to the quality of water supplied by the WSA or to the condition of the domestic distribution system.

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12.2 | The owner of a premises where the water is supplied as part of a commercial or public activity (including but not limited to schools, hospitals and restaurants) is required by regulation 6(2) to maintain the domestic distribution system within the premises so that its condition does not cause, or risk, a failure of a standard in tables A or B in part 1 of the schedule to the Regulations. Where there has been a failure, or risk of a failure, in such premises, the WSA shall ensure, by direction if necessary, that the owner (or WSA) takes appropriate action to (regulation 6(3)):

- immediately prevent or restrict the supply as the WSA deems appropriate until the system is restored. Before taking this action, the WSA must take into account the risk to health an interruption to supply may cause and it must consult, and agree the action, with the HSE; and
- restore the system to the standard necessary to comply with the standards and values.

It is an offence for the owner of premises to fail to comply with these requirements.

12.3 | Where a premises described in paragraph 12.2 is owned by a WSA, the WSA must inform promptly the EPA of the non-compliance and the action it proposes to take and it must inform the EPA when that action is complete. It is an offence for a WSA to fail to inform the EPA and the EPA is required to verify that the action has restored the system to the standard necessary to achieve compliance.

12.4 | Where the non-compliance, or risk of non-compliance is in premises where the water is not supplied as part of a commercial or public activity, the WSA must ensure under regulation 6(6) that:

- measures are taken to reduce or eliminate the risk, including advising the owners of any possible remedial action they can take; **or**
- other measures are taken to reduce or eliminate the risk of not complying after supply, such as appropriate treatment to change the nature or properties of the water before it is supplied; **and**
- the consumers are informed of these measures and advised of any possible additional remedial action they should take.

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12.5 | Regulation 19 provides for an authorised person from a WSA or the EPA to enter premises for the purpose of their functions under the Regulations and to bring on to the premises other persons and equipment to carry out such work as the authorised person considers necessary. A WSA may need to use this provision to enable it to comply with its duties under regulation 6.

13. Treatment, equipment and materials

13.1 | Regulation 13(1) requires each WSA to ensure that the substances and materials (and any impurities in them) used in the treatment or distribution of water at new installations do not remain in the water supplied in concentrations higher than necessary for their purpose of use and that they do not reduce the protection of health provided by the standards and other requirements of the Regulations.

13.2 | WSAs must ensure when disinfecting a water supply that the efficiency of disinfection is verified and that the concentrations of disinfection by-products (such as trihalomethanes) are kept as low as possible without compromising disinfection (regulation 13(2)).

13.3 | The EPA can direct WSAs to take specific measures on the above matters and it is an offence for a WSA to fail to comply with a direction (Regulations 13(3) and (4)).

14. Audit of WSAs by EPA

14.1 | Regulation 17(1) requires the EPA to audit the water supplies made by WSAs to ensure that the provisions of the Regulations (standards, monitoring, investigations and remedial action etc) are met by WSAs.

15. Offences, prosecutions and penalties

15.1 Offences

15.1.1 | A WSA commits an offence under the Regulations if it fails to:

- inform the EPA of a non-compliance caused by the domestic distribution system in premises owned by the WSA (regulation 6(4)(b));

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- comply with a direction from the EPA regarding its monitoring functions (regulation 7(14));
- comply with a direction from the EPA regarding its record keeping (regulation 8(6));
- comply with a direction from the EPA regarding the protection of human health (regulation 9(6));
- fails to inform the EPA of a public water supply that constitutes a potential danger to human health (regulation 9(7));
- inform the EPA of a failure to meet the standards or values in tables A, B and C of part 1 of the schedule to the Regulations (regulation 10(3)) in accordance with the guidance in Section 6 of this handbook;
- comply with a direction from the EPA regarding an action programme (regulation 10(12(a));
- inform consumers of the remedial action taken (regulation 10(12(b)). It is unlikely that the EPA will issue a direction regarding remedial action when the EPA regards a breach to be trivial;
- maintain records of each incidence of failure to meet the standards or values in part 1 of the schedule to the Regulations (regulation 10(12(c));
- make the record of such a failure available to the EPA on request (regulation 10(12)(d));
- comply with a direction from the EPA regarding the use of substances and materials and the efficiency of disinfection (regulation 13(4)); and
- notify the population that they are served by an exempted (unregulated) supply and give them appropriate advice (regulation 14(4)).

15.1.2 | A person commits an offence under the Regulations if the person:

- fails to comply with a direction from the EPA about any matter the EPA considers appropriate (regulation 16(2)).

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- contravenes the requirement to maintain the domestic distribution system within premises in a satisfactory condition (regulation 6(7)(a));
- fails to comply with a direction from a WSA regarding the domestic distribution system within premises (regulation 6(7)(b)); and
- fails to allow an authorised person to enter premises, obstructs or impedes, gives false or misleading information to or fails to comply with a direction issued by an authorised person (regulation 19(3)).

15.2 Prosecutions and penalties

15.2.1 | Regulation 22(1) permits the EPA to bring a prosecution against a WSA or a person who has committed a summary offence under the Regulations. A person who commits an offence under the Regulations is liable to:

- on summary conviction, to a fine not exceeding 5,000 Euros, or imprisonment for a term not exceeding 3 months, or both; or
- on conviction on indictment, to a fine not exceeding 500,000 Euros, or imprisonment for a term not exceeding 3 years, or both.

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SECTION 2: STANDARDS FOR DRINKING WATER QUALITY

2

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Section 2: Standards for drinking water quality

Summary of Section 2

- Describes the standards of wholesomeness that public water supplies provided by Water Services Authorities (WSAs) are required to meet. If there is a failure to meet a standard, the WSA is required to take remedial action to ensure compliance with the standard.

- Describes the indicator parameter values and the actions that are necessary where there has been a failure to meet one of the indicator parameter values.

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1. Introduction

1.1 | Regulation 4 requires Water Service Authorities (WSAs) to ensure that their water supplies are wholesome and clean, and that they meet the requirements of the Regulations. Water that is "wholesome and clean" is defined as water which:

- is free from any micro-organisms and parasites and from any substances which in numbers or concentrations, constitute a potential danger to human health; and

- meets the quality standards specified in Tables A (microbiological) and B (chemical) in part 1 of the schedule to the Regulations.

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1.2 | The indicator parameter values in Table C of part 1 of the schedule to the Regulations are not part of the definition of a wholesome and clean water. However if there is a breach of one of these values, the Environment Protection Agency (the EPA) is required to consider, in consultation and agreement with the Health Service Executive (the HSE), whether the breach poses a risk to human health and if it does the EPA can require the relevant WSA to take action to restore the quality of water. In practice the WSA consults the HSE and if the HSE agrees that there is a risk to human health, the WSA informs the EPA and the EPA then requires the WSA to take action.

1.3 | The quality standards and indicator parameter values are collectively referred to as parameter values in the Regulations.

2. Parameter categories

2.1 Introduction

2.1.1 | The Regulations define three categories of parameters. These are **microbiological** parameters, **chemical** parameters and **indicator** parameters. The **indicator** parameters include some **microbiological** and **chemical** parameters and two parameters under the heading **radioactivity**. The main difference between the first two categories and the third is related to the actions that are necessary following non-compliance with the specified parametric values. Where there is non-compliance with a microbiological or chemical parameter the WSA is required to take remedial action to bring the water supply into compliance. Where there is non-compliance with an indicator parametric value the supervisory authority (the EPA) must determine, in consultation and agreement with the HSE, whether the non-compliance poses a risk to human health and if it does it may require, by means of a direction, the WSA to take remedial action to restore the quality of water. Where the EPA is satisfied that there is no risk to human health, the WSA may not be required to take remedial action. In practice the WSA consults the HSE and if the HSE agrees that there is a risk to human health, the WSA informs the EPA and then the EPA requires the WSA to take action. If the EPA requires further advice it will consult HSE directly.

2.2 Microbiological parameters

2.2.1 | The microbiological parameters and their standards in table A of the schedule to the Regulations are shown in table 2.1 below.

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Table 2.1: microbiological parameters

Parameter number	Parameter	Parameter value (number/100ml)
1	*Escherichia coli* (*E. coli*)	0
2	Enterococci	0

2.2.2 | The parameter *E. coli* is of paramount importance for the assessment of the microbiological quality of drinking water. It has been used for many years as an indicator of contamination by faecal matter. Properly treated and disinfected water will not contain *E. coli*. If *E. coli* is detected in treated or distributed water, there is a potential risk to human health. The cause of the presence of *E. coli* must be investigated immediately and remedial action must be taken promptly. The enterococci parameter comprises another group of faecal indicator organisms and its determination complements and supplements that of *E. coli*.

2.3 Chemical parameters

2.3.1 | These form the largest group of parameters in the Regulations. The parameters range from specific substances such as individual metals, individual organic compounds to generic substances such as pesticides and the disinfection by-products, trihalomethanes. The parameters and their parametric values in table B of the schedule are further defined by reference to the notes associated with the table. For example for the generic substances the notes specify the individual substances to be included within the generic parameter.

2.3.2 | Table 2.2 sets out the chemical parameters, their parametric values and measurement units and the comments as in the Regulations, but omitting some standards that are no longer applicable because a more stringent standard is now in force. The notes in the schedule are reproduced in italics after the table and where necessary are amplified in normal type to provide further explanation. Some additional explanatory notes are indicated by a superscript applied to the parameter name.

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Table 2.2: chemical parameters

Parameter number	Parameter	Parametric value	Units	Comments
3	Acrylamide	0.10	µg/l	Note 1
4	Antimony	5.0	µg/l	
5	Arsenic	10	µg/l	
6	Benzene	1.0	µg/l	
7	Benzo(a)pyrene	0.010	µg/l	
8	Boron	1.0	mg/l	
9	Bromate[1]	10	µg/l	
10	Cadmium	5.0	µg/l	
11	Chromium	50	µg/l	
12	Copper	2.0	mg/l	Note 2
13	Cyanide	50	µg/l	
14	1,2-Dichloroethane	3.0	µg/l	
15	Epichlorohydrin	0.10	µg/l	Note 1
16	Fluoride[2] (a) fluoridated supplies (b) supplies with naturally occurring fluoride, not needing further fluoridation	 0.8 1.5	mg/l	
17	Lead Until 24 December 2013 From 25 December 2013	 25 10	 µg/l µg/l	Notes 2 and 3
18	Mercury	1.0	µg/l	
19	Nickel	20	µg/l	Note 2
20	Nitrate	50	mg/l	Note 4
21	Nitrite	0.50	mg/l	Note 4
22	Pesticides	0.10	µg/l	Notes 5 and 6
23	Pesticides – Total	0.50	µg/l	Notes 5 and 7
24	Polycyclic aromatic hydrocarbons	0.1	µg/l	Sum of concentrations of specified compounds; Note 8
25	Selenium	10	µg/l	

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Parameter number	Parameter	Parametric value	Units	Comments
26	Tetrachloroethene and Trichloroethene	10	μg/l	Sum of concentrations of specified parameters
27	Trihalomethanes – Total	100	μg/l	Sum of concentrations of specified compounds; Note 9
28	Vinyl chloride	0.50	μg/l	Note 1

Note 1: **acrylamide, epichlorohydrin and vinyl chloride**. *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.*

Acrylamide is the unit chemical (monomer) from which polyacrylamides, used as coagulant aids in drinking water treatment, are prepared. If polyacrylamides are used in the treatment process it is essential that the amount of acrylamide monomer in the product is determined. This will be available from the manufacturer but it should also be checked independently on a regular basis by the WSA. This figure is used with the dosage of polyacrylamide to calculate the maximum concentration of acrylamide monomer that could be present in the treated water if none is removed in the waterworks sludge. Direct measurement of acrylamide monomer in treated drinking water is only practical in specialist laboratories and should not be carried out by WSAs unless a routinely practical method becomes available. Additional acrylamide monomer may be present in the treated water when polyacrylamides are used in the waterworks sludge treatment and the supernatant is returned to works inlet. If this is the case a similar calculation will be necessary. WSAs using polyacrylamides should only use those products that have been approved (for example by the Drinking Water Inspectorate (the DWI) of England and Wales or other equivalent European approval scheme). WSAs should have regard to the CEN Report IS CR 14269:2001: Chemicals Used for the Treatment of Water Intended for Human Consumption – Guidelines for the Purchase.

Epichlorohydrin is one of the unit chemicals from which the polyamines, used as coagulants and coagulant aids in drinking water treatment, are prepared. Similar information and a similar calculation are needed as for acrylamide. WSAs using polyamines should only use those products that have been approved (for example by the DWI or other equivalent European approval scheme). WSAs should have regard to the CEN Report IS CR 14269:2001: Chemicals Used for the Treatment of Water Intended for Human Consumption – Guidelines for the Purchase. Epichlorohydrin is also one of the unit chemicals used to prepare epoxy resins that can be used to line the internal surfaces of service reservoirs, water towers and distribution mains. WSAs using epoxy resins should only use those products that have been approved (for example by the DWI or other equivalent European approval scheme) because they will meet the requirements of the Regulations.

Vinyl chloride is the unit chemical used to make unplasticised polyvinyl chloride (uPVC) pipes used for distribution mains. WSAs using uPVC should only use those products that have been approved (for example by the DWI or other equivalent European approval scheme) because they will meet the requirements of the Regulations.

*Note 2***: copper, lead and nickel**. *The value applies to a sample of water intended for human consumption obtained by an adequate sampling method at the tap and taken so as to be representative of a weekly average value ingested by consumers and that takes account of the occurrence of peak levels that may cause adverse effects on human health.* Section 4, paragraph 4.3 describes in more detail the recommended sampling method for these parameters and particularly for lead.

*Note 3***: lead**. The lead standard is 25 µg/l until the end of 24 December 2013. From the start of 25 December 2013 the new standard of 10 µg/l must be met. *All appropriate measures shall be taken to reduce the concentration of lead in water intended for human consumption as much as possible during the period needed to achieve compliance with the parametric value. When implementing the measures priority shall be progressively given to achieve compliance with that value where lead concentrations in water intended for human consumption are highest*. Section 6, subsection 5, paragraphs 5.3.9 to 5.3.13 describe the actions WSAs are required to take to meet the new lead standard.

*Note 4***: nitrate and nitrite**. *Compliance must be ensured with the conditions that [nitrate]/50 + [nitrite]/3 ≤ 1, the square brackets signifying concentrations in mg/l for nitrate (NO3) and nitrite (NO2), and the value of 0.10 mg/l for nitrite ex water treatment works*. The combined standard for nitrate and nitrite is important when chloramination is used as the disinfection method.

*Note 5***: pesticides**. Only those pesticides which are likely to be present in a given supply require to be monitored. “Pesticides” means:

– organic insecticides,
– organic herbicides,
– organic fungicides,
– organic nematocides,
– organic acaricides,
– organic algicides,
– organic rodenticides,
– organic slimicides,
– related products [inter alia, growth regulators]
and their relevant metabolites, degradation and reaction products.

Section 4, paragraph 4.2 gives detailed advice to WSAs on how to decide which pesticides are likely to be present in water supplies, what constitutes relevant metabolites, degradation and reaction products and therefore which pesticides need to be included in their compliance monitoring programme.

Note 6: **pesticides**. *The parametric value applies to each individual pesticide. In the case of aldrin, dieldrin, heptachlor and heptachlor epoxide the parametric value is 0.030 mg/l.*

Note 7: **total pesticides**. *"Pesticides – Total" means the sum of all individual pesticides detected and quantified in the course of the monitoring procedure*. Any pesticide included in the compliance monitoring programme that was not detected, that is its concentration was between 0.0 µg/l and the limit of detection of the method used, is assumed not to be present and to make no contribution to the total pesticides concentration.

Note 8: **polycyclic aromatic hydrocarbons**. *The specified compounds are:*

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

Thus the polycyclic aromatic hydrocarbons (PAH) parameter refers to the sum of the detected and quantified concentrations of the specified individual PAH calculated in a similar manner to the total pesticides parameter. WSAs should note that there is a separate standard for another individual PAH, benzo(a)pyrene, of 0.01 µg/l as it is the most toxic of the PAHs found in drinking water. The usual source of PAH in drinking water is from the degradation of the internal lining of coal tar pitch applied to some of the older cast iron distribution mains.

Note 9: **trihalomethanes**. For the "trihalomethanes – total" parameter – the *specified compounds are chloroform, bromoform, dibromochloromethane and bromodichloromethane*. Thus the total trihalomethanes (THMs) parameter refers to the sum of the detected and quantified concentrations of the specified individual THMs calculated in a similar manner to the total pesticides parameter. The following part of the note in the schedule to the Regulations is now irrelevant because WSAs were required to meet the standard for total THMs of 100 μg/l by the start of 25 December 2008. *All appropriate measures must be taken to reduce the concentration of THMs in water intended for human consumption as much as possible during the period needed to achieve compliance with the parametric value. When implementing the measures to achieve this value, priority must progressively be given to those areas where THM concentrations in water intended for human consumption are highest*

[1]**Bromate.** This is a disinfection by-product that occurs when waters containing bromide are treated with strong oxidants such are ozone. Bromate is also present in sodium hypochlorite solutions that are often used to disinfect drinking water supplies.

[2]**Fluoride.** The standard for fluoride for those water supplies that are fluoridated is 0.8 mg/l. For supplies that are not fluoridated, that is containing only naturally occurring fluoride, the standard is 1.5 mg/l.

2.4 Indicator parameters

2.4.1 | The indicator parameters are a mixture of microbiological, chemical and radiological parameters and parameters covering other characteristics of drinking water supplies. A failure to meet an indicator parameter value does not necessarily mean that there is a human health risk from the supply. A failure is a signal that there may be a problem with the supply that needs investigation and consideration of whether there is a human health risk. For example a failure to meet the aluminium indicator parameter value could be a signal that the coagulation and filtration treatment plant is not being operated effectively or the detection of coliform bacteria could be a signal that the water supply has become contaminated. Any failure to meet an indicator parameter must be investigated by the WSA to determine the cause but the EPA is only required to take enforcement action against the WSA requiring the WSA to take remedial action

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when the EPA, in consultation and agreement with the HSE, decides that there is a risk to human health. In practice the WSA consults the HSE under regulation 10(9) and if the HSE agrees that there is a risk to human health, the WSA informs the EPA. This decision on the risk to human health takes into account the nature of the parameter and the extent and duration of the failure and whether other indicator parameters fail in the same supply. Many of the indicator parameters describe the aesthetic quality of water supplies – the characteristics of drinking water that are noticed by consumers because of its appearance, taste or smell.

2.4.2 | Table 2.3 sets out the indicator parameters except for radiological parameters, their parametric values and measurement units and the comments as in the Regulations. The radiological parameters are set out similarly in table 2.4. The notes in the schedule are reproduced in italics after the tables and where necessary are amplified in normal type to provide further explanation. Some additional explanatory notes are indicated by a superscript applied to the parameter name.

Table 2.3: indicator parameters (excluding radiological parameters)

Parameter number	Parameter	Parametric value	Units	Comments
29	Aluminium	200	μg/l	
30	Ammonium	0.30	mg/l	
31	Chloride	250	mg/l	Note 1
32	*Clostridium perfringens* (including spores)	0	Number/100ml	Note 2
33	Colour[1]	Acceptable to consumers and no abnormal change		
34	Conductivity	2500	$\mu S\ cm^{-1}$ at 20°C	Note 1
35	Hydrogen ion concentration	≥6.5 and ≤ 9.5	pH units	Note 1
36	Iron	200	μg/l	
37	Manganese	50	μg/l	
38	Odour[1]	Acceptable to consumers and no abnormal change		
39	Oxidisability	5.0	mg/l O_2	Note 3
40	Sulphate	250	mg/l	Note 1
41	Sodium	200	mg/l	

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Parameter number	Parameter	Parametric value	Units	Comments
42	Taste[1]	Acceptable to consumers and no abnormal change		
43	Colony count 22°C[2]	No abnormal change		
44	Coliform bacteria	0	Number/100 ml	
45	Total organic carbon [TOC][2]	No abnormal change		Note 4
46	Turbidity[1]	Acceptable to consumers and no abnormal change		Note 5

Note 1: **chloride, conductivity, pH value and sulphate**. *The water should not be* aggressive. The values of these parameters should be such that the water does not corrode the tanks and pipes at the treatment works and in the distribution network.

Note 2: **clostridium perfringens (including spores)**. *This parameter need not be measured unless the water originates from or is influenced by surface water. 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, e.g. Cryptosporidium.*

Note 3: **oxidisability**. *This parameter need not be measured if the parameter TOC is analysed.* The EPA recommends that TOC is measured rather than oxidisability in all water supplies as it is a more useful parameter and easier to determine.

Note 4: **total organic carbon (TOC)**. *This parameter need not be measured for supplies of less than 10,000 m3 a day.* The EPA recommends that TOC is measured rather than oxidisability in all water supplies as it is a more useful parameter and easier to determine.

Note 5: **turbidity**. *In the case of surface water treatment, a parametric value not exceeding 1.0 NTU (nephelometric turbidity units) in the water ex treatment works must be strived for.* If the turbidity exceeds 1.0 NTU in the water leaving a treatment works that is a strong indication that the coagulation and filtration process is not working efficiently and there could be harmful micro-organisms, such as *Cryptosporidium*, in the supply.

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1 **Colour, odour, taste and turbidity**. The requirement for these parameters is that they should be acceptable to consumers and no abnormal change. Acceptable to consumers means that consumers are not rejecting the water for drinking, cooking etc because of its taste, smell or appearance. No abnormal change means that there is no significant variation in the value for the parameter compared to the value normally expected in that supply.

2 **Colony counts at 22˚C and TOC**. The requirement for these parameters is that there is no abnormal change. This means that there is no significant variation in the value for the parameter compared to the value normally expected in that supply.

Table 2.4: radiological parameters

Parameter number	Parameter	Parametric value	Units	Comments
47	Tritium	100	Bq/l	Notes 6 and 8
48	Total indicative dose	0.10	mSv/year	Notes 7 and 8

Note 6: **tritium**. *Monitoring frequencies to be set at a later date in Part 2 of the Schedule*. The Department of Environment, Heritage and Local Government (DoEHLG) has not modified part 2 to include monitoring frequencies for tritium. Meanwhile guidance on monitoring for tritium is given in section 4, sub-section 4.4.

Note 7: **total indicative dose**. *Excluding tritium, potassium-40, radon and radon decay products; monitoring frequencies, monitoring methods and the most relevant locations for monitoring points to be set at a later date in Part 2 of the Schedule*. DoEHLG has not modified part 2 to include monitoring locations for total indicative dose. Meanwhile guidance on monitoring for total indicative dose is given in section 4, sub-section 4.4.

Note 8: **tritium and total indicative dose**. *(A) The proposals required by Note 6 on monitoring frequencies, and in Note 7 on monitoring frequencies, monitoring methods and the most relevant locations for monitoring points in Part 2 of the Schedule shall be adopted in accordance with the Committee procedure laid down in Article 12 of Council Directive 98/83/EEC. (B) Drinking water need not be monitored for tritium or radioactivity to establish total indicative dose where, on the basis of other monitoring carried out, the levels of tritium or the calculated total indicative dose are well below* *the parametric value*. The European Commission has not yet promulgated requirements on monitoring for these parameters. Meanwhile guidance on monitoring for these parameters is given in section 4, sub-section 4.4.

SECTION 3: MONITORING OF DRINKING WATER QUALITY

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Section 3: Monitoring of drinking water quality

Summary of Section 3

- Describes the difference between "compliance monitoring" and "operational monitoring".
- Sets out and describes the parameters included in the compliance monitoring categories of check monitoring and audit monitoring.
- Sets out the monitoring frequencies (number of samples) for the check monitoring and audit monitoring parameters.
- Sets out the requirement for a pre-determined compliance monitoring programme and describes the relationship with the Drinking Water National Monitoring Programme (DWNMP).
- Describes the general requirement for a separate operational monitoring programme.

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Table 3.6: minimum frequency of sampling at consumers taps in the distribution network

1. Introduction

1.1 | Water Services Authorities (WSAs) carry out two types of monitoring of drinking water quality. The first type is **"compliance monitoring"** to determine whether water supplies comply with the standards and indicator parameter values in the Regulations. The compliance monitoring samples should be analysed in accredited laboratories (see section 5). The second type is **"operational monitoring"** to check that treatment works and distribution networks are operating effectively to deliver water that meets the standards and to provide early warning that source water quality is deteriorating, a treatment process is failing or there is a problem in the distribution networks. The operational monitoring samples need not be analysed in accredited laboratories – they may be analysed in small laboratories/benches at treatment works provided the methods are properly calibrated and subject to analytical quality control. WSAs should have separate pre-determined compliance and operational monitoring programmes.

2. Compliance monitoring

2.1 Monitoring categories

2.1.1 The Regulations specify two categories of compliance monitoring – **check monitoring** and **audit monitoring** – to determine compliance with the standards and indicator parameter values in the Regulations. Check monitoring is carried out relatively frequently for a limited range of parameters. Audit monitoring is carried

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less frequently for all the parameters, including those parameters subject to check monitoring. This means that for some parameters the monitoring frequency is the sum of the check and audit monitoring frequencies.

2.2 Check monitoring parameters

2.2.1 | Part 2 of the schedule to the Regulations states *"The purpose of check monitoring is regularly to provide information on the organoleptic and microbiological quality of the water supplied for human consumption as well as information on the effectiveness of drinking-water treatment (especially of disinfection) where it is used, in order to determine whether or not water intended for human consumption complies with the relevant parametric values laid down in Part 1 of this Schedule."* The term "organoleptic" means the properties and parameters of water that can be detected by the sensory organs such colour, taste and odour.

2.2.2 | The parameters set out in table 3.1 are subject to check monitoring. Some of these parameters are always included in check monitoring whilst others are only included when the specified circumstances described in the notes exist. If the specified circumstances do not exist the parameter must be included in audit monitoring. The notes in italics are quoted directly from the schedule to the Regulations.

Table 3.1: parameters subject to check monitoring

Parameter number	Parameter	Notes (specified circumstances)
29	Aluminium	Necessary only when used as a flocculant (coagulant)
30	Ammonium	
32	*Clostridium perfringens* (including spores)	*Only need be measured if the water originates from or is influenced by surface water*
33	Colour	
34	Conductivity	
1	*Escherichia coli [E. coli]*	
35	Hydrogen ion concentration	
36	Iron	*Necessary only when used as a flocculant (coagulant)*
21	Nitrite	*Necessary only when chloramination is used as a disinfectant*
38	Odour	
42	Taste	

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Parameter number	Parameter	Notes (specified circumstances)
44	Coliform bacteria	
46	Turbidity	

2.3 Audit monitoring parameters

2.3.1 | Part 2 of the schedule to the Regulations states *"The purpose of audit monitoring is to provide the information necessary to determine whether or not all the parametric values specified in Part I of this Schedule are being complied with. All such parameters must be subject to audit monitoring unless it can be established by a sanitary authority [now called a WSA], for a period of time to be determined by it, that a parameter is not likely to be present in a given supply in concentrations which could lead to the risk of a breach of the relevant parametric value. This paragraph does not apply to the parameters for radioactivity, which, subject to Notes 6, 7 and 8 in Table C in Part 1 of the Schedule will be monitored in accordance with monitoring requirements adopted under the Committee procedure set out in Article 12 of Council Directive 98/83/EC."*

2.3.2 | The Regulations require that all parameters are subject to audit monitoring unless it can be shown that a parameter is unlikely to be present. This means that some parameters are subject to both check and audit monitoring for the same supply. For these particular parameters, the monitoring frequency is the sum of the check and audit monitoring frequencies. This is particularly important for small supplies that are monitored infrequently as it means extra surveillance of their quality, particularly microbiological quality.

2.3.3 | The European Commission has not yet promulgated requirements on monitoring for the radiological parameters, tritium and total indicative dose. In the meantime and in order to acquire information about the presence of radioactivity in Irish drinking water supplies, it is recommended that WSAs include the radiological parameters in audit monitoring. Guidance on monitoring for radiological parameters is given in Section 4, paragraph 4.4.

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2.3.4 | 2.3.4 Table 3.2 sets out the parameters subject to audit monitoring. Some of these parameters are only included in audit monitoring if the specified circumstances exist. If they do not exist those parameters must be included in check monitoring. Note that it is not possible to analyse for certain parameters and they must be controlled by product specification (see notes to table 2.2 in section 2).

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Table 3.2: parameters subject to audit monitoring

Parameter number	Parameter	Specified circumstances
Microbiological parameters		
2	Enterococci	
Chemical parameters		
3	Acrylamide	Analysis not practical. Controlled by product specification.
4	Antimony	
5	Arsenic	
6	Benzene	
7	Benzo(a)pyrene	
8	Boron	
9	Bromate	
10	Cadmium	
11	Chromium	
12	Copper	
13	Cyanide	
14	1,2-Dichloroethane	
15	Epichlorohydrin	Analysis not practical. Controlled by product specification.
16	Fluoride	
17	Lead	
18	Mercury	
19	Nickel	
20	Nitrate	
21	Nitrite	When chloramination is not used as the disinfectant
22	Pesticides	
23	Pesticides – total	
24	Polycyclic aromatic hydrocarbons	
25	Selenium	
26	Tetrachloroethene and trichloroethene	
27	Trihalomethanes – total	
28	Vinyl chloride	Analysis not practical. Controlled by product specification.
Indicator parameters		

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Parameter number	Parameter	Specified circumstances
29	Aluminium	Only when not used as a flocculant (coagulant)
31	Chloride	
32	*Clostridium perfringens* (including spores)	Only when the water does not originate from surface water or is not influenced by surface water
36	Iron	Only when not used as a flocculant (coagulant)
37	Manganese	
39	Oxidisability	Monitor TOC instead
40	Sulphate	
41	Sodium	
43	Colony count 22˚C	
45	Total organic carbon (TOC)	Monitor instead of oxidisability
[47]	[Tritium]	Include pending advice from European Commission
[48]	[Total indicative dose]	Include pending advice from European Commission

2.4 Summary of check and audit monitoring parameters

2.4.1 | Table 3.3 sets out for ease of reference a summary of the check and audit monitoring parameters by parameter category and monitoring category. This takes into account the comments and recommendations made in sub-sections 2.2 and 2.3 above.

Table 3.3 summary of check and audit monitoring parameters

Parameter		Parameter category			Monitoring category	
No.		Microbio-logical	Chemical	Indicator	Check	Audit
1	*Escherichia coli (E. coli)*	Yes			Yes	Yes
2	Enterococci	Yes				Yes
3	Acrylamide		Yes			
4	Antimony		Yes			Yes
5	Arsenic		Yes			Yes
6	Benzene		Yes			Yes
7	Benzo(a)pyrene		Yes			Yes
8	Boron		Yes			Yes

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Parameter		Parameter category			Monitoring category	
9	Bromate		Yes			Yes
10	Cadmium		Yes			Yes
11	Chromium		Yes			Yes
12	Copper		Yes			Yes
13	Cyanide		Yes			Yes
14	1,2-Dichloroethane		Yes			Yes
15	Epichlorohydrin		Yes			
16	Fluoride		Yes			Yes
17	Lead		Yes			Yes
18	Mercury		Yes			Yes
19	Nickel		Yes			Yes
20	Nitrate		Yes			Yes
21	Nitrite		Yes		Yes*	Yes*
22	Pesticides		Yes			Yes
23	Pesticides – Total		Yes			Yes
24	Polycyclic aromatic hydrocarbons		Yes			Yes
25	Selenium		Yes			Yes
26	Tetrachloroethene and Trichloroethene		Yes			Yes
27	Trihalomethanes – Total		Yes			Yes
28	Vinyl chloride		Yes			
29	Aluminium			Yes	Yes*	Yes*
30	Ammonium			Yes	Yes	Yes
31	Chloride			Yes		Yes
32	*Clostridium perfringens* (including spores)			Yes	Yes*	Yes*
33	Colour			Yes	Yes	Yes
34	Conductivity			Yes	Yes	Yes
35	Hydrogen ion concentration			Yes	Yes	Yes
36	Iron			Yes	Yes*	Yes*
37	Manganese			Yes		Yes
38	Odour			Yes	Yes	Yes
39	Oxidisability			Yes		

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Parameter		Parameter category			Monitoring category	
40	Sulphate			Yes		Yes
41	Sodium			Yes		Yes
42	Taste			Yes	Yes	Yes
43	Colony count 22°C			Yes		Yes
44	Coliform bacteria			Yes	Yes	Yes
45	Total organic carbon (TOC)			Yes		Yes
46	Turbidity			Yes	Yes	Yes
47	Tritium			Yes		Yes
48	Total indicative dose			Yes		Yes

*These parameters can be either check or audit monitoring depending on the circumstances.

2.5 Monitoring frequencies

2.5.1 | WSAs are required to monitor each of their water supplies to determine compliance with the standards and indicator parameters at the minimum frequencies set out in table B of part 2 of the schedule to the Regulations for the check monitoring and audit monitoring parameters. A large supply may be divided into supply zones in which the water quality is regarded as being approximately the same (see section 4 of this handbook). The monitoring frequencies are based on the volume of water distributed or produced each day within a supply zone. If the volume distributed or produced is not known, WSAs may use the population supplied within a supply zone assuming 1,000 m3/day supplies 5,000 population. For small supplies the frequencies are not specified and are to be determined by the WSAs, subject to any guidance from the EPA. Such guidance is given in section 4 of this handbook based on the use of risk assessments to determine the parameters most at risk of failing to comply.

2.5.2 | WSAs must take the samples at the points of compliance defined in regulation 5. This requires that for water supplied through a distribution network samples must be taken from the tap or taps in premises where the water is used for human consumption. This means the kitchen tap (consumer's tap) in normal domestic premises and any appropriate tap (kitchen tap or other tap where water is used for drinking) in premises that are used for commercial or public activities. However, the Regulations allow WSAs to take samples for particular parameters from within the supply zone (for example at a service reservoir) or from the water leaving the treatment works instead of from consumers' taps if they can demonstrate that there would be no adverse change to the measured value of the parameters concerned.

2.5.3 | The check monitoring frequencies may be reduced by up to 50% in certain specified circumstances. Particular parameters may be excluded from audit monitoring if a WSA can demonstrate for those parameters that they are unlikely to be present in a water supply. Guidance on how this may be demonstrated is given in section 4 of this handbook.

2.5.4 | Table 3.4 sets out the minimum monitoring frequencies per year for various sizes of supply zone based on table B of part 2 of the schedule to the Regulations. The notes associated with that table are reproduced in italics with further amplification or explanation in normal type.

Table 3.4: minimum frequency of sampling at consumers' taps in the distribution network

Volume of water distributed within a supply zone (m^3/d) (Notes 1 and 2)	Number of samples per year	
	Check monitoring (Notes 3, 4 and 5)	Audit monitoring (Notes 3 and 5)
< 10*	Note 6	Note 6
$\geq 10 - \leq 100$	2	Note 6
$> 100 - \leq 1{,}000$	4	1
$> 1{,}000 - \leq 10{,}000$	4 + 3 for each 1,000 m^3/d and part thereof of the total volume	1 + 1 for each 3,300 m^3/d and part thereof of the total volume
$> 10{,}000 - \leq 100{,}000$		3 + 1 for each 10,000 m^3/d and part thereof of the total volume
$> 100{,}000$		10 + 1 for each 25,000 m^3/d and part thereof of the total volume

*Only where water is supplied as part of a commercial or public activity

Note 1: *A supply zone is a geographically defined area within which water intended for human consumption comes from one or more sources and water quality may be considered as being approximately uniform.* See section 4 of this handbook for definition of a supply zone.

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Note 2: *The volumes are calculated as averages taken over a calendar year. The number of inhabitants in a supply zone may be used instead of the volume of water to determine the minimum frequency, assuming a water consumption of 200 l/day/ capita*. This means 1,000 m^3/d supplies a population of 5,000.

Note 3: *In the event of intermittent short-term supply the monitoring frequency of water distributed by tankers is to be decided by the sanitary authority [WSA] concerned.* See section 4 of this handbook for advice on sampling from tankers.

Note 4: *Where the values of the results obtained from samples taken during the preceding two years are constant and are significantly better than the values specified in Part 1 of the Schedule, and no factor is likely to cause deterioration in the quality of the water, the number of samples specified in Table B of Part 2 of the Schedule may be reduced and the reduction shall not (except in the case of a supply where the volume distributed or produced each day within a supply zone does not exceed 100m3) be more than 50%*.

Note 5: *As far as possible, the number of samples should be distributed equally in time and location*. EPA advises that the premises at which samples should be taken should be selected at random from all the premises in a supply zone in accordance with the advice in section 4 of this handbook.

Note 6: *To be determined by the sanitary authority* [WSA], *subject to any relevant guidance issued by the Agency* [the Environment Protection Agency (EPA)]. The EPA's guidance is set out in section 2.6 below.

2.5.5 | The frequencies of compliance monitoring set out above are the ***minimum*** frequencies and, while they are the lowest permissible, they should afford, in normal circumstances, sufficient degree of protection of drinking water quality. However there may be circumstances when increased frequencies for particular parameters in particular supplies may be necessary such as:

- past monitoring has indicated quality problems;
- there is a significant degree of variability in the concentrations of parameters;
- there is a perceived risk to the supply; and
- the EPA has granted an authorised departure from a standard (see section 6 of this handbook).

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2.6 Monitoring of small public water supplies of ≤ 100 m3/d

2.6.1 | The Regulations require check monitoring at a frequency of 2 per year for the check monitoring parameters for supplies between ≥ 10 – ≤ 100 m^3/d but do not specify a frequency for audit monitoring. The Regulations also apply to supplies of less than 10m^3/day that are part of a public or commercial activity but dot not specify check or audit monitoring frequencies for these supplies, The Regulations require the frequency of monitoring for these small supplies to be determined by the WSA taking into account guidance from the EPA. This sub-section sets out the EPA guidance.

2.6.2 | Sampling and analysis, even once per year, for a whole range of parameters that are unlikely to be present in small supplies is not an effective use of resources. Therefore the EPA recommends that for each of these small supplies the WSA carries out a risk assessment (see Section 9.2 of this Handbook) taking into account the nature of the catchment, the activities in the catchment and any treatment provided to decide whether any of the parameters are likely to be present in the supply.

2.6.3 | For audit monitoring of supplies between ≥ 10 – ≤ 100 m^3/d, the WSA should monitor any parameters identified in the risk assessment that are not included in the check monitoring at a frequency of 2 per year (in other words add them to the list of check monitoring parameters).

2.6.4 | For check and audit monitoring of supplies of less than 10 m^3/d that are supplied as part of a public or commercial activity, the WSA should monitor any parameters identified in the risk assessment at a frequency of 2 per year (in other words combine the check and audit monitoring for a limited number of parameters).

2.7 Check monitoring frequencies

2.7.1 | Table 3.4 shows how the monitoring frequencies (number of samples) increases with increasing volume of water supplied, but it does not readily allow WSAs to determine the frequencies required for a given size of supply. Appendix 1 expands the check monitoring frequency table (table 3.5) to cater for the entire spectrum of volumes supplied and population served for Irish public water supplies. The notes associated with table 3.4 still apply.

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2.8 Audit monitoring frequencies

2.8.1 | Table 3.4 shows how the monitoring frequencies (number of samples) increases with increasing volume of water supplied, but it does not readily allow WSAs to determine the frequencies required for a given size of supply. Appendix 2 expands the audit monitoring frequency table (table 3.6) to cater for the entire spectrum of volumes supplied and population served for Irish public water supplies. The notes associated with table 3.4 still apply. For supplies of > 100 to ≤ 1,000 m^3/d (serving > 500 to ≤ 5,000 people), the minimum audit monitoring frequency is 1 per year and it is recommended that WSAs increase this to a minimum of 2 per year.

2.9 The Drinking Water National Monitoring Programme

2.9.1 | Each WSA should prepare, before the beginning of each calendar year, its pre-determined compliance monitoring programme for that year. This programme should set out for each water supply zone the check monitoring and audit monitoring parameters, the frequency of monitoring for each parameter, the randomly selected premises at which samples are to be taken (or the treatment works if sampling for particular parameters is permitted there) and the timing of the samples during the year. The WSA should consult the HSE when preparing its monitoring programme to avoid duplication of monitoring.

2.9.2 | The Drinking Water National Monitoring Programme (DWNMP) issued in December 2004 by the Department of Environment, Heritage and Local Government (DoEHLG) under circular letter, reference WSP11/04, and was the basis of the pre-determined compliance monitoring programme. It set out the monitoring frequencies for all the parameters in the Regulations for each of the then identified supply zones and treatment works for each sanitary authority, now WSA. The DWNMP was based on the check and audit monitoring frequencies described in the above sub-sections. The DWNMP is still valid although WSAs may have made some changes to the supply zones including some additional supply zones and some changes to the frequencies because of changes to the volumes distributed and the population supplied.

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3. Operational monitoring

3.1 | Each WSA must have an operational monitoring programme for each of its raw water sources, treatment works and associated distribution networks. This programme is entirely separate from the compliance sampling programme. Operational monitoring is sampling and analysis carried out to check that treatment works and distribution networks are operating effectively to deliver water that meets the standards and to provide early warning that source water quality is deteriorating, a treatment process is failing or there is a problem in the distribution networks. At a modern treatment works many of the operational parameters will be monitored continuously or very frequently by instrumentation. These instruments will have alarm levels linked to the treatment works control room, or for an unmanned works linked by telemetry to a remote control room or automatic dial up to an operator cascade system, so that rapid action can be taken when there is deterioration in performance.

3.2 | In general a WSA's operational monitoring programme should consist of the following elements:

- monitoring of the source water for parameters that provide a general indication of water quality, which if their concentration or value changed significantly would indicate that there could be deterioration in source water quality. It should also include any parameters that the treatment works is specifically designed to remove;
- monitoring of the coagulation, settlement and filtration processes for those parameters that provide evidence of the effectiveness of treatment such as jar tests for optimum coagulation conditions, coagulant residual, pH value and turbidity;
- monitoring of the disinfection process for those parameters that provide evidence of the effectiveness of disinfection such as chlorine residual, pH value and microbiological parameters;
- monitoring of the water leaving the treatment works for parameters that the works is designed to remove that are not adequately monitored by the compliance monitoring such as nitrate if nitrate removal id practised; and
- monitoring within the distribution network for parameters that provide evidence that there is no deterioration or contamination within distribution that are not adequately monitored by the compliance monitoring such as chlorine residual.

3.3 | Further guidance on operational monitoring is given in section 4 of this handbook.

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Appendix 1: Check monitoring frequencies

Table 3.5: minimum frequency of sampling at consumers taps in the distribution network

Volume of water distributed within a supply zone (m^3/d)	Equivalent population served	Check monitoring Number of samples per year
< 10	< 50	2 (see section 2.6)
≥ 10 – ≤ 100	≥ 50 – ≤ 500	2
> 100 – ≤ 1,000	< 500 – ≤ 5,000	4
> 1,000 – ≤ 2,000	< 5,000 – ≤ 10,000	10
> 2,000 – ≤ 3,000	> 10,000 – ≤ 15,000	13
> 3,000 – ≤ 4,000	> 15,000 – ≤ 20,000	16
> 4,000 – ≤ 5,000	> 20,000 – ≤ 25,000	19
> 5,000 – ≤ 6,000	> 25,000 – ≤ 30,000	22
> 6,000 – ≤ 7,000	> 30,000 – ≤ 35,000	25
> 7,000 – ≤ 8,000	> 35,000 – ≤ 40,000	28
> 8,000 – ≤ 9,000	> 40,000 – ≤ 45,000	31
> 9,000 – ≤ 10,000	> 45,000 – ≤ 50,000	34
> 10,000 – ≤ 11,000	> 50,000 – ≤ 55,000	37
> 11,000 – ≤ 12,000	> 55,000 – ≤ 60,000	40
> 12,000 – ≤ 13,000	> 60,000 – ≤ 65,000	43
> 13,000 – ≤ 14,000	> 65,000 – ≤ 70,000	46
> 14,000 – ≤ 15,000	> 70,000 – ≤ 75,000	49
> 15,000 – ≤ 16,000	> 75,000 – ≤ 80,000	52
> 16,000 – ≤ 17,000	> 80,000 – ≤ 85,000	55
> 17,000 – ≤ 18,000	> 85,000 – ≤ 90,000	58
> 18,000 – ≤ 19,000	> 90,000 – ≤ 95,000	61
> 19,000 – ≤ 20,000	> 95,000 – ≤ 100,000	64
> 20,000 – ≤ 21,000	> 100,000 – ≤ 105,000	67
> 21,000 – ≤ 22,000	> 105,000 – ≤ 110,000	70

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Volume of water distributed within a supply zone (m^3/d)	Equivalent population served	Check monitoring Number of samples per year
> 22,000 – ≤ 23,000	> 110,000 – ≤ 115,000	73
> 23,000 – ≤ 24,000	> 115,000 – ≤ 120,000	76
> 24,000 – ≤ 25,000	> 120,000 – ≤ 125,000	79
> 25,000 – ≤ 26,000	> 125,000 – ≤ 130,000	82
> 26,000 – ≤ 27,000	> 130,000 – ≤ 135,000	85
> 27,000 – ≤ 28,000	> 135,000 – ≤ 140,000	88
> 28,000 – ≤ 29,000	> 140,000 – ≤ 145,000	91
> 29,000 – ≤ 30,000	> 145,000 – ≤ 150,000	94
> 30,000 – ≤ 31,000	> 150,000 – ≤ 155,000	97
> 31,000 – ≤ 32,000	> 155,000 – ≤ 160,000	100
> 32,000 – ≤ 33,000	> 160,000 – ≤ 165,000	103
> 33,000 – ≤ 34,000	> 165,000 – ≤ 170,000	106
> 34,000 – ≤ 35,000	> 170,000 – ≤ 175,000	109
> 35,000 – ≤ 36,000	> 175,000 – ≤ 180,000	112
> 36,000 – ≤ 37,000	> 180,000 – ≤ 185,000	115
> 37,000 – ≤ 38,000	> 185,000 – ≤ 190,000	118
> 38,000 – ≤ 39,000	> 190,000 – ≤ 195,000	121
> 39,000 – ≤ 40,000	> 195,000 – ≤ 200,000	124
> 40,000 – ≤ 41,000	> 200,000 – ≤ 205,000	127
> 41,000 – ≤ 42,000	> 205,000 – ≤ 210,000	130
> 42,000 – ≤ 43,000	> 210,000 – ≤ 215,000	133
> 43,000 – ≤ 44,000	> 215,000 – ≤ 220,000	136
> 44,000 – ≤ 45,000	> 220,000 – ≤ 225,000	139
> 45,000 – ≤ 46,000	> 225,000 – ≤ 230,000	142
> 46,000 – ≤ 47,000	> 230,000 – ≤ 235,000	145
> 47,000 – ≤ 48,000	> 235,000 – ≤ 240,000	148
> 48,000 – ≤ 49,000	> 240,000 – ≤ 245,000	151
> 49,000 – ≤ 50,000	> 245,000 – ≤ 250,000	154

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Volume of water distributed within a supply zone (m³/d)	Equivalent population served	Check monitoring Number of samples per year
> 50,000 – ≤ 51,000	> 250,000 – ≤ 255,000	157
> 51,000 – ≤ 52,000	> 255,000 – ≤ 260,000	160
> 52,000 – ≤ 53,000	> 260,000 – ≤ 265,000	163
> 53,000 – ≤ 54,000	> 265,000 – ≤ 270,000	166
> 54,000 – ≤ 55,000	> 270,000 – ≤ 275,000	169
> 55,000 – ≤ 56,000	> 275,000 – ≤ 280,000	172
> 56,000 – ≤ 57,000	> 280,000 – ≤ 285,000	175
> 57,000 – ≤ 58,000	> 285,000 – ≤ 280,000	178
> 58,000 – ≤ 59,000	> 290,000 – ≤ 295,000	181
> 59,000 – ≤ 60,000	> 295,000 – ≤ 300,000	184
> 60,000 – ≤ 61,000	> 300,000 – ≤ 305,000	187
> 61,000 – ≤ 62,000	> 305,000 – ≤ 310,000	190
> 62,000 – ≤ 63,000	> 310,000 – ≤ 315,000	193
> 63,000 – ≤ 64,000	> 315,000 – ≤ 320,000	196
> 64,000 – ≤ 65,000	> 320,000 – ≤ 325,000	199
> 65,000 – ≤ 66,000	> 325,000 – ≤ 330,000	202
> 66,000 – ≤ 67,000	> 330,000 – ≤ 335,000	205
> 67,000 – ≤ 68,000	> 335,000 – ≤ 340,000	208
> 68,000 – ≤ 69,000	> 340,000 – ≤ 345,000	211
> 69,000 – ≤ 70,000	> 345,000 – ≤ 350,000	214
> 70,000 – ≤ 71,000	> 350,000 – ≤ 355,000	217
> 71,000 – ≤ 72,000	> 355,000 – ≤ 360,000	220
> 72,000 – ≤ 73,000	> 360,000 – ≤ 365,000	223
> 73,000 – ≤ 74,000	> 365,000 – ≤ 370,000	226
> 74,000 – ≤ 75,000	> 370,000 – ≤ 375,000	229
> 75,000 – ≤ 76,000	> 375,000 – ≤ 380,000	232
> 76,000 – ≤ 77,000	> 380,000 – ≤ 385,000	235

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Volume of water distributed within a supply zone (m³/d)	Equivalent population served	Check monitoring Number of samples per year
> 77,000 – ≤ 78,000	> 385,000 – ≤ 390,000	238
> 78,000 – ≤ 79,000	> 390,000 – ≤ 395,000	241
> 79,000 – ≤ 80,000	> 395,000 – ≤ 400,000	244
> 80,000 – ≤ 81,000	> 400,000 – ≤ 405,000	247
> 81,000 – ≤ 82,000	> 405,000 – ≤ 410,000	250
> 82,000 – ≤ 83,000	> 410,000 – ≤ 415,000	253
> 83,000 – ≤ 84,000	> 415,000 – ≤ 420,000	256
> 84,000 – ≤ 85,000	> 420,000 – ≤ 425,000	259
> 85,000 – ≤ 86,000	> 425,000 – ≤ 430,000	262
> 86,000 – ≤ 87,000	> 430,000 – ≤ 435,000	265
> 87,000 – ≤ 88,000	> 435,000 – ≤ 440,000	268
> 88,000 – ≤ 89,000	> 440,000 – ≤ 445,000	271
> 89,000 – ≤ 90,000	> 445,000 – ≤ 450,000	274
> 90,000 – ≤ 91,000	> 450,000 – ≤ 455,000	277
> 91,000 – ≤ 92,000	> 455,000 – ≤ 460,000	280
> 92,000 – ≤ 93,000	> 460,000 – ≤ 465,000	283
> 93,000 – ≤ 94,000	> 465,000 – ≤ 470,000	286
> 94,000 – ≤ 95,000	> 470,000 – ≤ 475,000	289
> 95,000 – ≤ 96,000	> 475,000 – ≤ 480,000	292
> 96,000 – ≤ 97,000	> 480,000 – ≤ 485,000	295
> 97,000 – ≤ 98,000	> 485,000 – ≤ 490,000	298
> 98,000 – ≤ 99,000	> 490,000 – ≤ 495,000	301
> 99,000 – ≤ 100,000	> 495,000 – ≤ 500,000	304
> 100,000 – ≤ 101,000	> 500,000 – ≤ 505,000	307
etc	etc	etc

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Appendix 2: Audit monitoring frequencies

Table 3.6: minimum frequency of sampling at consumers taps in the distribution network

Volume of water distributed within a supply zone (m³/d)	Equivalent population served	Audit monitoring Number of samples per year
< 10	< 50	2 (see section 2.6)
≥ 10 – ≤ 100	≥ 50 – ≤ 500	2 (see section 2.6)
> 100 – ≤ 1,000	> 500 – ≤ 5,000	1
> 1,000 – ≤ 3,300	> 5,000 – ≤ 16,500	2
> 3,300 – ≤ 6,600	> 16,500 – ≤ 33,000	3
> 6,600 – ≤ 9,900*	> 33,000 – ≤ 49,500	4
> 10,000 – ≤ 20,000	> 50,000 – ≤ 100,000	5
> 20,000 – ≤ 30,000	> 100,000 – ≤ 150,000	6
> 30,000 – ≤ 40,000	> 150,000 – ≤ 200,000	7
> 40,000 – ≤ 50,000	> 200,000 – ≤ 250,000	8
> 50,000 – ≤ 60,000	> 250,000 – ≤ 300,000	9
> 60,000 – ≤ 70,000	> 300,000 – ≤ 350,000	10
> 70,000 – ≤ 80,000	> 350,000 – ≤ 400,000	11
> 80,000 – ≤ 90,000	> 400,000 – ≤ 450,000	12
> 90,000 – ≤ 100,000	> 450,000 – ≤ 500,000	13
> 100,000 – ≤ 125,000	> 500,000 – ≤ 625,000	14
> 125,000 – ≤ 125,000	> 625,000 – ≤ 750,000	15
etc pro rata	etc pro rata	etc pro rata

* The formula gives rise to this number and does not allow for volumes between 9,900 and 10,000. WSAs should assume that this includes volumes up to ≤ 10,000 and populations up to ≤ 50,000.

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SECTION 4: GUIDANCE ON SAMPLING

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Section 4: Guidance on Sampling

Summary of Section 4

- Describes the difference between "compliance monitoring" and operational monitoring".
- Sets out the recommended contents of the sampling manual by reference to pre-determined compliance and operational sampling programmes and sampling procedures.
- Describes compliance sampling from consumers' taps in the distribution network and from water leaving the treatment works including the pre-determined sampling programme, sampling points, delineation of supply zones and selection of the premises to be sampled.
- Sets out advice on compliance sampling for special groups of parameters.
- Describes the compliance sampling from tankers when Water Services Authorities (WSAs) need to deploy them.
- Provides guidance on the operational sampling programme for raw water, treatment works and distribution networks, including the parameters to be monitored and the frequencies.
- Describes other situations when WSAs may be required to take samples.
- Sets out advice on the training, supervision and monitoring of samplers.

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Appendix 1: Sample bottles, sample preservation and storage

Appendix 2: Specimen field log sheet

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1. Introduction

1.1 | Water Services Authorities (WSAs) take samples for two types of monitoring of water supplies. The first type is **"compliance monitoring"** to determine whether water supplies comply with the standards and indicator parameter values in the Regulations. The compliance monitoring samples should be analysed in accredited laboratories (see section 5). The second type is **"operational monitoring"** to check that treatment works and distribution networks are operating effectively to deliver water that meets the standards and to provide early warning that source water quality is deteriorating, a treatment process is failing or there is a problem in the distribution network. The operational monitoring samples need not be analysed in accredited laboratories – they may be analysed in small laboratories/benches at treatment works provided the methods are properly calibrated and subject to analytical quality control. WSAs should have separate pre-determined sampling programmes for compliance and operational monitoring.

1.2 | Sampling is a very important part of the monitoring procedure. If the samples are not representative of the water supplied or the samples are not taken correctly, there is no point in carrying out expensive analysis because the results will have little use. Therefore the Environment Protection Agency (the EPA) recommends that each WSA has a **sampling manual** that sets out all the procedures and precautions that samplers should take for every aspect of the sampling process. The EPA also recommends that all samplers are thoroughly trained in these sampling procedures and precautions. The Water Services Training Group (WSTG) has a course on sampling procedures for the Drinking Water National Monitoring Programme (DWNMP) (***www.wsntg.ie/courses***).

2. Sampling manual

2.1 Introduction

2.1.1 | Each WSA and its laboratory (or contract laboratories) should produce a sampling manual that sets out the comprehensive sampling arrangements needed to ensure compliance with the Regulations. One member of the WSA's staff or the laboratory's staff should be designated as responsible for the production and circulation of the sampling manual, for reviewing the sampling manual periodically and for issuing and recording receipt of amendments and additions to the sampling manual. This person should ensure that the sampling manual (and any revisions) is circulated to all appropriate members of staff who may need to use it.

2.1.2 | As a minimum the sampling manual should contain the following sections:

- the procedures and precautions to be taken when sampling for each parameter or groups of parameters;
- The pre-determined **compliance** sampling programme which includes samples from consumers' taps in the supply zones and, where appropriate, samples from water treatment works (for nitrite and turbidity and, if the WSA chooses, the other parameters set out in table 4.3 of this section). Further guidance on compliance sampling is given in paragraph 3 of this section;
- any pre-determined **operational** sampling programme to check the effectiveness of water treatment and the quality of water leaving treatment works and in service reservoirs/water towers that is not adequately covered by the **compliance** sampling programme;
- any appropriate **operational** raw water sampling programme to enable the correct treatment to be applied and adjustments of treatment processes to be made when there are changes in raw water quality. This programme should take into account any monitoring programme under the 1989 Regulations[1] (S.I. 294 of 1989) or the 2003 Regulations[2] (S.I. 722 0f 2003);
- a **compliance** monitoring strategy for pesticides see paragraph 4.2 of this section; and
- **compliance** sampling from tankers when water is supplied by tankers for drinking and food preparation instead of through the distribution network (see paragraph 5 of this section).

1 European Communities (Quality of Surface Water Intended for Abstraction of Drinking Water) Regulations 1989 (S.I. 294 of 1989)

2 European Communities (Water Policy) Regulations 2003 (S.I. 722 of 2003)

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2.2 Sampling procedures

2.2.1 | The sampling manual should set out the procedures and precautions to be adopted for each parameter or group of parameters. The table in Appendix 1 of this section gives specific guidance on the types of bottles/containers, the cleaning procedures for them, any preservatives that need to be added, storage conditions and the maximum storage period before analysis. The following is the minimum that should be included in the sampling manual:

- in respect of "non-microbiological" parameters, the:
  - types of bottles/containers/lids;
  - cleaning procedures for the bottles/containers/lids;
  - preservatives to be added to bottles;
  - type of sample (first draw, flushed etc) and the sequence for taking each sample from the sampling point;
  - storage and transport conditions for each type of sample; and
  - time allowed before analysis commences.
- in respect of microbiological parameters, the:
  - bottle type, bottle closure and bottle shelf life specification;
  - method and conditions of bottle and bottle closure sterilisation and incorporation of disinfectant neutralising reagent;
  - arrangements to avoid accidental contamination during sampling;
  - sequence of taking samples when "non-microbiological" samples are also being taken;
  - guidance for selection of taps for sampling (covering water treatment works, service reservoirs/water towers and consumers' taps) and in respect of consumers' taps any features to be avoided (such as tap inserts);
  - precautions for sampling from taps at water treatment works, service reservoirs/ water towers and in consumers' premises;

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- preparation, cleaning, disinfection and flushing of taps for sampling;
- storage and transport conditions and arrangements for cooling samples;
- cleaning of sample boxes;
- time limits for starting sample analysis; and
- arrangements for keeping samples cool in the laboratory if there are delays between receipt and examination;

◆ In respect of all samples, sampler should:

- have a written work list showing all samples to be taken and clearly identifying compliance samples and operational samples;
- have a log sheet that can be filed for record purposes (a specimen field log sheet is given in Appendix 2);
- record the reasons for postponing or cancelling compliance samples on the log sheet;
- fix securely a sample label with a unique sample number to the container – this must make clear whether it is a **compliance** sample or an **operational** sample;
- record clearly the unique sample number, location (address/site and grid reference), date, time and sampler identification on the log sheet;
- record clearly all field measurements and observations at the time they are made on the log sheet and make sure they are associated with the correct samples and containers; and
- for samples to be taken from consumers' taps, the sampler should show his/her ID (identification) or otherwise establishes his/her bona fides and should advise the consumer that he/she can check the sampler's bona fides by telephoning the WSA or the laboratory.

all samples should be transported as quickly as practical to the laboratory (or contract laboratory) in a sampling vehicle that, as a minimum, meets the following advice:

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- it is clean and has adequate storage facilities for empty sample containers and for containers filled with samples;
- it has provision for keeping samples cool and for cooling samples, when necessary;
- it is not used for any purpose that might cause contamination of samples; and
- its interior and cool boxes/refrigerators are regularly cleaned and maintained.

3. Compliance sampling from consumers' taps in the distribution network (and treatment works)

3.1 Introduction

3.1.1 | Paragraph 2.1.2 of this section states that each WSA's compliance monitoring programme should be pre-determined before the start of each sampling year. The programme should set out the number of samples to be taken for each parameter, the points (a specific point such as a tap in a specific premises or a tap at one of the premises in a small area of the supply) at which the samples are to be taken and when the samples are to be taken. The Regulations require that the samples taken in each water supply zone are representative of the quality of water consumed throughout the year and are equally distributed through the supply. Effectively this means equally distributed in time and location. Samples are required to be taken from consumers' taps, but WSAs may take samples of the water leaving treatment works (or at points within the supply zone) for particular parameters if it can be demonstrated that there would be no adverse change to the measured value of the parameters concerned. WSAs are required to take samples from the water leaving treatment works for nitrite and, for surface water treatment works only, for turbidity.

3.2 Compliance sampling programme

3.2.1 | Each WSA should set out in its sampling manual its pre-determined compliance sampling programme for each year. This programme should be based on the Drinking Water National Monitoring Programme (DWNMP issued to WSAs by the Department of Environment, Heritage and Local Government (DoEHLG) in December 2004, appropriately modified from time to time to take into account changes in water supplies in the intervening period. The WSA should consult the HSE when preparing this programme to avoid duplication of monitoring. This programme must set out the frequencies of sampling for **each parameter** or **groups of parameters** (for many parameters the frequencies will be the same) in:

- each supply zone (consumers' taps) (all parameters – unless the WSA chooses to sample specified parameters in the water leaving the treatment works – see table 4.3 in this section); and
- each water treatment works (nitrite and turbidity, the latter at surface water treatment works only) and, if the WSA chooses, the other parameters that may be sampled in the water leaving the treatment works – see table 4.3 in this section.

3.2.2 | The frequencies must be a least the minimum specified for **check monitoring** and **audit monitoring** in table B of part 2 of the Schedule to the Regulations and amplified in the tables 3.5 and 3.6 in Appendices 1 and 2 of section 3 of this Handbook. WSAs may programme for slightly higher frequencies, say about 10% higher than the minimum, so that if samples are lost or damaged or there is a problem with analysis they will still comply with the minimum frequencies. However, WSAs should not significantly over-programme for particular parameters that are easy to sample and analyse and are likely to comply with the standards as this would bias the overall picture of drinking water quality (if WSAs consider that more samples should be taken for particular parameters the **additional** samples should be regarded as **operational** samples – see sub-section 6 of this section). The samples should be programmed to be taken at regular intervals at each point (consumers' taps in supply zones and treatment works). If the sampling frequency is 52 each year, this means a sample must be taken in each week of the year, but it should not be taken on the same day in each week – the day and the timing during the day of the sample should be varied.

3.2.3 | WSAs should note that reduced frequencies can be used for the check monitoring parameters only in the following circumstances:

"Where the values of the results obtained from samples taken during the preceding two years are constant and are significantly better than the values specified in Part 1 of the Schedule, and no factor is likely to cause deterioration in the quality of the water, the number of samples specified in Table B of Part 2 of the Schedule may be reduced and the reduction shall not (except in the case of a supply where the volume distributed or produced each day within a supply zone does not exceed 100m^3) be more than 50%."

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The EPA recommends that this provision should not be applied to supplies providing between 10 and 1,000 m3/day so that the minimum check monitoring frequency for these supplies is 4 per year.

3.2.4 | Section 2 of part 2 of the schedule to the Regulations (states, in respect of the **audit monitoring parameters**, that *"All such parameters must be subject to audit monitoring unless it can be established by a sanitary authority [now a WSA], for a period of time to be determined by it, that a parameter is not likely to be present in a given supply in concentrations which could lead to the risk of a breach of the relevant parametric value."* WSAs are advised that an audit monitoring parameter may be omitted from its compliance monitoring programme for a particular supply when that parameter has not been detected in significant concentrations in the last three years' monitoring under these Regulations or the previous Regulations (SI 439 of 200). Generally, WSAs should regard a significant concentration as greater than 50% of the parametric value. WSAs may also use other appropriate evidence to justify omitting an audit monitoring parameter from its compliance monitoring programme. For example in soft water supplies where evidence from conductivity monitoring for the last three years has shown conductivities are always less than, say, 250 µS/cm, then chloride and sulphate may be omitted because their concentrations will be significantly below 250 mg/l.

3.3 Compliance sampling points

3.3.1 | WSAs or laboratories should set out the procedures and precautions to be adopted for the selection of **compliance** sampling points and for the taking of samples from each type of sampling point. The Regulations require samples to be taken from consumers' taps. They also require samples to be taken from the water leaving treatment works for turbidity and nitrite. WSAs are permitted to take samples for particular parameters from the water leaving treatment works instead of from consumers' taps if they can demonstrate that there will be no adverse change in the concentration of those parameters (see paragraph 4.3 of this section).

3.3.2 | The following is the minimum that should be included in the sampling manual regarding sampling points for compliance sampling from consumers' taps:

- a protocol for the selection of premises from which samples are to be taken. These sampling points should be pre-determined before the start of the each year. They should be selected in accordance with guidelines specified in paragraph 3.6 of this section. The grid reference of each selected premises or alternate premises (see next bullet below) should be noted to facilitate recording of drinking water quality information on Geographic Information Systems (GIS);

- a protocol for the selection of alternate premises when access cannot be obtained to the selected premises. Similar, neighbouring premises could be chosen. Alternatively the original selection could identify precisely a small group of similar premises from which the sampler is free to choose one that access can be obtained;
- a map or maps showing the sampling locations for the year; and
- guidance on the taking of samples. Where possible for microbiological parameters samples should be taken from metal taps that have been disinfected before sampling. Where only plastic taps or mixer taps are available they should be cleaned or disinfected before sampling. All external fittings such as anti-splash devices and hoses should be removed before sampling. Internal inserts should also be removed if possible without damaging the tap. Mixer taps should be avoided if possible and only sampled if there is no other practical choice available.

3.3.3 | The following is the minimum that should be included in the sampling manual regarding sampling points for compliance sampling from the water leaving treatment works:

- the precise location of the point or points at which samples are to be taken of the water leaving each treatment works. If there is more than one point where the water leaves a treatment works, then each point should be sampled unless the WSA has evidence to show that water quality is the same at each point. The sampling point may be downstream of the treatment works (because disinfection may not be complete at the outlet of some small works) provided there is no change in water quality to that point and it is before the first consumer and any service reservoirs/water towers;
- sampling points should be reasonably accessible and uniquely labelled;
- a schematic diagram of each treatment works showing the location of each sampling point or points;

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- guidance on the sampling points. All treatment works sampling points should be fitted with metal sampling taps of a hygienic design that do not have attachments or inserts and are made of materials that do not affect the concentrations of the parameters being monitored. Water should be supplied to the sampling tap through a sample line of a suitable material that should be as short as possible. These materials should meet British Standard BS6920 regarding tests for the effect on water quality (or equivalent Irish or other European standard).

3.4 Delineation of supply zones

3.4.1 | Table B of part 2 of the schedule to the Regulations, amplified in the tables 3.5 and 3.6 in appendices 1 and 2 of section 3 this handbook, sets out the minimum number of samples that must be taken for check and audit monitoring each year based on the volume of water distributed or produced each day within a supply zone. A supply zone is a geographically defined area within which water intended for human consumption comes from one or more sources and water quality may be considered as approximately uniform. **Therefore each WSA has to divide its area into supply zones for monitoring purposes**.

3.4.2 | Each WSA must delineate its supply zones towards the end of each year for the following year. These supply zones are then used to determine the sampling programme at consumers' taps for that year. Each WSA should have a written procedure that sets out how it will delineate its supply zones. The following principles should be used:

- a discrete area supplied by a single treatment works is a supply zone;
- a discrete area supplied by more than one treatment works should be sub-divided into 2 or more supply zones if there are, or could be, significant differences in water quality within the zone;
- sub-division should normally be based on features of the distribution network, leading to supply zones supplied from a service reservoir (or water tower), pumping or booster station or pressure zone;
- in areas where variations in water quality are complex or not predictable, such as conurbations, it may be necessary to use a convenient geographical boundary for each supply zone;

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- temporary introduction of stand-by or emergency sources to cater for temporarily increased populations during holiday seasons should not affect delineation of water supply zones.

3.4.3 | Towards the end of each year, each WSA should review the delineation of its supply zones for the following year. However the number of changes to delineation should be kept to a minimum to facilitate year on year assessment of drinking water quality.

3.4.4 | It is recognised that WSAs may have to take temporary operational actions to maintain water supplies or deal with incidents affecting drinking water quality that may involve the introduction of water from treatment works not designated for that supply zone. Such temporary measures should not influence the annual delineation of supply zones.

3.5 Parameters sampled from consumers' taps

3.5.1 | WSAs are required to sample many parameters at the taps normally used for human consumption (consumers' taps) because their concentrations or values could be affected by the WSA's distribution network or by the condition or maintenance of the domestic distribution system within the premises or establishments. WSAs may sample some parameters at treatment works (or other point within the distribution network such as a service reservoir or water tower) if the concentrations of those parameters are not affected by the WSA's distribution network or by the condition or maintenance of the domestic distribution system within the premises or establishments. WSAs will probably find it more cost effective to take advantage of sampling for some parameters at treatment works in the larger water supplies in conurbations and towns. On the other hand, WSAs may find it more cost effective to sample all parameters at consumers' taps for small supplies.

3.5.2 | WSAs must sample the parameters specified in table 4.1 at consumers' taps because their concentrations or values could be affected by the WSA's distribution network or by the condition or maintenance of the domestic distribution system within the premises or establishments. In addition WSAs should monitor residual disinfectant on each sampling occasion for those supplies that are disinfected with a chemical disinfectant.

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Table 4.1: parameters that must be monitored at consumers' taps

Parameter number	Parameter	Comments
1	*E coli*	
2	Enterococci	
4	Arsenic	See note 1
5	Antimony	See note 1
7	Benzo(a)pyrene	
8	Bromate	Only when sodium hypochlorite is added downstream of the treatment works
10	Cadmium	See note 1
11	Chromium	See note 1
12	Copper	
17	Lead	
18	Nickel	
20	Nitrate	Because needed to satisfy formula for nitrate and nitrite
21	Nitrite	Must also be monitored in the water leaving treatment works
24	Polycyclic aromatic hydrocarbons	
25	Selenium	See note 1
27	Trihalomethanes	
29	Aluminium	
30	Ammonium	
33	Colour	
35	Hydrogen ion concentration (pH value)	
36	Iron	
37	Manganese	
38	Odour	
41	Sodium	
42	Taste	
43	Colony count at 22oC	
44	Coliform bacteria	

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Parameter number	Parameter	Comments
46	Turbidity	Must also be monitored in the water leaving treatment works for surface water supplies
	Residual disinfectant	For most supplies this will be residual chlorine

*Note 1***:** This parameter must be monitored at consumers' taps in a supply zone unless a WSA can demonstrate for that supply zone that the parameter has not been detected at significant concentrations (more than 50% of the standard) in sufficient samples (at least 10) from consumers taps in previous years, in which case the parameter may be monitored in the water leaving the treatment works supplying that zone.

3.6 Selection of consumers' taps for sampling

3.6.1 | WSAs are required to select sample locations (consumers' taps) that are representative of the quality of water consumed throughout the year and, as far as possible, the number of samples should be distributed equally in time and location. This implies that samples taken should be distributed evenly throughout the distribution network and throughout the year. Ideally the premises at which samples are taken should be selected at random from a list of all the premises supplied. If it is practical to do so, WSAs should select the premises at random from electoral lists, postal areas or other suitable lists.

3.6.2 | If this is not practical, the WSA should map out each water supply zone and its associated water distribution network and divide it into roughly equal geographic areas (small supply zones will be a geographic area). Within each geographic area, premises should be selected for sampling for the forthcoming year from domestic dwellings, public buildings (for example but not limited to schools, hospitals and restaurants) and food production undertakings. The total number of premises selected for the year in all the geographic areas that make up the supply zone will be the sum of the number of check and audit monitoring samples required with a small excess to allow for sample breakages etc. The number of premises selected in each category should be in proportion to the numbers of domestic dwellings, public buildings and food production undertakings in the zone. For most zones the premises sampled for compliance monitoring during the year will all be different – a particular premises will not be sampled on more that one occasion during the year. However, for the small supply zones this may not be practical because of the small number of premises and gaining access. In these cases a particular premises may be sampled on more than

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one occasion, but WSAs should strive to keep repeat sampling to a minimum. When a WSA has selected all the premises for sampling during the forthcoming year, it must arrange the premises in a sampling programme so that the order of visiting the premises is such that the samples are distributed evenly in time and location.

3.6.3 | If the selected premises is a normal domestic residential premises (house or flat), the sampler must take the sample from the kitchen tap in the premises as that will be the point at which the water is normally taken for human consumption. If the selected premises are in an area that the WSA considers unsafe for a "public" official such as a sampling officer to enter, the sampler should obtain a sample from similar premises close to but outside the unsafe area. If the selected premises or establishment is not a normal domestic residential premises, the sampler should ask the owner, occupiers or manager of the premises or establishment to identify the taps that are normally used for human consumption and take the sample from one of those taps. If the sampler cannot gain access to the selected premises, the sample should be taken from a similar nearby premises to which access can be obtained.

3.6.4 | WSAs must select sufficient premises or establishments in each water supply zone each year to meet the sampling frequencies specified in tables 3.5 (check monitoring parameters) and 3.6 (audit monitoring parameters) in appendices 1 and 2 of section 3 this handbook. Check monitoring samples will be taken from all the selected premises. Audit monitoring samples will be taken from a limited number of these premises. WSAs must make sure that the premises selected for audit monitoring are also evenly distributed in time and location.

3.6.5 | WSAs should note that samples from normal domestic residential premises must be taken from the kitchen tap. It is not acceptable to take compliance samples from outside taps at these premises as these will not be representative of water used for human consumption. Similarly WSAs should not take samples from taps in public conveniences as these taps should not be used for water for human consumption. WSAs may take operational samples from taps other than kitchen taps.

3.7 Sampling from the water leaving treatment works

3.7.1 | The Regulations require WSAs to monitor the parameters specified in table 4.2 in the water leaving treatment works. In addition WSAs should monitor residual disinfectant on each sampling occasion in order to check the effectiveness of disinfection when a chemical disinfectant is dosed at the treatment works.

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Table 4.2: parameters that must be sampled in the water leaving treatment works

Parameter number	Parameter	Comments
1	Nitrite	Against the standard of 0.1 mg/l
46	Turbidity	Against the indicator parameter value of 1NTU for surface water supplies only

3.7.2 | WSAs may, if they wish, monitor the parameters specified in table 4.3 in the water leaving treatment works (or at some other representative point in the water supply zone such as a service reservoir or water tower) instead of at consumers' taps because the concentrations or values for these parameters are not affected significantly by the WSA's distribution network or the domestic distribution system within premises.

Table 4.3: parameters that may be sampled in the water leaving treatment works

Parameter number	Parameter	Comments
4	Arsenic	See note 1
5	Antimony	See note 1
6	Benzene	
8	Boron	
10	Cadmium	See note 1
11	Chromium	See note 1
13	Cyanide	
14	1,2-dichloroethane	
16	Fluoride	
18	Mercury	
22	Pesticides	
23	Pesticides – Total	
25	Selenium	See note 1
26	Tetrachloroethene and trichloroethene	
31	Chloride	
32	*Clostridium perfringens* (including spores)	Only monitored for surface water supplies
34	Conductivity	
39	Oxidisability	Monitor TOC instead

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Parameter number	Parameter	Comments
40	Sulphate	
45	Total organic carbon (TOC)	Monitor instead of oxidisability
47	Tritium	
48	Total indicative dose	Assume that gross αand gross αactivities will be used to monitor total indicative dose

Note 1: This parameter can only be monitored in the water leaving the treatment works when a WSA can demonstrate for the zone supplied by that treatment works that the parameter has not been detected at significant concentrations (more than 50% of the standard) in sufficient samples (at least 10) from consumers taps in previous years.

3.7.3 | WSAs must meet the sampling frequencies specified in tables 3.5 (check monitoring parameters) and 3.6 (audit monitoring parameters) in appendices 1 and 2 of section 3 this handbook for the average volume of water produced each day by the treatment works (or the equivalent population supplied by the treatment works). Where a treatment works has more than one outlet mains and the water quality could be different in each mains because the mains are fed by different treatment streams, the WSA should sample each mains at the frequency for the average volume of water leaving each mains each day. If a WSA does not wish to sample the parameters in table 4.3 above in the water leaving treatment works, then it must sample them at consumers' taps.

3.7.4 | The sampling point for the water leaving the treatment works (works outlet) should be located so as to provide a representative sample of the water entering the distribution network. It should be downstream of all treatment processes including any contact tanks for the final disinfection process. All treatment works outlets from which samples are to be taken should be fitted with metal sampling taps of a hygienic design that do not have attachments or inserts and that are made of materials that comply with British Standard BS6920 regarding tests for the effect on water quality (or equivalent Irish or European standard). If a sample line is needed between the outlet mains and the sampling tap, it should be as short as possible and made of materials that comply with BS6920 (or equivalent Irish or European standard).

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4. Compliance sampling for specific parameters

4.1 Acrylamide, epichlorohydrin and vinyl chloride

4.1.1 | The standards for acrylamide of 0.1 µg/l, epichlorohydrin of 0.1 µg/l and vinyl chloride of 0.5 µg/l refer to the residual monomer concentration in the water as calculated according to the specifications of the maximum release from the corresponding polymer in contact with water. This is because there are not any sufficiently sensitive analytical methods to determine these parameters in drinking water at concentrations close to the standards.

4.1.2 | Acrylamide can be present in water supplies from the use of polyacrylamides as coagulant aids in water treatment and in water works sludge treatment. Epichlorohydrin can be present in water supplies from the use of polyamines as coagulants in water treatment and from epoxy resin linings of water mains and water retaining structures. Vinyl chloride can be present in water supplies from the use of unplasticised polyvinyl chloride (uPVC) pipes in water distribution networks.

4.1.3 | WSAs can assume that the standards for these three parameters are met provided that the products that contain these parameters are approved (for example by the Drinking Water Inspectorate (DWI) in England and Wales or any other equivalent European approval system pending the development of the European Acceptance Scheme (EAS)) and that the WSAs are using the products in accordance with any conditions of approval. The Drinking Water Inspectorate's latest list is posted on its website: ***http://www.dwi.gov.uk/31/soslist06.pdf***. If WSAs are using products containing these parameters that are not approved, WSAs must obtain information about the content of the parameters in the products and the leaching of the parameters from the product under the conditions of use and calculate whether the standards for these parameters are met.

4.2 Pesticides monitoring strategy

4.2.1 | The Regulations set the following standards for pesticides and related products:

- 0.03 µg/l for each of the individual pesticides aldrin, dieldrin, heptachlor and heptachlor epoxide;
- 0.1 µg/l for each other individual pesticide and related product (such as a growth regulator) and their relevant metabolites, degradation and reaction products; and

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- 0.5 µg/l for total pesticides.

Pesticides and related products are defined in the Regulations as any organic insecticide, herbicide, fungicide, nematocide, acaricide, algicide, rodenticide, slimicide and any product related to these including any growth regulator and their relevant metabolites, degradation and reaction products. The European Commission is preparing a Guidance Document on the definition and interpretation of relevant metabolites, degradation and reaction products in the context of the EC Directive 91/414/EEC concerning the placing of plant protection products on the European market. This may form the basis for the interpretation of relevant in the context of the EC Drinking Water Directive. The guidance on monitoring for pesticides in this handbook will be up-dated if necessary when the European Commission publishes its Guidance Document.

4.2.2 | Meanwhile WSAs should assume that relevant means any metabolites, degradation and reaction products that have similar pesticidal properties to the parent pesticide. WSAs should further assume that the pesticides currently in widespread use in Ireland do not have any relevant metabolites, degradation and reaction products in the context of drinking water.

4.2.3 | The Regulations state that total pesticides means the sum of all individual pesticides detected and quantified in the monitoring procedure. WSAs should assume that this means the sum of the detected concentrations of all individual pesticides and related products and any relevant metabolites, degradation and reaction products on a particular sampling occasion from a sampling point. WSAs should be aware that on a particular sampling occasion more than one sample bottle might need to be collected to enable all the individual pesticides of interest to be determined. If an individual pesticide is not detected above the limit of detection of the analytical method it is assumed to be absent.

4.2.4 | The Regulations state that samples may be taken within the supply zone (at consumers' taps) or at the treatment works for particular parameters if it can be demonstrated that there would be no adverse change to the measured value of the parameters concerned. WSAs may assume that for all individual pesticides that there is unlikely to be any significant change in concentration between the treatment works and consumers' taps and therefore they may take all samples from the treatment works if they wish.

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4.2.5 | It is not practical or necessary to monitor for every pesticide that is used within the catchment of a water source. The Regulations recognise this by noting that only those pesticides that are likely to be present in a given supply need to be monitored. To effectively implement this requirement, each WSA should develop a **monitoring strategy** for individual pesticides for each treatment works (or supply zone if the WSA decides to sample from consumers' taps) based on the likely risk of particular pesticides being present in the water source or sources from which water is abstracted for treatment at that treatment works. In developing a **monitoring strategy**, which should form part of the sampling manual, WSAs should:

- assess as far as practical which pesticides are used in significant amounts within the catchment area of each water source (information and advice should be available from the Pesticides Unit of the Department of Agriculture (***www.pcs.ie***) and local farming groups and from local authorities in respect of non-agricultural use);
- assess as far as practical on the basis of the properties and method of use of these pesticides and local catchment knowledge whether any of these pesticides are likely to reach water sources in the catchment area (information and advice should be available from the Pesticides Unit of the Department of Agriculture and local farming groups and from local authorities in respect of non-agricultural use);
- assess as far as practical when these pesticides are used to determine when they are likely to be present in the water source and therefore in the drinking water supply (information and advice should be available from the Pesticides Unit of the Department of Agriculture and local farming groups and from local authorities in respect of non-agricultural use);
- take into account the results of any monitoring for pesticides in water sources within the catchment area carried out by the WSA, the EPA and any other organisations under the Regulations S.I. 294 of 1989 or S.I. 722 of 2003;
- take into account the results of any monitoring at treatment works or in supply zones carried out under these or the previous Regulations (S.I. 439 of 2000); and
- include any individual pesticide for which a treatment process has been installed at the treatment works to remove that pesticide.

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4.2.6 | On the basis of this **monitoring strategy** each WSA should monitor the water leaving each treatment works (or in each supply zone) at at least the minimum audit monitoring frequency specified in table 3.6 of Appendix 2 of section 3 of this handbook for each of the individual pesticides identified as likely to reach a water source from which water is abstracted to that treatment works. Although the timing of audit monitoring samples for other parameters should be evenly distributed throughout the year, the EPA strongly recommends that for pesticides the samples are targeted at the times when pesticides are likely to be used. The EPA will consider taking appropriate action against a WSA that only takes samples for pesticides at times when they are unlikely to be found in water supplies.

4.2.7 | Towards the end of each calendar year each WSA should review its **monitoring strategy** for each treatment works (or each supply zone) using the above guidance. A particular pesticide may be omitted from the **monitoring strategy** if it has not been detected at significant concentrations in the water supplied from the works in the previous three years' compliance monitoring under these Regulations or the previous Regulations (S.I. 439 of 2000). A pesticide for which a treatment process has been installed should only be omitted from the **monitoring strategy** for that treatment works if the WSA can show, either from its own operational monitoring of the water source or the monitoring carried out under the Regulations S.I. 294 of 1989 or S.I. 722 of 2003 by the WSA, the EPA or other organisations on the water source, that the pesticide has not been detected in the water source for three years, provided that this monitoring was undertaken when the pesticide was most likely to be found in the water supply.

4.2.8 | WSAs and the laboratories they use should be aware that particular analytical methods for pesticides enable a suite of pesticides of similar chemical structure or properties to be determined. WSAs may continue to monitor all the pesticides in a suite even if a particular pesticide could be omitted because it had not been detected at significant concentrations in the previous three years.

4.2.9 | If at any time a WSA has any reasonable grounds for believing that a pesticide not included in its **monitoring strategy** for a particular treatment works could be present at concentrations approaching or exceeding the standard, the WSA should include that pesticide in its monitoring strategy for that works.

4.3 Lead monitoring strategy

4.3.1 | The standard for lead is 25 µg/l until the end of 24 December 2013 and becomes 10 µg/l from the start of 25 December 2013. WSAs must be taking action now to make sure they comply with the 10 µg/l standard and the other requirements for lead by that date.

4.3.2 | Lead is included within the audit monitoring category of the Regulations to determine compliance with these standards. The number of samples taken in each water supply zone is relatively small (1 for a supply serving 5,000 population to 13 for a supply serving 500,000 population) and the results may not give a true picture of lead concentrations at consumers' taps within the zone because they can be highly variable. The results can depend on:

- the length of any lead distribution mains;
- the length of lead pipe, if any, in the WSA's part of the service connection pipe to the premises (in general the WSA owns the part of the service connection from the mains to the external stop tap located usually just outside the boundary to the premises and the owner of the property owns the part of the service connection from the stop tap to the internal stop tap within the premises);
- the length of lead pipe, if any, in the property owner's part of the service connection pipe to the premises;
- the length of lead pipe, if any, within the internal plumbing to the kitchen tap in the property;
- the presence of copper pipe work joined by lead based solder;
- the type of sample taken (random daytime, stagnation and fully flushed – the first of these types of sample is defined and explained in paragraph 4.3.3 of this section and the latter two types in paragraph 6.7 of this section);
- the time of sampling in relation to previous water use within the property (generally a sample taken following recent water use will have a lower lead concentration than a sample taken after a long period of no water use;
- the volume of sample collected; and

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- the temperature (lead concentrations are higher in summer months than in winter months.

4.3.3 | There are three main types of sample that can be taken for monitoring lead concentrations – random daytime samples used for compliance monitoring; stagnation samples used for operational monitoring; and fully flushed samples used for operational monitoring. The latter two types of sample are described in paragraph 6 on operational monitoring. A brief description of random daytime samples is given below.

- **Random Daytime Sample** – this is where the sample is taken directly from the tap normally used for drinking without flushing the tap. The sample is taken at a random time during the day and once the sampler enters the sample location he/she takes the first litre of water from the tap. The purpose of this is to replicate how people consume water during the day (i.e. at random times without flushing the tap). This type of sampling is used for **compliance monitoring** as the Regulations require that the sample be representative of the weekly average ingested by consumers and that takes account of the occurrence of peak levels that may cause adverse effects on human health.

4.3.4 | It can be assumed that a high lead concentration (above 10 µg/l) in a compliance sample taken from a consumers' tap is indicative of lead pipe work in the WSA's or owner's part of the supply pipe or in the internal plumbing. But it cannot be assumed that a low lead concentration (less than 10 µg/l) is indicative of the absence of lead pipe within the pipe work system. Thus the limited number of compliance samples taken under audit monitoring will not give an accurate picture of compliance with the lead standard in the zone nor will they assist in identifying the extent of lead pipe within the supply pipe and internal plumbing. The EPA recommends that WSA's supplement the compliance audit monitoring with operational sampling as part of **lead surveys** as described in sub-section 6 of this section and in section 6 of this handbook on procedures for non-compliances with the standards.

4.3.5 | WSAs that need to get a much better picture of **compliance with the lead standard** should increase the number of **random daytime samples** taken from consumers' taps from the small number required by the Regulations.

4.4 Radioactivity

4.4.1 | The Regulations include the following two indicator parameters of radioactivity:

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- 100 Bq/l for tritium; and
- 0.1 mSv/year for total indicative dose.

However, the Regulations do not set monitoring requirements for these parameters because the Directive indicates that the frequencies, methods and locations are to be determined by a Committee set up under Article 12 of the Directive. This Committee has drafted some requirements but they have not been adopted by the European Commission.

4.4.2 | The Regulations also state that *"Drinking water need not be monitored for tritium or radioactivity to establish total indicative dose where, on the basis of other monitoring carried out, the levels of tritium or the calculated total indicative dose are well below the parametric value."*

4.4.3 | In the absence of guidance from the European Commission, the Radiological Protection Institute of Ireland (RPII) recommends that monitoring be carried out as follows:

- **Total Indicative Dose (TID)**. All water supplies of more than 1000 m^3/d should be monitored at least once every four years. As total indicative dose cannot be measured directly, samples should be screened using gross alpha and gross beta activity measurements. Where the **gross alpha** and **gross beta** activity concentrations are found to be less that 0.1 Bq/l and 1 Bq/l respectively then the sample is deemed to be in compliance with the parametric value for TID. Where either the gross alpha or gross beta concentration exceeds these screening levels, then the individual radionuclides should be measured and the TID determined in accordance with the methodology set out in the WHO Guidelines for Drinking Water (1993). If the total indicative dose is exceeded, the WSA should consult with the EPA, the RPII and the Health Service Executive (HSE) about what action, if any, needs to be taken.; and
- **Tritium**. Where a source of tritium is present in the catchment with the potential to contaminate a raw water source used for water supplies, any such supplies of more than 1000 m^3/d should be monitored at the audit monitoring frequency. Tritium concentrations should be measured directly using ultra low background liquid scintillation counting or other equivalent method.

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5. Compliance sampling from tankers

5.4.1 | The standards in the Regulations apply at the point at which water emerges from the tanker when a WSA supplies water by tanker (or similar container) instead of through the distribution network. In Ireland water supplied by tankers is only likely to happen for short periods in an emergency or when there is an incident affecting drinking water quality or when work is being carried out on the distribution network. The Regulations do not include any specific requirements for monitoring water supplied by tankers. Instead, the monitoring frequency is to be decided by the WSA concerned.

5.4.2 | WSAs are advised that when it is necessary to supply water by tanker they should fill each tanker with water that meets all the standards in the Regulations (the indicator parameter values in Table C do not have to be met but if they are not met the water must not pose a risk to health) and place a notice on each tanker advising consumers to boil water before using it for drinking and cooking. This is because the WSA cannot ensure the hygienic condition of the tap on the tanker or the containers used by consumers to collect water. If they do this, WSAs do not need to sample the water from the tanker provided the tanker is emptied and refilled within 48 hours with water that meets the standards. If the tanker is not emptied and refilled within 48 hours, the WSA should sample for E coli, pH value and conductivity. If the tanker is not emptied and refilled within 96 hours, the WSA should sample for all the parameters in the Regulations.

5.4.3 | WSAs should keep adequate records of the deployment of each tanker that include:

- the material of construction of the internal surface of the tanker (ideally it should be approved by the Drinking Water Inspectorate of England and Wales or equivalent approval system:
    - the water supply that was used to fill the tanker and the quality of that water;
    - the times the tanker was filled, emptied and refilled;
    - the results of any sampling that was necessary; and
    - the cleaning of the tanker before and after use.

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6. Operational sampling of water supplies

6.1 Introduction

6.1.1 | Paragraph 2.1.2 of this section states that each WSA should have a pre-determined **operational** sampling programme to check the quality of the raw water, the effectiveness of water treatment and the quality of water leaving treatment works and in service reservoirs/water towers that is not adequately covered by the **compliance** sampling programme. The programme should set out the number of samples to be taken for each parameter, the points at which the samples are to be taken and when the samples are to be taken. This sub-section provides guidance on the operational sampling programme, including where **on-line continuous** monitors can be used and where they must be used.

6.2 Operational sampling programme

6.2.1 | Each WSA should set out in its sampling manual its pre-determined **operational** sampling programme for each year. This programme must set out the frequencies of sampling and how quickly the result is required for **each relevant parameter** at:

- each of the raw water sources (intakes to treatment works);
- each treatment works (or each part of the treatment process);
- suitable points in each distribution network including each service reservoir/water tower; and
- at consumers' taps in particular supply zones when the WSA considers that the compliance sampling needs supplementing for particular parameters. Note that such operational samples can be taken from a "sentinel" tap, or taps, (such as an outside tap that can be sterilised) in each zone to monitor quality at the same point over time.

6.2.2 | The frequency of sampling for each parameter will depend on how variable its concentration or value is likely to be in the raw water source, during treatment, in the water leaving the treatment works and in the distribution network and its importance or significance in relation to water quality. WSAs may have to carry out additional

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operational sampling in response to incidents affecting drinking water quality or in emergencies or may wish to carry out additional microbiological monitoring of the supply to ensure that contamination has not occurred.

6.3 Operational sampling points

6.3.1 | Operational samples may need to be taken from the raw water sources, from individual treatment processes, from the water leaving treatment works, from points in the distribution network such as service reservoirs and water towers and from consumers' taps.

6.3.2 | The following is the minimum that should be included in the sampling manual regarding sampling points for operational sampling from the raw water source:

- the precise location of the point at which samples of the raw water source are to be taken;
- the sampling points should be reasonably accessible and if possible uniquely labelled; and
- a schematic diagram of each raw water source showing the location of the sampling point.

6.3.3 | The following is the minimum that should be included in the sampling manual regarding sampling points for operational sampling from the treatment works:

- the precise location of the points at which samples are to be taken of the water from the treatment processes and the water leaving the treatment works;
- sampling points should be reasonably accessible and uniquely labelled;
- a schematic diagram of each treatment works showing the location of each sampling point or points; and
- guidance on the sampling points. All treatment works sampling points should be fitted with metal sampling taps of a hygienic design that do not have attachments or inserts and that are made from materials that do not affect the concentrations of the parameters being monitored. Water should be supplied to the sampling tap

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through a sample line of a suitable material that should be as short as possible. The materials should meet British Standard BS6920 regarding tests for the effect on water quality (or equivalent Irish or European standard).

6.3.4 | The following is the minimum that should be included in the sampling manual regarding sampling points for operational sampling from service reservoirs and water towers and other points in the distribution network:

- the precise location of the point or points from which a representative sample or samples of the water flowing into the distribution network can be obtained. Where reservoirs/towers are divided into compartments and water does not mix freely between the compartments, the sampling points should be located so that samples are representative of all the water leaving the service reservoir/water tower or alternatively each compartment or its outlet should have a separate sampling point. Similar sampling arrangements should apply where there are two or more service reservoirs on a site;
- sampling points should be reasonably accessible and uniquely labelled;
- a schematic diagram of each service reservoir/tower or service reservoir/tower complex showing the location of the sampling point or points;
- all service reservoir/tower outlets should be fitted with metal sampling taps of a hygienic design that do not have attachments or inserts and that are made from materials that do not affect the concentrations of the parameters being monitored. Water should be supplied to the sampling tap through a sample line of a suitable material that should be as short as possible. The materials should meet British Standard BS6920 regarding tests for the effect on water quality (or equivalent Irish or European standard). Where it is impracticable to provide a tap on the reservoir site, a tap should be provided on the outlet main at the nearest possible point to the reservoir. Dip sampling should not be used. Break pressure tanks that do not provide a strategic reserve of water are not considered as service reservoirs/water towers; and
- other operational sampling points in the distribution system could be selected consumers' taps, or "sentinel" taps (such as outside taps or taps in public buildings) or hydrants depending on the purpose of the operational sampling.

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6.4 Raw water source

6.4.1 | Each WSA should have a **raw water operational sampling programme** to determine the quality of the source water to enable it to adjust and operate the treatment processes effectively. The WSA should make arrangements to be informed of the results of any sampling and analysis it or the EPA has carried out under the 1989 Regulations (S.I. 294 of 1989) or the 2003 Regulations (S.I. 722 of 2003) on the raw water source. Each WSA should also make arrangements with the EPA and other appropriate organisation to be informed of any pollution incidents that might affect adversely the quality of the water abstracted for treatment. The WSA should take this information into account when determining its own raw water sampling programme.

6.4.2 | The sampling manual should set out the parameters to be monitored, the frequency of sampling and analysis and the speed with which the results are required. Some parameters may be monitored continuously on-line with the results automatically relayed to the treatments works control room or to a remote control room for an unmanned works. Other parameters will be monitored at appropriate intervals. These will depend on the nature of the water source and the activities in the catchment that might affect water quality and the likely variations in quality. For example for a surface water source these could include conductivity, pH value, colour, turbidity and any parameters determined by a risk assessment to be important for that source (e.g. Cryptosporidium or pesticides). For a ground water source these could include conductivity and any parameters determined by a risk assessment to be important for that source (e.g. iron/manganese in aerobic ground waters). The programme should be reviewed and if necessary modified in the light of experience and the results obtained.

6.5 Treatment works

6.5.1 | Each WSA should **have a treatment works operational sampling programme** to check the overall effectiveness of the treatment processes and to check the operation of individual processes, in particular the effectiveness of disinfection and the minimisation of disinfection by-products. Sampling points for operational samples should be representative of water quality for the process to be monitored.

6.5.2 | Each WSA should specify the parameters and the frequency of sampling for each important process. Some parameters must be monitored continuously on-line (turbidity and residual chlorine) with the results automatically relayed to the treatment works control room or to a remote control room for an unmanned works and other parameters may be monitored continuously on-line (for example pH value, conductivity, colour). Other parameters will be monitored at appropriate intervals. The parameters will depend on raw water quality and the treatment processes used and should include monitoring for those parameters that the treatment processes are designed to remove (such as microbiological, pesticides, nitrate etc). WSAs should also specify how quickly the samples should be analysed and the results sent to the operator of the treatment works. The following paragraphs give some examples for the common treatment processes.

6.5.3 | For works using coagulation the operational monitoring could include:

- jar tests to determine optimum coagulant dose and coagulation pH (or automatic coagulation controller;
- coagulant dose;
- coagulation pH;
- residual coagulant following clarification/settlement (aluminium or iron).

6.5.4 | For works using conventional filtration the operational monitoring could include:

- on-line continuous turbidity monitoring of the filtrate from each filter;
- on-line continuous turbidity monitoring of the combined filtrate from all filters; and
- pH value as it may need adjusting for efficient disinfection.

6.5.5 | For works using granular activated carbon (GAC) either as a separate filtration process or incorporated into slow sand filters, the operational monitoring will depend of the purpose of the GAC (colour removal, general organics removal or specific organics removal such as individual pesticides) and could include:

- total organic carbon (TOC);
- colour;
- turbidity; and
- specific organic compounds such as individual pesticides.

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6.5.6 | For works using chlorination as the disinfectant:

- chlorine dose;
- pH value; and
- on-line continuous monitoring of chlorine residual in the final water.

6.5.7 | For the final water before entering the distribution network for a works using the above processes the operational monitoring could include:

- coliform bacteria and E. coli;
- colony counts at 22˚C;
- on-line continuous monitoring for chlorine residual;
- on-line continuous monitoring for turbidity;
- conductivity;
- pH value;
- colour;
- aluminium or iron residual;
- fluoride (when the supply is fluoridated);
- trihalomethanes; and
- any other parameter the works is specifically designed to remove

6.6 Distribution network

6.6.1 | Each WSA should have a **distribution network operational sampling programme** to check whether there has been any contamination or deterioration of quality within the network. Often this programme will consist of sampling from service reservoirs and water towers but may also include other points within the network. Each WSA should specify the parameters and the frequency of sampling. WSAs should also specify how quickly the samples should be analysed and the results sent to the network operator. The following paragraphs give some examples for distribution networks.

6.6.2 | For service reservoirs and water towers the operational monitoring could include:

- coliform bacteria and *E. coli*;
- colony counts at 22°C; and
- chlorine residual.

6.6.3 | For the distribution network the operational monitoring could include, at appropriate points throughout the network that are representative of the whole network:

- chlorine residual; and
- pH value/conductivity.

6.7 Lead

6.7.1 | Paragraph 4.3 describes sampling for lead and some of the difficulties and issues with the use of random daytime samples for **compliance monitoring**. Because of this it is necessary for WSAs to carry out **operational sampling** for lead to assist in determining the extent of lead pipe work within the water supply zone, the extent of non-compliance with the lead standard and the remedial action that might be required. The two types of operational monitoring samples for lead are described below:

Stagnation sample – this is where the water is allowed to stagnate in the pipes for a set period prior to taking the sample. The water is fully flushed prior to the stagnation period. In general this period should be at least 30 minutes but to get the "worst-case" scenario the sample can be taken first thing in the morning before any taps are used (this is usually accomplished by the sampler leaving sample containers with the occupier of the house the previous day). This will give the "worst-case" scenario. This type of sampling is regarded as **operational monitoring** and should be used for lead surveys to determine where lead pipes are located (i.e. results <5 μg/l indicate no

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lead pipes present). It may also be used to monitor the effectiveness of any treatment introduced to reduce plumbosolvency. Regard should be had to the location of lead in the plumbing system to ensure that the water sampled has been in contact with lead during the stagnation period.

Fully flushed sample – This is where water is fully flushed (run to waste) prior to sampling. The length of time a tap has to been run depends on several factors including length of pipe, rate of flow through the pipe and water pressure For example, if the service connection to a house is a 20 m long 1" pipe, approximately 10 L of water (i.e. a sink full) will need to be run to waste. This method determines the quality of water in the distribution network as the volume of water in the service connection and internal plumbing is run to waste. This method is used where consumers have been advised to fully flush their taps. The purpose is to confirm that the levels of lead in the fully flushed water (i.e. what is being consumed) are satisfactory. Where these levels are high it indicates that there may be a long service connection comprised of lead or there may be lead in the distribution main. The amount of water to be flushed through the system prior to sampling should be *calculated having regard to the length of lead service pipe and design of the* plumbing system.

6.7.2 | These operational samples are used as part of a **lead survey** to determine the extent of lead pipes in the distribution network, the supply pipe work (service connections) and the internal plumbing within premises. Guidance on the use of lead surveys is given in section 6 of this handbook on procedures for non-compliance with standards.

6.8 Cryptosporidium

6.8.1 | There is no regulatory requirement for WSAs to monitor for *Cryptosporidium*. Monitoring for *Cryptosporidium* requires specialist sampling equipment and a laboratory equipped for specialist analysis. The EPA Environmental Enforcement Network Cryptosporidium Working Group recommends that for an initial period of two years the following minimum monitoring frequencies are implemented:

- for treatment works serving a population greater than 20,000, once every week a sample collected continuously over 24 hours should tested for *Cryptosporidium*; and

- for treatment works serving a population less than 20,000, a sample collected continuously over 24 hours should be tested for *Cryptosporidium* at a frequency to be determined from the risk category and results of treatment works monitoring.

After two years of testing, a review of results for each water treatment works will allow the monitoring frequencies to be adapted to better suit the characteristics of each supply. The EPA regards the preparation and implementation of Drinking Water Safety Plans (DWSPs), including risk assessments for *Cryptosporidium*, as a key measure to ensuring a secure and safe drinking water supply. Comprehensive advice on preparing DWSPs and on carrying out risk assessments for *Cryptosporidium* is given in section 10 of this handbook.

6.8.2 | Where a public water supply is clearly high risk in respect of *Cryptosporidium* because there is *Cryptosporidium* in the catchment and there are insufficient treatment barriers (such as coagulation/filtration or membrane filtration) or disinfection (such as irradiation with ultraviolet (UV) light) in place to remove or inactivate *Cryptosporidium*, monitoring should be carried out to determine whether there is a risk to health. The monitoring frequency should be determined in consultation with the HSE. Where there is a treatment barrier and/or disinfection or a barrier/disinfection has been installed to remove/inactivate *Cryptosporidium*, there is a case for some operational monitoring for *Cryptosporidium* to establish that the barrier/disinfection is working satisfactorily. Similarly where there is some doubt about the accuracy of the risk assessment because there is uncertainty about the risk of *Cryptosporidium* in the catchment of the source or about the effectiveness of the barrier/disinfection, there is a case for monitoring for *Cryptosporidium* to establish/confirm the risk before installing new or additional barriers/treatment.

6.8.3 | Where a WSA decides it is necessary to monitor for *Cryptosporidium*, it should only carry out the monitoring until it has established/confirmed that there is, or is not, a risk. Where monitoring is necessary, a minimum of 40 litres per hour of water should be collected continuously from the water leaving treatment works over 24 hours in a special sampling device and tested for *Cryptosporidium* at an appropriate frequency determined in consultation with the HSE. The amount of *Cryptosporidium* in the sample is estimated using an appropriate analytical technique. Comprehensive guidance on suitable sampling devices and on appropriate analytical techniques is available on the web-site of the Drinking Water Inspectorate (DWI) for England and Wales (***http://www.dwi.gov.uk/regs/crypto/legalindex.htm***).

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7. Other types of samples

7.1 | From time to time WSAs will be required to take and analyse other samples. One example is samples taken to investigate failures to comply with the standards and indicator parameter values. Another example is samples taken in response to consumers' complaints about drinking water quality. These samples are not included in the formal **compliance** or **operational** monitoring programme. However the WSA should keep adequate records of these other types of sample and the results of any analysis so that they can be provided to the EPA on request. Sometimes consumers collect samples when they are concerned about water quality. There is no guarantee that consumers have taken these samples properly or collected them into appropriate containers. WSAs should still analyse these samples unless it is obvious that the results would be meaningless in which case the WSA should explain to the consumers why the samples are not being analysed. When WSAs do analyse samples taken by consumers, they should treat the results with caution. WSAs should also always collect and analyse their own samples when investigating consumers' complaints.

8. Training of samplers

8.1 | In order to carry out sampling correctly it is essential that all samplers are fully trained and competent before they are allowed to work unsupervised. The WSA or its laboratory (or its sampling/laboratory contractor) should produce a comprehensive sampler's training programme to cover all aspects of sampling and include:

- the criteria for selection of persons suitable to train as samplers;
- supervised training in all relevant aspects of sampling, including in the field;
- the criteria and method of assessment of competence to work supervised and unsupervised;
- the criteria and method of assessment of competence for trainers of samplers to train, audit and supervise samplers;
- the monitoring and supervision of trained samplers to check that they continue to perform satisfactorily and the criteria for satisfactory performance;
- re-training when performance is not satisfactory; and

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- an annual review of each sampler's training to assess whether further training is necessary.

8.2 | Samplers should not carry out sampling procedures unless they have been successfully trained to an acceptable standard or they are being supervised by a competent and experienced sampler as part of their training. All samplers should have:

- a copy of the sampling manual;
- been trained in all the relevant procedures in, and practices of, the sampling manual that they are, or could be, required to carry out; and
- a training record that sets out clearly those procedures and practices in which they have been trained, the dates and results (competency) of that training, the dates and results of monitoring/audits of training and any re-training and the results of the annual review.

8.3 | The Water Services Training Group (WSTG) has a course on sampling procedures for the Drinking Water National Monitoring Programme (DWNMP) (***www.wsntg.ie/courses***). Other organisations may offer suitable training courses for samplers.

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Appendix 1: Sample bottles, sample preservation and storage

1. The following table gives an alphabetical list of the regulatory parameters with the recommended sample bottle types, nominal sample volumes, storage times and preservatives. This information is based largely on International Standard ISO 5667-3:2004 "Water Quality – Sampling – Part 3: Guidance on the preservation and handling of water samples".

2. While the information in the table is generally applicable, it should be remembered that analytical techniques are continually evolving and undergoing improvement. It may therefore be the case that for some of the parameters for which large volumes in specially cleaned glass bottles are prescribed, that smaller quantities would be acceptable to the laboratory and the analyst. Samples for several parameters can be collected in the same sample bottle with the same preservative.

3. While the recommendations represent an ideal situation the logistics of sample collection and transport may mean that it is impractical to meet these recommendations. Where this is the case alternative recommendations are presented. For microbiological parameters it is imperative that time delay between sampling and analysis is kept to a minimum.

4. Where extended storage times are utilised it is recommended that laboratories verify the validity of such approaches by conducting storage recovery tests. Analytical measurements should be subject to appropriate Analytical Quality Control (Refer to International Standard ISO/TS 13530:2009 "Water quality – Guidance on analytical quality control for chemical and physicochemical analysis") and sample bottles used should be assessed for possible contamination.

5. In case of any doubt the laboratory or the analysts should be consulted prior to sampling.

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Key to the table

ASAP:	Analysis as soon as possible (on-site or within a maximum of 24 hours)
D:	Maximum recommended storage time after preservation (if applicable)
Glass*:	Glass bottle rinsed with 5% HNO3
Glass+:	Glass bottle rinsed with suitable solvents.
IA:	Immediate analysis
P/G:	Plastic or glass
P/G-AW:	Plastic or glass – acid washed (e.g. 5% v/v HNO3)
R:	Refrigerate at 1-5˚C
RD:	Refrigerate in the dark
Sterile:	Pre-sterilised container

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Parameter		Bottle Type	Bottle Volume	Preservation and storage conditions	Storage Period after preservation[1]
29	Aluminium	P/G-AW	250 ml	Acidify with HNO_3 to pH 1-2	1month[6]
30	Ammonium	P/G	500 ml	ASAP R Acidify with H_2SO_4 to pH <2 Freeze to – 20˚C	< 2 hours 24 hours 21 days 1 month
4	Antimony	P/G-AW	100 ml	Acidify with HNO_3 to pH 1-2	1 month[2,6]
5	Arsenic	P/G-AW	500 ml	Acidify with HNO_3 to pH 1-2	1 month[2,6]
6	Benzene	Glass+	2500 ml	R, do not pre-rinse bottle with sample	7 days
7	Benzo(a)pyrene	Glass+	2500 ml	R, do not pre-rinse bottle with sample	7 days
8	Boron	Plastic	100 ml	Acidify with HNO_3 to pH 1-2	1 month
9	Bromate	P/G	100 ml	R	1 month
10	Cadmium	P/G-AW	100 ml	Acidify with HNO_3 to pH 1-2	1 month[6]
31	Chloride	Plastic	100 ml	R	1 month
11	Chromium	PG-AW	100 ml	Acidify with HNO_3 to pH 1-2	1 month[6]
32	*Clostridium perfringens*	G/P Sterile	200 ml	Store in cooler box, 2-8˚C	6 hours[7]
44	Coliform bacteria	G/P Sterile	200 ml	Store in cooler box, 2-8˚C	6 hours[7]
43	Colony count 22˚C	Glass S	200 ml	Store in cooler box, 2-8˚C	6 hours[7]
33	Colour	Plastic	250 ml	RD	5 days[3]
34	Conductivity	Plastic	100 ml	R	7 days[4]
12	Copper	P/G-AW	100 ml	Acidify with HNO_3 to pH 1-2	1 month
13	Cyanide	Plastic	500 ml	Add NaOH to pH>12; RD	7 days

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Parameter		Bottle Type	Bottle Volume	Preservation and storage conditions	Storage Period after preservation[1]
14	1,2-Dichloroethane	Glass+	2500 ml[9]	R; if residual chlorine is present add 80 mg $Na_2S_2O_3$ per litre of sample	14 days
2	Enterococci	G/P Sterile	200 ml	Store in cooler box, 2-8˚C	6 hours[7]
1	Escherichia coli [E.coli]	G/P Sterile	200 ml	Store in cooler box, 2-8˚C	6 hours[7]
16	Fluoride	Plastic	500 ml	R	1 month
35	Hydrogen ion concentration (pH)	Plastic	100 ml	IA (on-site if possible and preferably within 6 hours	6 hours[5]
36	Iron	P/G-AW	100 ml	Acidify with HNO_3 to pH 1-2	1 month[6]
17	Lead	P/G-AW	100 ml	Acidify with HNO_3 to pH 1-2	1 month[6]
37	Manganese	P/G-AW	100 ml	Acidify with HNO_3 to pH 1-2	1 month[6]
18	Mercury	Glass*	500 ml	Acidify with HNO_3 to pH 1-2 Add 0.05%w/v K_2CrO_7; R	1 month
19	Nickel	P/G-AW	50 ml	Acidify with HNO_3 to pH 1-2	1 month[6]
20	Nitrate	P/G	100 ml	Add H_2SO_4 to pH<2; R	48 hours
21	Nitrite	Plastic	100 ml	R Acidify with HCl to pH <2 Freeze to – 20˚C	24 hours 7 days 1 month
38	Odour	Glass	500 ml	ASAP, R	6 hours
39	Oxidisability	P/G	500 ml	Acidify with 8M H_2SO_4 to pH 1-2 Refrigerate at 1-5˚C Freeze to – 20˚C	2 days 2 days 1 month
22	Pesticides	————	See pesticides – Total – ———-		

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Parameter		Bottle Type	Bottle Volume	Preservation and storage conditions	Storage Period after preservation[1]
23	Pesticides – Total	Glass+	2500 ml	R; do not pre-rinse bottle with sample; if residual chlorine is present add 80 mg $Na_2S_2O_3$ per litre of sample	5 days[8]
24	Poly aromatic hydrocarbons	Glass+	2500 ml	R; do not pre-rinse bottle with sample; if residual chlorine is present add 80 mg $Na_2S_2O_3$ per litre of sample	7 days[8]
25	Selenium	P/G-AW	100 ml	Acidify with HNO_3 to pH 1-2	1 month[6]
41	Sodium	P/G	100 ml	Acidify with HNO_3 to pH 1-2 if by atomic spectrometry R; if by ion chromatography	1 month[6] 1 month
40	Sulphate	P/G	200 ml	R	14 days
42	Taste	Glass	500 ml	ASAP; R	24 hours
26	Tetrachlorethene and trichlorethene	Glass+	2500 ml9	R; if residual chlorine is present add 80 mg Na2S2O3 per litre of sample	14 days
45	Total organic carbon [TOC]	P/G	150 ml	R Freeze to – 20°C	7 days 1 month
27	Trihalomethanes – Total	Glass+	250 ml9	R; if residual chlorine is present add 20 mg $Na_2S_2O_3$ per 250 ml of sample	14 days
46	Turbidity	Plastic	500 ml	Store in dark <24 hours	24 hours

[1] Though the storage period for preserved samples may be up to one month for some parameters, it is recommended that analysis for drinking water parameters be carried out within at least 14 days of the sample being taken.

[2] HCl should be used if the hydride technique is used for this analysis.

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[3] Samples should be kept in the dark. In the case of groundwater rich in iron II analysis should preferably be carried out on site within 5 minutes of collection to avoid precipitation of Iron oxides.

[4] Analysis within 24 hours is recommended in the ISO standard. However, if no significant changes are likely samples can be analysed within 7 days.

[5] In-situ pH measurements should be made using instruments calibrated before use. While laboratory measurements are generally more accurate the actual pH of samples (particularly lime-treated waters) could change during transport to the laboratory and stability may require to be verified. Samples should be kept cool and laboratory analysis commenced within 24 hours.

[6] Samples for metal analysis should preferably be analysed within 1 month but may be stored up to 6 months if recovery after extended storage has been validated.

[7] Samples for microbiological parameters should be kept in the dark refrigerated during transportation to the laboratory. If samples are kept at ambient temperature (in the dark, not exceeding 25°C) the examination shall begin within 6 h after taking the sample. Samples may be kept at (5 ± 3°C) for up to 24 h prior to examination however the time between sampling and examination must be kept to a minimum. Refer to ISO 9308-1:2000 for further details.

[8] Extraction for Pesticides/PAHs should ideally be undertaken within 24 hours. The preservation time given is for the extracted sample.

[9] Analysis for organics by purge/trap or GCMS techniques may require as little as 40 ml (in duplicate). Check with the laboratory or analyst before sampling.

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Appendix 2: Specimen field log sheet

European Communities (Drinking Water) (No. 2) Regulations 2007

Water Services Authority:
[A separate sheet for each supply to be completed at the time of sampling]

Date of sample:
Name of sampler:
Name of water supply:
Full details of sampling point and its location:
Sample identification:
Time of Sampling:
General observations:
Results of Field Measurements:
Conductivity: µS/cm
pH value: pH units
Temperature: o C
Total chlorine: mg/l
Free chlorine: mg/l
Others:

Details of samples taken

Bottle No	Bottle type	Bottle volume	Preservation details	Comments
1				
2				
3				
4				
5				
etc				

Observations:
Signature of sampler:
Sample received in the laboratory at (time and date):
By:
From:

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SECTION 5: GUIDANCE ON ANALYSIS

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Section 5: Guidance on Analysis

Summary of Section 5

- Sets out the requirements of the Regulations on analysis and emphasises the importance of accreditation.
- Advises Water Services Authorities (WSAs) and their laboratories on the competence, training and supervision of analysts and the monitoring and audit of analysts' performance.
- Provides guidance on the storage and preservation of samples in the laboratory.
- Describes the criteria for the suitability of laboratory equipment.
- Sets out the regulatory requirements for the performance of analytical methods.
- Provides advice on how to determine the performance of analytical methods for specified parameters, on those parameters for which analytical methods are specified and on those parameters for which performance is not specified.
- Sets out the requirements of the Regulations on analytical quality control.
- Provides advice on the internal and external analytical quality control procedures to satisfy the regulatory requirements.
- Advises WSAs and their laboratories on the calibration of analytical systems.
- Provides advice on how to correct analytical results for recovery losses when analysing for organic parameters.
- Provides advice on what information to retain in the laboratory's records of analysis.
- Describes the importance of the integrity of analytical results and advises on how to ensure integrity.
- Provides brief details of the annual reporting of analytical results to the Environment Protection Agency (the EPA).

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Appendix 1: parameters for which performance characteristics are specified

Appendix 2: parameters for which methods of analysis are specified

1. Introduction

1.1 | Part 3 of the schedule to the Regulations states that *"Each laboratory at which samples are analysed must have a system of analytical quality control that is subject from time to time to checking by a person who is not under the control of the laboratory and who is approved by the Agency [the Environment Protection Agency*

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(the EPA)] for that purpose". Part 3 also specifies the methods that must be used for the microbiological parameters and the performance that must be achieved for the non-microbiological parameters in terms of trueness, precision and limit of detection.

1.2 | Laboratories may satisfy these requirements and the guidance in this section for particular parameters if they maintain **accreditation for those parameters, in drinking water, to the ISO/IEC Standard 17025 "General Requirements for the Competence of Calibration and Testing Laboratories".** Assessment for compliance with the above standard is carried out in Ireland by the **Irish National Accreditation Board (INAB)**. Following the award of accreditation, laboratories should ensure that testing for all parameters continues to meet the requirements of ISO/IEC 17025 and that all test results are reported as accredited results. Laboratories that are not accredited for all the required individual parameters in drinking water will need to demonstrate to the EPA, or a person or organisation authorised by the EPA, that they have an appropriate quality management system in place and that they satisfy the requirements of the Regulations and the guidance in this section. The key requirements of a quality management system include document control of all procedures and analytical methods used in the laboratory, standards for sub-contracting analysis to another laboratory, procedures for dealing with complaints about the service, satisfactory laboratory accommodation, a self-assessment process including internal audit and management review, integrity and impartiality, valid test procedures, competence of personnel and traceability of measurements.

1.3 | **Laboratories carrying out analysis of drinking waters attain accreditation to ISO 17025 for all parameters** in drinking water and as such the EPA considers that laboratories that maintain such accreditation will satisfy the requirements of Part 3 of the schedule to the Regulations. **Laboratories that carry out analysis for determining compliance with the water quality standards must be accredited for all drinking water parameters by the end of 2015. The EPA will not accept unaccredited monitoring results after the end of 2015. When uploading drinking water data from laboratory information systems to EDEN, WSAs should only populate the accreditation field as "True" if the laboratory is accredited to the ISO 17025 standard for that individual drinking water result.**

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2. Competency and training of analysts

2.1 | Water Services Authorities (WSAs) and their laboratories or their contract laboratories should ensure that samples are analysed by, or under the supervision of, a person who is competent to perform that task. As many laboratories will have some staff with only basic technical qualifications and limited experience in water analysis, the organisational and management structure of the laboratory is important. The following should be included in the laboratory structure:

- the laboratory manager is supported by an adequate number of qualified staff, trained in the principles and practice of relevant areas of analysis;
- there is a nominated deputy for the manager who is suitably qualified and experienced;
- an up-to-date record is kept of the structure and organisation of the laboratory;
- an up-to-date record is kept of the qualifications, experience and training of each member of staff;
- the proportion of senior to junior staff is such as to ensure a satisfactory level of supervision;
- unqualified temporary staff are adequately supervised and the proportion of unqualified staff to qualified staff does not impair the quality of analysis performed; and
- there is a suitably qualified quality control manager responsible for all quality control activities in the laboratory and who has direct access to senior management outside the laboratory.

2.2 | In order to carry out monitoring of drinking water quality correctly it is essential that all analysts are fully trained and competent before they are allowed to work unsupervised. WSAs and their laboratories or their contract laboratories should produce a comprehensive analyst training manual and programme to cover all aspects of analysis that as a minimum should include:

- the criteria for selection of persons suitable to train as analysts, if necessary sub-divided by type of analysis;

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- the relevant principles and practice of analysis, including calibration and internal and external analytical quality control;
- supervised training and experience of the relevant analytical systems;
- the criteria and method of assessment of competence to work supervised and unsupervised;
- the criteria and method of assessment of competence for senior analysts to train, audit and supervise others;
- the monitoring/audit of trained analysts to check that they continue to perform satisfactorily and the criteria for satisfactory performance;
- re-training when performance is not satisfactory; and
- an annual review of each analyst's training to assess whether further training is necessary.

2.3 | All analysts should have:

- a copy of the analytical methods that they are trained to use and access to a copy of the laboratory analysis manual;
- been trained in all the relevant analytical methods that they are, or could be, required to carry out;
- been trained in the principles and practices of calibration of equipment and methods and in analytical quality control; and
- a training record that sets out clearly those procedures and practices in which they have been trained, the dates and results (competency) of that training, the dates and results of audits of training and any re-training and the results of the annual review.

2.4 | Analysts should not carry out analytical procedures unless they have been successfully trained to an acceptable standard or they are being supervised by a competent and experienced analyst as part of their training.

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3. Sample storage and preservation

3.1 | Samples must be transported to the laboratory with the minimum of delay in an appropriate sampling vehicle under appropriate conditions (see paragraph 2.2 of section 4 of this handbook). The laboratory manual should contain written instructions for the storage and preservation of samples or sample portions that include:

- adequate refrigerated storage capacity and precautions to ensure that samples are not contaminated;
- monitoring and recording of refrigerator temperature;
- commencing and carrying out sample preservation within the maximum acceptable time, when it has not been carried before or at the time of sampling and it is necessary;
- procedures for dividing samples into portions and preserving such sample portions when necessary within the maximum acceptable time, when sample portions are required prior to analysis;
- clear labelling of preserved and unpreserved sample portions and preserved and unpreserved samples;
- commencing analysis within the maximum acceptable time when sample preservation has been carried out before or at the time of sampling;
- not analysing samples and sample portions that have not been preserved in sufficient time; and
- a requirement to carry out "blank checks" on reagents and/or apparatus used for sample preservation and for action to be taken in the event of an unsatisfactory blank.

3.2 | Further guidance on appropriate sample bottle types, sample preservation techniques and sample storage conditions is given paragraph 2.2 of section 4 of this handbook.

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4. Suitability of analytical equipment

4.1 | The analytical equipment (including the principal apparatus and all standard laboratory apparatus such as balances, glassware, thermometers, incubators etc) should be of the type specified in the analytical method and it should comply with each of the following criteria before it can be regarded as suitable for the purpose:

- located and used in appropriate conditions;
- maintained and serviced according to the manufacturer's or supplier's instructions or recommendations or equivalent procedures that are auditable;
- operated according to the manufacturer's or supplier's instructions or recommendations or equivalent procedures that are auditable;
- calibrated according to the manufacturer's or supplier's instructions or recommendations or equivalent procedures that are auditable;
- have a current calibration that is both valid and traceable to national or international standards; and
- all system suitability and analytical quality control criteria.

4.2 | Further guidance is given in ISO/IEC Standard 17025 "General Requirements for the Competence of Calibration and Testing Laboratories".

5. Performance of analytical methods

5.1 Introduction

5.1.1 | In order to ensure the accuracy of the results of monitoring drinking water quality, it is an essential requirement of the Regulations that laboratories use either the specified methods or alternative methods approved by the EPA (for microbiological parameters) or methods which meet the performance characteristics (trueness, precision and limit of detection) set out in part 3 of the schedule to the Regulations (for chemical and other parameters) and that they operate a system of analytical quality control that is checked by a person who is not under the control of the laboratory and who is approved by the EPA. For some indicator parameters there is no numerical indicator parameter value but there is a descriptive value either "no abnormal change" or "acceptable to consumers and no abnormal change". For these parameters an analytical method or the performance to be achieved by an analytical method is not specified.

5.1.2 | **Each laboratory should have tested the performance of the analytical methods used for each parameter or each determined constituent of a parameter (for chemical and other non-microbiological parameters), and to have demonstrated that the method is capable of meeting the performance requirements set out in Part 3 of the schedule to the Regulations before that method is used for routine analysis of compliance samples**. Performance testing should cover the entire analytical method, including any sample preparation and concentration steps. Performance testing should be carried out in a manner emulating that used routinely, without taking special precautions that would not generally apply to achieve optimum performance. An analytical method is the specific combination of laboratory, analysts, instrumentation and analytical procedure used to analyse the sample, including any sample preparation or pre-treatment steps. Provided all analysts have been trained to the same standard and their competence has been assessed using the same criteria they can be regarded as equivalent for the purposes of initial performance testing of the analytical method.

5.1.3 | Laboratories may satisfy the performance requirements of the Regulations and the guidance in this section for particular parameters if they have gained accreditation for those parameters to the ISO/IEC Standard 17025 "General Requirements for the Competence of Calibration and Testing Laboratories" from the Irish National Accreditation Board (INAB). This is amplified in paragraph 1 of this section.

5.2 Parameters for which performance is not specified

5.2.1 | For the following parameters an analytical method or the performance to be achieved by an analytical method is not specified. The EPA advises the following:

Colour: qualitative assessments of the colour of water on different sampling occasions are unlikely to enable "no abnormal change" to be detected. WSAs and their laboratories should use an appropriate quantitative method for determining colour in mg/l Pt/Co that has a trueness, precision and limit of detection each equal to or better than 2 mg/l Pt/Co;

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Odour and taste: quantitative assessments of the odour and taste of water are time consuming and require a specialist panel of persons to smell and taste samples. Qualitative assessments by an experienced analyst are likely to be able to detect abnormal changes and therefore be able to determine whether the regulatory requirement of "no abnormal change" has been met. Analysts carrying out qualitative assessments of odour and taste must avoid in a period prior to the assessment activities that could affect the assessment, such as smoking, drinking and eating and wearing excessive cosmetics. **Taste assessments should not be carried out on any supply that is not disinfected or where disinfection is practised but may not be effective**;

Colony count at 22˚C: WSAs and their laboratories should use the method in ISO 6222 for the enumeration of culturable micro-organisms or an alternative method approved by the EPA;

Total organic carbon (TOC): WSAs and their laboratories should use an appropriate quantitative method for determining TOC in mgC/l that has a trueness, precision and limit of detection each equal to or better than 0.5 mgC/l; and

Turbidity: qualitative assessments of the turbidity of water on different sampling occasions are unlikely to enable "no abnormal change" to be detected. WSAs and their laboratories should use an appropriate quantitative method for determining turbidity in nephelometric turbidity units (NTU) that has a trueness, precision and limit of detection each equal to or better than 0.25 NTU.

5.3 Parameters for which performance is specified

5.3.1 | For the most of the non-microbiological parameters, the methods of analysis are not specified in the Regulations. Instead the Regulations specify the performance to be achieved by the methods of analysis. **WSAs and their laboratories may use any analytical methods they wish provided they meet the performance specifications**. The table in appendix 1 reproduces the Regulations and sets out the performance characteristics (trueness, precision and limit of detection as a percentage of the standard or parametric value) that the methods of analysis used must, as a minimum, be capable of measuring.

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Initial performance testing

5.3.2 | The analytical method should be subjected to testing of its trueness, precision and limit of detection, including spiking recovery. **Laboratories should have a written procedure for the initial performance testing and validation of methods and the results should be kept for audit purposes**. The specifications for these performance characteristics are given in appendix 1 of this section. In addition any method that is not referenced to a fully validated authoritative method should be subjected to testing of its resilience against possible interferences. The minimum acceptable specifications for performance testing are given in the paragraphs below. The design of tests and calculation of performance characteristics should be in accordance with the guidance given in for example the UK publication 'A Manual of Analytical Quality Control for the Water Industry' (NS30) or any equivalent publication.

5.3.3 | A laboratory using an analytical method that is not referenced to a fully validated authoritative method should demonstrate that the method has been fully documented and tested to the standard currently expected of an authoritative reference method. It should demonstrate that the following have been established:

- the required tolerances of all measurements undertaken within the method (volumes, temperatures, masses etc);
- the forms of the determinand measured, including speciation;
- the effect of interferences has been widely investigated and quantified; and
- significant sources of error have been identified and adequate means of controlling them documented.

5.3.4 | For most parameters the minimum specification for the performance characteristics to be determined is as follows. Estimate the within-laboratory total standard deviation of individual analytical results for blanks, standard solutions, samples and spiked samples on at least 5 separate days (further advice on number of batches and period of testing is given in the paragraphs below). The number of replicate determinations of each solution in each batch should be the same and not less than two. All estimates of standard deviation used to estimate limit of detection or precision, or used in significance tests should have at least 10 degrees of freedom. The trueness for standard solutions, mean spiking recovery and standard deviation of spiking recovery should also be determined.

Limit of detection is to be calculated as:

- three times the relative within batch standard deviation of a natural sample containing a low concentration of the parameter; **or**
- five times the relative within batch standard deviation of a blank sample.
- **Precision** (the random error) is to be calculated as twice the standard deviation (within batch and between batches) of the spread of the results about the mean.
- **Trueness** (the systematic error) is to be calculated as the difference between the mean value of the large number of repeated measurements and the true value.

5.3.5 | The range of the standard solutions tested should include the concentration or value of the parameter in tables A and B (the standards) and table C (the indicator parameter values) in the schedule to the Regulations wherever possible, but in all cases the whole calibrated range of the method should be covered subject to allowance for ensuring that all measurements fall within the calibrated range. This implies that a minimum of two different standard solutions should be included in the performance tests. All standard solutions should be prepared immediately prior to analysis for each batch, either from the pure substance or a stock solution that is known to be stable for the period of the tests.

5.3.6 | The sample(s) and spiked sample(s) selected for use should represent the type or types of drinking water normally analysed. The same bulk sample(s) should be used throughout the tests. Samples should be spiked immediately before analysis for each batch. The spiking standard should either be known to be stable for the period of the tests or be prepared in the same way as for standard solutions.

5.3.7 | Where there is a choice of key instruments, including electrodes and chromatographic columns, each combination used should be regarded as a separate analytical method. For instruments that are not identical full testing should be carried out for each analytical method. For identical instruments full validation should be carried out for each method except where the results of limited testing of the instruments under the conditions used in the analytical method have demonstrated that there is no statistically significant (at the 95% confidence level) difference in performance between the instruments, in which case only one method requires full validation. The tests should be performed on a minimum of five separate days and include the analysis of typical real samples and spiked samples. Limited testing should be appropriate for electrodes or chromatography columns from the same manufacturer or supplier. If the internal AQC record subsequently shows a significant difference in performance between methods each method should then be fully tested. Alternatively, independent data may be available, for example from the manufacturers or suppliers, to demonstrate the equivalence of items such as electrodes and chromatographic columns.

5.3.8 | WSAs and their laboratories should note that 5 batches of duplicate analyses cannot give 10 degrees of freedom. While many combinations of number and size of batch may give 10 degrees of freedom, a minimum of 11 batches is required to guarantee that number of degrees of freedom, irrespective of the number of replicates included in the batch. Laboratories are therefore strongly recommended to adopt 11 batches of duplicates as their minimum specification. The formula for calculating the number of degrees of freedom is given on page 57 of NS30 (or equivalent publication). A laboratory may however check whether at least 10 of degrees of freedom have been achieved by performing the calculation any time after at least 6 batches of duplicate analysis have been carried out provided they have been done on at least 5 separate days.

5.3.9 | For methods where the discrimination of the method is insufficient to record values other than zero for most blank determinations, the within-batch standard deviation of either the low standard solution or the within batch standard deviation of the sample may be used to calculate the limit of detection. Alternatively, a very low standard solution, at a concentration approximately two to three times the expected limit of detection when using the best currently available method, may be used as a surrogate blank. Some methods, particularly those involving simple titrations or the use of colour comparators, may be incapable of measuring any within-batch differences. In such cases the limit of detection should be quoted as the lowest measurable concentration or value.

5.3.10 | The bulk sample may not always be stable over the entire period of testing, resulting in an artificially high estimate of between-batch standard deviation. This instability may be recognised by a distinct trend in results for the sample over the period of testing and a between-batch standard deviation that, statistically, is significantly greater (at the 95% confidence level) than would be expected from the estimates obtained for the standard solutions. In such cases a surrogate between-batch standard deviation should be calculated using procedure (a) on page 53 of NS30 (or equivalent publication). Where the instability is so great that the estimate of within-batch standard deviation is significantly affected it may be possible to improve stability

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by ageing of the sample. Where ageing is either impractical or ineffective in reducing sample instability sufficiently to avoid a statistically significant effect on the estimate of within-batch standard deviation, procedure (b) on pages 53 and 54 of NS30 should be used (or equivalent publication).

5.3.11 | The period of testing should be continuous and not unduly long. Not more than 2 batches may be analysed on any day. When 2 batches are analysed on the same day all instruments used should be shut down to overnight conditions, daily reagents freshly prepared and all test solutions freshly prepared between the first and second batches.

5.3.12 | For physical parameters for which values are not truly additive spiking recovery tests may yield little useful information and need not be done. It is not possible to either analyse a blank or do spiking recovery tests for hydrogen ion concentration (pH value). For these parameters the calibrated range (or ranges) must include the full range of values encountered and the value in table B (the standards) and table C (the indicator parameter values) in the schedule to the Regulations.

5.3.13 | Methods may be used for compliance monitoring against the standards and indicator parameter values in the Regulations once it has been established that the performance characteristics determined by the procedures set out above meet the specifications for trueness, precision and limit of detection in part 3 of the schedule to the Regulations and set out in appendix 1 of this section.

Re-determination of performance characteristics

5.3.14 | Once a method is in routine use it will be necessary from time to time to re-determine its performance for a variety of reasons to make sure it still meets the performance characteristics in part 3 of the schedule to the Regulations. The performance characteristics of an analytical method should be re-determined whenever a significant change has occurred such as a change in:

- the analytical procedure used (a);
- the key equipment used (b);
- the laboratory environment I; or

- a change of staff carrying out the procedure (this does not include routine changes that normally occur within the laboratory that are supported by appropriate training and properly trained supervisors) (d).

- The significance of any change should be assessed by a competent analyst, and any decision that a change is not significant supported by the results of limited but adequate testing.

5.3.15 | When a change of premises occurs it is not always possible to revalidate all analytical methods before they are used. In such cases it is essential that methods which on transfer also undergo a change of one of the types (a), (b) and (d) in paragraph 5.3.14 above are revalidated before they are used, as should those which are known to be susceptible to changes in laboratory environment e.g. ammonium and trihalomethanes. Other analytical methods should normally be revalidated within three months of relocation.

5.3.16 | The performance characteristics of analytical methods should also be re-determined whenever the results of routine analytical quality control (AQC) (internal or external) indicate that a statistically significant deterioration in performance has occurred which cannot be corrected, or that there is a significant discontinuity in the routine AQC record, whether due to a failure to perform routine AQC or disuse of the analytical method. Laboratories may also wish to re-determine the performance characteristics whenever routine AQC indicates that a statistically significant improvement in performance has occurred. Statistical significance should normally be assessed at the 95% confidence level.

5.3.17 | When an analytical method has been in continuous use for several years, typically between three and five years, without re-determination of performance characteristics, the method should be re-evaluated and the need for re-determination of the performance characteristics considered.

5.4 Microbiological parameters

5.4.1 | The Regulations do not specify the performance to be achieved by the methods to be used for determining the microbiological parameters because performance cannot be specified in the same way as for non-microbiological parameters. Instead the Regulations require that WSAs and their laboratories or contract laboratories must use the methods for microbiological parameters specified in section 1 of part 3 of the

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schedule to the Regulations unless an alternative method has been approved by the EPA, in which case the authorised alternative may be used subject to any conditions given in the approval. Appendix 2 reproduces the specified methods for the microbiological parameters in the Regulations.

5.4.2 | Any WSA or laboratory wishing to use an alternative method that has not been approved must first make an application in writing to the EPA and must include a full description of the method to be used along with results of tests demonstrating both the reliability of the method and its equivalence to the specified method. Further information on the testing requirements and criteria to demonstrate equivalence are given in ISO/TR 17944:2004 – Water Quality – Criteria for establishing the equivalence between microbiological methods. An alternative method will only be approved if it is adequately documented and the results of tests demonstrate to the satisfaction of the EPA that results obtained using the method are at least as reliable as those produced by the use of the prescribed method. The EPA may make any approval subject to such conditions as it considers appropriate, e.g. limitation of the types of sample matrix it may be used to analyse or specific extra quality control requirements.

5.4.3 | The EPA is satisfied that the results obtained by the Idexx (Colilert 18) Quanti-Tray™ method for coliform bacteria and *E. coli* are at least as reliable as the results obtained by the method specified in the Regulations (ISO 9308-1). Therefore laboratories may use the Idexx (Colilert 18) Quanti-Tray™ method instead of the ISO 9308-1 method specified in the Regulations.

6. Analytical quality control (AQC)

6.1 Introduction

6.1.1 | Part 3 of the schedule to the Regulations states that *"Each laboratory at which samples are analysed must have a system of analytical quality control that is subject from time to time to checking by a person who is not under the control of the laboratory and who is approved by the Agency [the Environment Protection Agency (the EPA)] for that purpose"*. It follows that each laboratory must operate a system of routine internal AQC when analysing batches of samples for each parameter. Each laboratory should participate in external AQC schemes (proficiency testing schemes) if such schemes are available. The EPA operates a suitable scheme for some parameters.

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6.2 Non-microbiological parameters

Routine internal AQC

6.2.1 | As a minimum, the laboratory should run with each batch of samples an analytical quality control solution that contains a known concentration at, or close to, the standard or indicator value for each parameter or determined constituent of a parameter for each analytical method, except as provided for below. The term "close to the standard or indicator value" should be interpreted as meaning the standard or indicator value ± 25%. The frequency of use of AQC solutions will vary according to the particular analytical technique used but normally between five and twenty percent of all samples analysed should be AQC solutions, subject to a minimum of one per batch of analyses for batches of less than 20 samples. All AQC solutions should be subject to the full analytical procedure that is used for analysing samples and analysed with each batch of analyses.

6.2.2 | For permanent laboratory tests a "batch of analyses" should be regarded as a group of measurements or observations of standards, samples and/or AQC solutions that have been performed together in respect of all procedures, either simultaneously or sequentially, by the same analysts using the same reagents, equipment and calibration. For field tests (such as pH and conductivity tests) a "batch of analyses" should be regarded as a group of measurements or observations of standards, samples and/or control solutions which have been performed on the same day by the same analysts using the same reagents, equipment and calibration.

6.2.3 | In the following cases the guidance on selection of AQC solutions given above is not appropriate:

- the standard or indicator parameter value represents a concentration or value outside the normal analytical range of a particular method;
- there is no standard or indicator parameter value;
- the indicator parameter value is descriptive; or
- the indicator parameter value is a range.

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In these cases, as a minimum, an AQC solution with a known concentration or value within both the calibrated range of the method and the range of interest should be used.

6.2.4 | When a wide range of concentrations or values is calibrated that includes the standard or indicator value for a parameter but the overwhelming majority of drinking water samples have concentrations or values that are within a narrow band of the calibration range for which control at the standard is inappropriate, as a minimum two AQC solutions should be used, one with a known concentration or value at or close to the standard or indicator value and the other with a known concentration or value within the range of interest.

6.2.5 | As a minimum, all the results obtained from all AQC solutions should be used to plot, for each solution or calculated quality control characteristic, a Shewhart chart that is used to decide whether a method is in statistical control. When other types of chart are used, including those using statistics calculated from individual values, the laboratory should demonstrate that its arrangements effect adequate statistical control over the systematic error, and both the within-batch and between-batch components of random error, though not necessarily as separate items. Further guidance on the construction and use of control charts is given in NS 30 (or equivalent publication) and the Drinking Water Inspectorate's 'Guidance on the Interpretation of Aspects of Analytical Control' (or equivalent publication).

6.2.6 | The WSA and its laboratory or its contract laboratory should have properly documented policy and procedures for routine AQC that stipulate what action or actions should be followed when an out of statistical control condition is shown to exist, include a definition of an out of control condition and detail the records to be made when such a condition exists. The results of analyses obtained using a method not in statistical control should not be released except in exceptional circumstances, when each result so released should carry an appropriate commentary in all records and reports. The circumstances in which such results can be released should be fully documented and state that the cause of the out of control condition should first be identified and shown not to affect the results of analysis of samples intended for release.

6.2.7 | The procedures should also include regular and frequent examination and review of all charts and include guidance for checking and investigating significant trends or changes in either random or systematic error, and for correct operation of the chart. The minimum examination and review periods for each chart should depend on the frequency with which datum points are produced but should not be less frequent than monthly for examination and annually for review. The examination and review should be carried out by a suitably qualified and competent person who is not directly involved in the analysis, such as the laboratory quality manager. There should be appropriate rules for assessing revised control limits.

6.2.8 | An analytical method that is not in statistical control must be investigated and the cause determined and rectified. The performance characteristics of the method may need re-determining in accordance with paragraphs 5.3.14 – 17.

External AQC

6.2.9 | The laboratory should participate in an appropriate external AQC scheme for each parameter or determined constituent of a parameter for which an appropriate scheme is available. The laboratory should also have a properly documented procedure for investigating and recording all failures notified by the organiser of a scheme. Guidance on the suitability of a scheme is given in "The International Harmonised Protocol for the Proficiency Testing of (Chemical) Analytical Laboratories" M Thompson, R Wood, Journal of AOAC International, Volume 76, No 4, 1993.

6.2.10 | In line with the recommendations of this document, laboratories are recommended to participate in schemes distributing drinking water samples of appropriate matrix and which conform to the relevant parts of the protocol. Samples should contain, or be spiked with, concentrations of interest (approximate range one tenth of the standard to twice the standard) and with appropriate speciation where this is of interest. When, in respect of any parameter, a laboratory participates only in schemes that do not meet all the recommended criteria it will be expected to demonstrate that it is participating in the most appropriate scheme currently available. The EPA operates a suitable scheme for some parameters.

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6.3 Microbiological parameters

Routine internal AQC

6.3.1 | Although WSAs must use the methods for microbiological methods specified in part 3 of the Schedule to the Regulations or alternative methods approved by the EPA, it is still necessary to carry out AQC to demonstrate that the methods are detecting the micro-organism of interest and that any organisms detected have been present in the original sample and have not been introduced inadvertently during sampling or in the laboratory.

6.3.2 | As a minimum the following internal AQC should be practised:

- equipment used for sterilisation should be regularly checked to ensure sterilisation is achieved. It is not sufficient to rely on autoclave tape as an indicator of sterility;
- all culture media and reagents should be sterile and every batch of completed culture medium should be checked for sterility before use;
- media should also be checked to ensure that each batch will support the growth of the organism to be detected and it will not support, or will minimise the support, of unwanted organisms;
- all media and reagents should be stored under conditions that ensure that deterioration does not occur and be marked with their shelf life. Media and reagents that have exceeded their shelf life should not be used;
- incubators should be fan assisted and incubation temperatures should be checked each day of use both when the incubator is loaded and unloaded;
- all cultures and sub-cultures should be labelled in such a way that they are clearly identifiable with the original sample;
- appropriate records should be kept to demonstrate that all necessary procedures have been followed during the examination of a particular sample or batch of samples; and
- AQC samples containing a known organism should be examined regularly to provide a check on method performance. For example a positive control containing *E coli*, such as natural water known to contain the organism, should be analysed

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with each batch of samples for *E coli*. Alternatively water to which reference organisms have been added should be examined with each batch of samples for that organism.

External AQC

6.3.3 | WSAs and their laboratories or contract laboratories should also participate in external quality control schemes involving the distribution of samples containing specific organisms when such schemes are available. Any evidence from participation in such schemes that shows that there are deficiencies in procedures should trigger immediate investigation of the cause and appropriate remedial action.

7. Calibration of analytical systems

7.1 | It is essential that the calibration procedure for each analytical system or method is fully documented and is sufficient to establish fully or check fully the calibration each time the system or method is used. The procedure will vary with the system or method used and the parameter being analysed, but in all cases the calibration should be established or checked over the entire range of the method and all results of analysis falling outside the applicable calibration range of the method should be rejected.

7.2 | Instrumental systems of analysis (such as chromatography, absorption and emission spectroscopy and automated colorimetric analysis) often require full calibration each time they are used. At least three calibration points are required to demonstrate a straight line. Generally the more complicated the calibration the greater the number of calibration points required. With long instrument runs it is essential that the validity of the calibration throughout the run is demonstrated and therefore as a minimum a repeat measurement of one of the calibration standards should be made at the end of the run.

7.3 | It is also essential that all other apparatus (apart from the analytical systems covered in the above paragraphs) used in the analytical procedure are also calibrated at appropriate intervals. Such apparatus includes, but is not limited to, balances and weights, volumetric equipment including micro-syringes and micropipettes and thermometers.

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8. Correction for analytical recovery losses for organic parameters

8.1 | Some methods used for the analysis of very low concentrations of organic chemical parameters do not fully recover the particular organic chemical sought by the method or the method may be prone to contamination from the environment. Recovery is the extent to which a known added quantity of a parameter can be measured by the analytical system. It is calculated from the difference between results obtained from a spiked and unspiked aliquot of the sample and is usually expressed as a percentage of the added parameter recovered as follows:

$$\% \text{ Recovery} = 100 \times (S(V+W) - UV)/CW$$

Where
C = concentration of parameter in spiking solution
V = volume of sample aliquot
W = volume of the spiking solution added
S = measured concentration in the spiked sample aliquot
U = measured concentration in the unspiked sample aliquot

8.2 | Recoveries between 90% and 110% are acceptable and no correction to analytical results is required. Recoveries of less than 90% and more than 110% should be investigated and any cause of loss, contamination or interference within the laboratory's control eliminated. When the recovery at a concentration close to the standard or indicator parameter value is significantly greater than 110% (at the 95% confidence level), an alternative analytical method should be sought.

8.3 | Recoveries for some organic analyses are generally less than 90%. In such cases recoveries and standard deviations should not be significantly different (at the 95% confidence level) from those obtained using the best currently available methods. If they are significantly different an alternative method should be sought. If they are not significantly different the guidance in the paragraphs below should be followed.

8.4 | One approach to the calibration of methods for organic parameters is to submit the calibration standard solutions to the whole procedure applied to samples, including any extraction and concentration steps. When this approach is adopted, a check standard at the same concentration as one of the calibration standards and preferably close to the standard or indicator parameter value that has been subjected

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to only the final measurement procedure should be analysed in order to monitor the actual recovery for that batch of analyses. The actual recovery should be recorded as a performance check and appropriate action taken when abnormal recovery is recorded.

8.5 | When the within batch standard deviation of the method is such that the approach in the above paragraph is not appropriate (for example calibration is not possible because of variability due to random errors), correction for recovery should be considered when recoveries are less than 90%. In such cases the recommended approach is to calculate a long-term mean correction factor using data from analyses of spiked samples. Results for AQC solutions must not be used. The actual recovery for the batch should be recorded as a performance check and appropriate action taken when abnormal recovery is recorded.

8.6 | The use of recovery correction factors should be regarded as a last resort and should only be applied after exhaustive attempts to eliminate the source of bias have been documented and proved unsuccessful. This information will often form part of an authoritative reference method. Good analytical methods that require neither compensation nor correction should be used in preference to those with built in compensation for poor recovery or those requiring correction.

8.7 | When an approach does not reduce the uncertainty associated with an individual result (as represented by the total error, calculated as bias plus twice the total standard deviation, after any relevant correction) that approach should not be adopted. In the absence of any acceptable procedure results should not be corrected. Results obtained with a method having a poor recovery that have not been corrected for recovery should carry an appropriate commentary on the analytical report.

9. Records of laboratory analysis and integrity of results

9.1 Records of laboratory analyses

9.1.1 | WSAs and their laboratories or contract laboratories should keep adequate records of key aspects of analytical procedures and the results. It is suggested that these records be kept for at least three years. As a minimum these records should include:

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- all key instrument installation, commissioning, maintenance and repair records, including any instrument log or diary;
- all basic calibration records (including proof of traceability), method suitability checks and any other record necessary to demonstrate the suitability of any equipment used at the time of the analysis;
- the analytical procedure used;
- all initial method performance testing data, including raw data, and similarly for any re-determination of performance;
- routine internal and external AQC data, including charts, investigations of out of control conditions and corrective action; and
- raw data for the whole analytical run and all calculations to obtain the final result of the analysis.

9.2 Integrity of results

9.2.1 | It is vitally important for public confidence in the results of compliance monitoring that WSAs and their laboratories or contract laboratories have arrangements and procedures in place to prevent unauthorised alteration of results at all stages of the production of the results in the laboratory and during the transfer of those results to the WSA's database

9.2.2 | The initial result in the laboratory may be a print out from the analytical equipment or the record of an analytical measurement in the analyst's workbook. The analyst may be required to manipulate the initial result and to make calculations to obtain the final compliance monitoring result. If the analyst makes a mistake during this process the result should be corrected in a way that shows exactly what the analyst has done – for example by putting a line through the mistake, entering the correct result alongside and initialling and dating the entry, but not by using correcting fluid to substitute the correct result for the incorrect result.

9.2.3 | A designated (experienced) person in the laboratory should be responsible for validating the result and authorising its transfer to the WSA's database. This person should check the analyst's result, that the analytical method is in statistical control from the AQC results and that the result relates to the appropriate compliance sample.

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If this person is satisfied the result can be validated and released to the database. Once a result is on the database it must not be deleted or altered. If it is subsequently discovered that a result on the database is incorrect the result may be qualified by a suitable explanation that gives the correct result. If the result is so wrong that it affects the statistical summary of compliance then the incorrect result may be replaced by the correct result, but the incorrect result must continue to be displayed with an appropriate explanation.

9.2.4 | Some laboratory methods may involve computers and laboratory results may be recorded on a computerised laboratory database. Computer access should be controlled by passwords that are set with sufficient level of access (analysts may not need the same level of access as the person validating the results) and passwords should be changed regularly. Any corrections to computerised data should follow the principles described in the previous paragraph.

10. Annual reporting to the EPA of results of monitoring public water supplies

10.1 | The requirement for WSAs to report annually to the EPA the results of all monitoring of public water supplies is covered fully in Section 9 of this handbook. The section sets out the format for the submission of the required information including monitoring results, supply information, sample information, analysis information and the timing for submission of this information.

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Appendix 1: parameters for which performance characteristics are specified

For the following parameters, the specified performance characteristics are that the method of analysis used must, as a minimum, be capable of measuring concentrations equal to the parametric value with a trueness, precision and limit of detection specified. Whatever the sensitivity of the method of analysis used, the result must be expressed using at least the same number of decimals as for the parametric value considered in tables B and C in part I of the schedule.

Parameter number	Parameter	Trueness % of parametric value (note 1)	Precision % of parametric value (note 2)	Limit of detection % of parametric value (note 3)	Notes
3	Acrylamide				*
29	Aluminium	10	10	10	
30	Ammonium	10	10	10	
4	Antimony	25	25	25	
5	Arsenic	10	10	10	
6	Benzo(a)pyrene	25	25	25	
7	Benzene	25	25	25	
8	Boron	10	10	10	
9	Bromate	25	25	25	
10	Cadmium	10	10	10	
31	Chloride	10	10	10	
11	Chromium	10	10	10	
34	Conductivity	10	10	10	
12	Copper	10	10	10	
13	Cyanide	10	10	10	Note 4
14	1,2 Dichloroethane	25	25	10	
15	Epichlorohydrin				*
16	Fluoride	10	10	10	
36	Iron	10	10	10	
17	Lead	10	10	10	

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Parameter number	Parameter	Trueness % of parametric value (note 1)	Precision % of parametric value (note 2)	Limit of detection % of parametric value (note 3)	Notes
37	Manganese	10	10	10	
18	Mercury	20	10	20	
19	Nickel	10	10	10	
20	Nitrate	10	10	10	
21	Nitrite	10	10	10	
39	Oxidisability	25	25	10	Note 5
22	Pesticides	25	25	25	Note 6
24	Polycyclic aromatic hydrocarbons	25	25	25	Note 7
25	Selenium	10	10	10	
41	Sodium	10	10	10	
40	Sulphate	10	10	10	
26	Tetrachloroethene	25	25	10	Note 8
26	Trichloroethene	25	25	10	Note 8
27	Trihalomethanes – Total	25	25	10	Note 7
46	Turbidity	25	25	25	^
28	Vinyl chloride				*

* To be controlled by product specification

^ As specified in the note in section 3 of part 3 of the schedule to the Regulations

For hydrogen ion concentration the specified performance characteristics are that the method of analysis used must be capable of measuring concentrations equal to the parametric value with a trueness of 0.2 pH unit and a precision of 0.2 pH unit.

*Note 1***:** Trueness is the systematic error and is the difference between the mean value of a large number of repeated measurements and the true value (this term is further defined in ISO 5725).

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Note 2: Precision is the random error and is usually expressed as the standard deviation (within and between batches) of the spread of results about the mean. Acceptable precision is twice the relative standard deviation (this term is further defined in ISO 5725).

Note 3: Limit of detection is either:

– three times the relative within batch standard deviation of a natural sample containing a low concentration of the parameter, or

– five times the relative within batch standard deviation of a blank sample.

Note 4: **The method should determine total cyanide in all forms**.

Note 5: **Oxidation should be carried out for 10 minutes at 100ºC under acid conditions using permanganate**.

Note 6: The performance characteristics apply to each individual pesticide and will depend on the pesticide concerned. The limit of detection may not be achievable for all pesticides at present, but sanitary authorities should strive to achieve this standard.

Note 7: The performance characteristics apply to the individual substances specified at 25% of the parametric value in part 1 of the schedule.

Note 8: The performance characteristics apply to the individual substances specified at 50% of the parametric value in part 1 of the schedule.

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Appendix 2: parameters for which methods of analysis are specified

The following principles for methods of microbiological parameters are given for reference whenever a CEN/ISO method is given for guidance, pending the possible future adoption, in accordance with the Committee procedure laid down in Article 12 of Council Directive 98/83/EC of further CEN/ISO international methods for these parameters. Sanitary authorities [WSAs] may use alternative methods, providing the provisions of sub-articles 7 (4) (a) and (b) are adhered to.

Coliform bacteria and Escherichia coli (E. coli) (ISO 9308-1)

Enterococci (ISO 7899-2)

Clostridium perfringens (including spores):

Membrane filtration followed by anaerobic incubation of the membrane on m-CP agar (Note 1) at 44 ± 1°C for 21 ± 3 hours. Count opaque yellow colonies that turn pink or red after exposure to ammonium hydroxide vapours for 20 to 30 seconds. The composition of the m-CP agar is:-

Basal medium	
Tryptose	30 g
Yeast extract	20 g
Sucrose	5 g
L-cysteine hydrochloride	1 g
MgSO4 7H20	0.1 g
Bromocresol purple	40 mg
Agar	15 g
Water	1000 ml
Dissolve the ingredients of the basal medium, adjust pH to 7.6 and autoclave at 121° for 15 minutes. Allow the medium to cool and add:	
D-cycloserine	400 mg
Polymyxine-B sulphate	25 mg
Indoxyl – β-D-glucoside to be dissolved in 8ml sterile water before addition	60 mg

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Filter-sterilised 0.5% phenolphthalein diphosphate solution	20 ml
Filter-sterilised 4.5% $FeCl_3.6H_2O$	2 ml

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Section 6: Procedures for non-compliance with standards

Summary of Section 6

- Provides a summary of Regulations 9, 10 and 11, particularly the requirement to protect human health, investigate non-compliances and prepare remedial action programmes and applications for departures.
- Sets out the offences under Regulations 9 and 10.
- Describes how Water Services Authorities (WSAs) protect human health in consultation and agreement with the Health Service Executive (the HSE).
- Describes the requirement for WSAs to investigate failures to comply with the standards and indicator parameter values to determine the cause and advises on the nature of investigations, including whether caused by the domestic distribution system.
- Sets out the notification to the Environment Protection Agency (the EPA) of failures to comply and advises on the timing and content of notifications for different parameter failures.
- Sets out the requirement on WSAs to prepare remedial action programmes for approval by the EPA and provides comprehensive advice on the content and timing of the programmes and on the content for common types of failures.
- Describes the contents of a monitoring programme for non-compliant supplies.
- Describes the short term interim measures that must be taken by WSAs pending completion of a permanent action programme.
- Sets out the timescales within which action programmes must be completed by WSAs.
- Sets out how WSAs must inform consumers of the details of remedial action programmes.
- Describes the EPA's "Remedial Action List" and its purpose.

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- Sets out the availability of departures from the standards and describes how WSAs may apply for a departure and the conditions the EPA may apply to a departure.

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1. Introduction and overview of Regulations 9, 10 and 11

1.1 Introduction

1.1.1 | Regulations 9 and 10 of the Regulations deal with the **protection of human health**, the investigations required and the **remedial action** to be taken when the public water supply constitutes a potential danger to human health or fails to meet the

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standards and indicator parameters values specified in the Regulations. Regulation 11 makes provision for a departure from the parametric values specified in table B in part 1 of the schedule to the Regulations.

1.1.2 | In the context of regulations 9 and 10, the Environment Protection Agency (the EPA) has been assigned specific powers to supervise Water Services Authorities (WSAs) and enforce the standards and other requirements in relation to the quality of public water supplies. The Regulations also authorise the EPA to prepare legally binding guidance on specific areas of regulations 9 and 10 and they make it an offence for WSAs to fail to comply with specific aspects of these Regulations. The guidance in this section is issued pursuant to regulations 9(5) and 10(8) and WSAs should take this guidance fully into account when fulfilling their obligations under regulations 9 and 10.

1.1.3 | The EPA recommends that each WSA should have written procedures for dealing with non-compliances with the standards in tables A and B of part 1 of the schedule to the Regulations and non-compliances of the indicator parameter values in table C of part 1 of the schedule to the Regulations. These procedures should cover the protection of human health, investigations of non-compliances and remedial action. Each WSA should have arrangements with its laboratory or contract laboratory for immediate notification of any result that does not comply with a standard or exceeds an indicator parameter value.

1.2 Overview of protection of human health

1.2.1 | Regulation 9 deals with circumstances where there may be a potential danger to human health due to the failure to meet a standard or indicator parametric value as specified in part 1 of the schedule to the Regulations or due to the presence of some other substance or micro-organism. Regulation 9 requires the WSA to:

- firstly, consult and agree with the Health Service Executive (the HSE) whether there is a potential danger to human health;
- restrict or prohibit use of water or take other action to protect consumers, if such a potential danger to human health exists;
- ensure consumers are informed of the above actions; and
- ensure the EPA is promptly notified.

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1.2.2 | In considering the action to be taken the WSA must have regard, in consultation and agreement with the HSE, to the risk to human health that would be caused by the interruption of supply or restriction of use.

1.2.3 | The EPA's role, as outlined in regulation 9, is to ensure where there is a risk to human health, that where necessary it directs a WSA (in consultation and agreement with the HSE) to take the appropriate action to prevent, limit, abate or eliminate the risk to human health. This guidance is issued pursuant to regulation 9(5) to assist WSAs to fulfil their obligations under regulation 9.

1.3 Overview of investigations of failures

1.3.1 | Each WSA is required by regulation 10(1) to ensure that any failure to meet the parametric values specified in part 1 of the schedule to the Regulations in its water supply is immediately investigated to determine the cause of such failure. The WSA should develop and implement a system to investigate non-compliances and include it in its written procedures. Each WSA must notify the EPA of any failure to comply and of the results of its investigation.

1.4 Overview of remedial action

1.4.1 | Regulation 10 of the Regulations sets out the actions that the WSA must take in the event of a failure to meet a parametric value as specified in tables A, B or C of part 1 of the schedule to the Regulations. Regulation 10 places a number of specific legal obligations on the WSA and the EPA as the supervisory authority when a non-compliance with the parametric value has been detected as a result of routine compliance monitoring, operational monitoring or monitoring following a consumer complaint. These include the requirement for the WSA to:

- immediately investigate the cause of the failure;
- carry out remedial action as soon as possible;
- where necessary notify the EPA in accordance with guidelines issued by the EPA;
- prepare an action programme for the improvement of the quality of water so as to secure compliance with the Regulations within 60 days of being directed to do so by the EPA;

- implement the action programme within at least one year of the approval of the action programme if the non-compliance presents a risk to human health or in at least two years if the non-compliance does not present a risk to human health; and
- ensure that consumers are informed of the corrective action where the non-compliance is non-trivial.

1.4.2 | The role of the EPA is also outlined in regulation 10. In summary, the EPA is required to:

- ensure that the WSA takes remedial action as soon as possible;
- give priority to enforcement action having regard to the extent of the non-compliance;
- where necessary, direct the WSA to prepare an action programme within 14 days of being notified of the non-compliance;
- review and amend as necessary the action programme prepared by the WSA; and
- issue guidelines in relation to the nature and timing of remedial, enforcement or other relevant action.

This section of the guidance is issued pursuant to regulation 10(8) and this section should be considered as the EPA guidance in relation to the nature and timing of remedial, enforcement or other relevant action.

1.5 Overview of departures

1.5.1 | Regulation 11 makes provision for a departure from the parametric values specified in table B in part 1 of the schedule to the Regulations. A departure may, on application by a WSA and subject to agreement with the HSE, be granted by the EPA in relation to a water supply up to a maximum value for the parameter, provided that it does not constitute a potential danger to human health and that the supply of water cannot be maintained by any other reasonable means. A departure is in effect permission to continue supplying water that does not comply with the standards whilst remedial action is taken provided there is not a potential danger to human health.

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1.5.2 | This section sets out what WSAs must include in any application for a departure and specifies what the EPA must include as conditions associated with any departure it grants.

1.6 Offences under Regulations 9 and 10

1.6.1 | In accordance with regulations 9 and 10 it is now an offence for a WSA to:

- fail to comply with a direction from the EPA to prevent, limit, eliminate or abate a non-compliance or take appropriate measures to deal with the presence of a substance or micro-organism for which no quality standard has been prescribed, where there is a risk to human health – regulation 9(6);
- fail to notify the EPA promptly that a water supply constitutes a potential danger to human health – regulation 9(7);
- fail to notify the EPA of a failure to meet the parametric values of Part 1 of the schedule to the Regulations in accordance with the EPA guidelines as outlined in this section of this handbook – regulation 10(3);
- fail to comply with a direction to submit an action programme within 60 days of being directed to do so by the EPA and implement such action programme, as amended by the EPA, for the improvement of the quality of water so as to secure compliance as soon as possible and no later than one year from the date of approval in the case of a non-compliance which presents a risk to human health and two years in the case of other non-compliances – regulation 10(12)(a);
- fail to inform consumers of the remedial action taken in accordance with the action programme – regulation 10(12)(b);
- fail to maintain records of an incident as outlined in regulation 10(12(c); and
- fail to make a record available to the EPA on request – regulation 10(12)(d).

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2. Protection of human health and consultation with the HSE

2.1 | Whenever a drinking water sample (compliance, operational, investigation of consumer complaint or incident) has failed to meet the parametric value for any of the parameters in part 1 of the schedule to the Regulations, the WSA must determine whether the non-compliance presents a risk/potential danger to human health. This also applies to situations where there has not been an identified non-compliance with a parametric value but there could be a potential danger to human health such as

- the presence of a substance or micro-organism for which no standard is specified in the Regulations;
- detection of an inefficiency of the disinfection process (such as insufficient chlorine in the final water to ensure that disinfection is complete); and
- an unexpected increase in the concentration or value of a parameter but not exceeding the parametric value indicating contamination or a problem with a treatment process (such as turbidity indicating inefficient filtration).

Consequently, each WSA should have in place documented procedures for consultation with the HSE when non-compliance is detected or another potential health risk exists. These procedures should include, as a minimum:

- contact details of the relevant personnel in the HSE;
- details of what additional information should be sent to the HSE in the event of a non-compliance (such as the results of investigations of the cause of the failure); and
- details of agreed actions to be taken in the event of specific failures (e.g. E. coli, detection of Cryptosporidium or the issue of a boil notice).

2.2 | WSAs should be aware that the HSE has published a document "Drinking Water and Health – a Review and Guide for Population Health, Health Service Executive 2008"(***www.hse.ie/eng/services/Publications/services/Environmentalhealth/HSE_Drinking_Water_and_Health_Review_and_Guide_2008.pdf***). This recognises the key role that the HSE has in assessing and advising WSAs and the EPA on potential risks to human health. The primary purpose of the document is to assure increased consistency of approach from and between the HSE staff of different professional

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backgrounds who are involved with drinking water safety throughout Ireland. WSAs should also be aware that HSE has prepared a document "Guidelines proposed by the Health Service Executive as a template document between the Health Service Executive and Water Services Authorities for Dealing with Exceedances and Incidents in Water Supplies" which is intended to facilitate a standardised framework nationally for dealing with microbiological, chemical and indicator parameter failures and incidents.

2.3 | When the HSE advises a WSA that there is a potential danger to human health from a public water supply, the WSA must take action to protect the consumers. The WSA must agree the action with the HSE which will be either to prohibit the supply of water or to restrict the use of the water. But in reaching that agreement both the WSA and the HSE must have regard to the risks to human health that would be caused by an interruption to the supply or restriction of the use of the supply. The WSA and the HSE must also consider and where possible agree the criteria to be used to decide when to stop the interruption to the supply or the restriction of its use. Once agreement has been reached, the WSA must issue the advice promptly to consumers. In the majority of situations the action will consist of restriction of the use of the supply by advising consumers to:

- boil water before using for drinking and food preparation, for example when there is a failure of a microbiological parameter or a problem with disinfection; or
- not to use the water for drinking and food preparation (the supply can still be used for other purposes), for example when there has been a serious failure of a chemical parameter. In this case the WSA must make arrangements to provide an alternative supply of water for drinking and food preparation such as in tankers or other appropriate containers; or
- to remove the water that has stagnated in the pipe work and use it for some other purpose than drinking or cooking, for example when there is a failure of the lead standard.

2.4 | If the EPA is not satisfied with the action being taken by the WSA, it must, in consultation and agreement with the HSE, issue a direction to the WSA to ensure that appropriate measures are taken to prevent, limit, eliminate or abate the risk to human health.

2.5 | Each WSA should have documented written procedures for the issue of the advice to consumers. The WSA should also have:

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- model leaflets for:
  - interruption to a supply with details of the availability of an alternative supply in tankers or containers;
  - advice to boil water notices with guidance on how to boil the water and what to use the boiled water for;
  - advice not to the use water for drinking and food preparation with details of the availability of an alternative supply in tankers or containers;
  - advice to remove the water that has stagnated in the pipe work and what other purposes than drinking and cooking it can be used for; and
  - withdrawal of any of the above advice;
- and these leaflets:
- should be capable of adaptation quickly to any situation where there is a potential danger to human health;
- should be very clear and use simple language; and
- may need to be provided in languages other than English in some cases (e.g. Irish and other languages).

Examples of the most common leaflets (notices) used by Scottish Water are contained in Appendix G of the Guidance Document for the Drinking Water Incident response Plan (DWIRP) published by the Water Services Training Group (WSTG) (see paragraph 3.1.1 of section 8 of this handbook).

3. Investigations of non-compliances

3.1 General

3.1.1 | Each WSA is required by regulation 10(1) to ensure that any failure to meet the parametric values specified in part 1 of the schedule to the Regulations in its water supply is immediately investigated to determine the cause of such failure. The WSA

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should develop and implement a system to investigate non-compliances and include it in its written procedures. This should include procedures and protocols to investigate the following:

- a review of previous results for that parameter at the same or similar sampling points in the affected water supply;
- a review of any results for that parameter at associated sampling points (for example at the treatment works for a failure within a supply zone);
- a review of the operation of the treatment works, service reservoir or distribution network associated with the failure;
- where the failure is with a microbiological parametric value then a review of the effectiveness and robustness of the disinfection and other treatment processes should be carried out to include a review of results and residual chlorine levels for the supply three days either side of the date the non-compliant sample was taken, review of the chlorine dosing systems and procedures, review of the maintenance of residual chlorine at the plant and in the distribution network and review of the integrity of the distribution network including service reservoirs. Where UV treatment forms part of the disinfection process the operation of this process should be thoroughly reviewed;
- a procedure to determine whether there has been any event in the catchment that might be responsible for the failure;
- a procedure for taking further samples from the same point and if necessary from associated points;
- when the failure is suspected to be due to the condition of the consumer’s tap, further samples should be taken from such points as will help to assess whether the failure was caused by the condition of the pipe work and fittings in the consumer’s premises. Inspection of the consumer’s pipe work and fittings may be necessary. In addition samples should be taken of the treated water leaving the drinking water treatment plant;

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- when the failure is due to the presence of E. coli or coliform bacteria in a sample taken from a consumer's tap, a sample shall be taken before and after disinfection of the tap and a swab sample from the surfaces of the tap that come into contact with water; and

- when the failure is lead or copper or nickel in respect of a sample taken from a consumer's tap, the WSA should consider wider sampling from other premises in the supply zone to establish whether the failure is restricted to one premises or whether there is a risk of failures at many premises in the zone.

3.2 Failures associated with the domestic distribution system

3.2.1 | One of the matters that the investigation has to establish is whether the cause of the failure of the standard or an indicator parameter value is due to the condition of the pipe work and fittings in the premises (i.e. the domestic distribution system) or other factors. The EPA will only consider failures to be attributable to pipe work and fittings where the WSA demonstrates comprehensively that it has carried out a detailed investigation with supporting evidence to show that consumer's plumbing is most likely to be the cause of the failure.

Microbiological failures

3.2.2 | Microbiological parameters, such as *E. coli* or coliform bacteria, may be influenced by the condition of the pipe work and fittings and particularly the design and hygienic status of the consumer's tap. The outcome of the further analysis described above provides important information on the likelihood that the non-compliance is attributable to the condition of the pipe work and fittings. There is a strong indication that the non-compliance is attributable to the pipe work and fittings when:

- the non-compliance recurs in the further sample from the original consumer's tap but all other samples in the supply zone meet the relevant standards or indicator parameter values; or

- the non-compliance recurs in a sample taken from the original consumer's tap before disinfection, but does not occur in a sample following disinfection.

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Lead, copper and nickel failures

3.2.3 | Non-compliances with the standards for copper, lead and nickel at the consumer's tap may be associated with the consumer's pipe work and fittings or the WSA's pipe work as the water interacts with copper or lead pipes (or solders) and brass fittings and plated taps that contain nickel. The WSA's investigation should establish whether these metals are present in its pipe work (unlikely to be the case for nickel) and whether they are present in the consumer's pipe work and fittings. It should also establish whether non-compliances also occur in similar premises in the supply zone.

3.2.4 | If these metals are present **only in the WSA's pipe work**, then the WSA is required to take action by following the advice in the EPA Guidance Circulars No. 1 (Lead compliance monitoring and surveys) and No.2 (Action programmes to restore the quality of drinking water impacted by lead pipes and lead plumbing). If they are present **only in the consumer's pipe work and fittings**, then the WSA should provide advice to consumers on the action they can take to reduce their exposure to these metals. If these metals are present in **both the WSA's and the consumer's pipe work**, then the WSA should follow the advice in EPA Guidance Circulars No. 1 and No. 2.

3.2.5 | This advice particularly applies to **lead** which has been widely used in the past and most water supplies are plumbosolvent unless adequately treated. The long term solution for dealing with failures for lead in drinking water is to replace any lead pipes with a suitable alternative. The EPA recommends a phased approach to dealing with lead pipes giving priority to areas where lead concentrations are highest, whilst taking any opportunities, such as leak detection programmes, mains refurbishment or replacement programmes or pavement improvement works, to replace lead pipes. Further advice on investigation and action in respect of lead failures is given in paragraphs 5.3.14 – 5.3.26 of this section.

4. Notification of non-compliances to the EPA

4.1 Introduction

4.1.1 | Regulation 10(2) places an obligation on each WSA to notify the EPA as soon as it becomes aware of a failure to meet the parametric values in part 1 of the schedule of the Regulations. It must also notify the EPA as to whether the HSE considers the failure to be a potential danger to human health. **From August 1st 2011, WSAs are required to notify the EPA through one of the following methods:**

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- **Online Drinking Water Notification System – for supplies which have not had previous exceedance(s) notified to the EPA for the exceeded paremeter.**
- **E-mail to drinkingwater@epa.ie – for supplies which have had any previous exceedance notified to the EPA for the exceeded paremeter. This method should be used even if the file relating to the previous exceedance has been closed.**

Notification by email should be in the format as specified in Appendix 1 and must contain all of the information requested.

For a period following the launch of the Online Drinking Water Notification System notification is required using both methods, above, in parallel for verification purposes. The duration of this period is as communicated directly to WSAs by e-mail from the EPA. The system log-in page, a user manual and training videos can be accessed on www.epa.ie.

4.1.2 | It is essential that WSAs review their current arrangements with laboratories carrying out analysis of drinking water on their behalf to ensure that the laboratory immediately makes the WSA aware of all non-compliances with the parametric values in tables A, B or C of part 1 of the schedule to the Regulations.

4.2 Non-compliance with the standards for microbiological and chemical parameters

4.2.1 | A non-compliance with the parametric value for the microbiological or chemical parameters as specified in tables A and B of the schedule of the Regulations or a notification under regulation 9(1)(c) that a supply is to be prohibited or restricted, must be promptly notified to the EPA, in accordance with regulation 10(2) and 9(5) respectively **no later than 11.00 a.m. on the next working day**. As well as the written notification, if a supply is to be prohibited or restricted, the WSA should notify its designated EPA Inspector by telephone. In advance of notifying the EPA, the WSA must, in all such cases, have notified and, if possible have consulted with the HSE to establish the level of risk to human health and agreed with the HSE any actions that need to be taken pursuant to these consultations, as required by Regulation 9(1). The arrangements with HSE must make all reasonable attempts to make the determination

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on risk to human health prior to the deadline to notify the EPA. Where the EPA considers the information in the notification provided by the WSA as insufficient further specific information may be requested.

4.2.2 | The only exception to the requirement for prompt notification of a failure to meet the parametric values in tables A and B of the schedule of the Regulations relates to the fluoride parameter where the supply is artificially fluoridated. The Department of Health and Children has published a Code of Practice on Fluoridation of Water Supplies 2007 (***http://www.dohc.ie/publications/fluoridation_2007.html***) and this Code includes a protocol for dealing with failures of the 0.8 mg/l standard. The EPA advises WSAs to adhere to the protocol outlined in this Code. In the event of a one-off non-compliance with the fluoride parametric value of 0.8 mg/l, the WSA is not required to notify immediately the EPA except where the result exceeds the EU Directive 98/83/EC parametric value of 1.5 mg/l. However, in all such cases of failure to meet 0.8 mg/l, the WSA should take immediate action to return the supply to compliance and should immediately retest the supply. Where the follow up sample fails to meet 0.8 mg/l, the Agency should be notified in accordance with the procedures outlined in the previous paragraph. Furthermore, if there is a pattern of intermittent non-compliance with the fluoride standard of 0.8 mg/l the Agency should also be notified of the non-compliance.

4.2.3 | Also in accordance with regulation 10(10) each WSA shall maintain a record of any incidence of failure to meet the parametric values specified in Part 1 of the schedule to the Regulations. This record shall be kept for inspection by the EPA.

4.3 Non-compliance with the indicator parameter values

4.3.1 | Immediate notification of the failure of a single sample in a water supply to comply with the indicator parametric values as specified in table C of the schedule to the Regulations is **not** required **except** where the non-compliance could be a **potential danger to human health** or is **non-trivial**. Some examples of the circumstances requiring immediate notification by the WSA to the EPA using the procedure in paragraph 4.1 are listed below;

- when, after consultation with the and agreement with HSE, the failure is considered to be a potential danger to human health;

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- persistent non-compliances with an indicator parameter in the same supply that has not been rectified, for example repeated coliform bacteria or aluminium failures;
- elevated turbidity in the treated water especially in cases where the plant has a high *Cryptosporidium* risk assessment score; and
- non-compliance with an indicator parameter value caused by incidents or not adhering to operational practice or procedures at the treatment plant.

4.3.2 | Where the failure is not trivial the WSA must also notify the EPA. A trivial non-compliance can be defined as a marginal failure of the parametric values in table C of the schedule of the Regulations or where a failure is a one-off linked to a specific event that was quickly rectified. However, if there is a relatively frequent recurrence of marginal failures or intermittent one-off failures, the EPA must be notified as soon as practical using the form at Appendix 1.

4.3.3 | Whether the non-compliance of an indicator parameter value is a potential danger to human health or not, the WSA must take immediate action to ensure that the cause of the non-compliance is investigated and that the appropriate corrective action is taken to ensure compliance with the relevant parametric value. The WSA shall in accordance with regulation 10(10) maintain a record of any incidence of failure to meet the indicator parametric values. This record shall be kept for inspection by the Agency.

5. Preparation of remedial action programmes

5.1 Introduction

5.1.1 | When the EPA has been notified of a failure to meet a parametric value specified in part 1 of the schedule to the Regulations and the EPA has directed a WSA to prepare an action programme and to submit it for the approval of the EPA, the WSA must prepare this programme within the timeframe specified in the direction (and not exceeding 60 days). The following paragraphs provide guidance to WSAs on the nature and timing of remedial, enforcement or other relevant action in accordance with regulation 10(8).

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5.1.2 | The action programme must ensure compliance with the Regulations. It must be submitted to the EPA within the period specified in the EPA's direction and it should be e-mailed to ***drinkingwater@epa.ie*** with a signed copy also posted to Drinking Water, Office of Environmental Enforcement, Environment Protection Agency, Johnstown Castle Estate, Co. Wexford and the action programme should contain as a minimum:

- actions taken/to be taken to identify the cause of the non-compliance;
- actions taken/to be taken to address the cause of the non-compliance including details of any enforcement (under the Local Government (Water Pollution) Acts 1977-1990 including enforcement of discharge licences under Section 4) and source protection measures proposed/implemented;
- actions taken/to be taken to improve the treatment at the plant;
- a proposed increased monitoring programme for the parameter that failed to meet the standards for the duration of the action programme;
- interim measures taken/to be taken to prevent, limit, eliminate or abate the likelihood of a failure in the short term;
- proposed timescales and reporting frequencies for all of the actions to be taken above;
- details of the documented management and control system in place; and
- details of how consumers are to be informed of the actions taken/to be taken.

5.1.3 | WSAs should note that an action programme (amended if necessary by the EPA under regulation 10(6)) is a legally binding document and failure to submit and implement an action programme is an offence under regulation 10(12)(a). Therefore, WSAs should consider carefully the information that is to be included as part of the action programme and should include the actions it intends to carry out and should not contain unrealistic actions or timescales.

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5.2 Actions to identify the cause of non-compliances

Failures suspected to be caused by contamination of the source water

5.2.1 | If the cause of the failure is suspected to be contamination of the source of the water then the action programme could include any or all of the following actions:

- **Assessment of the geology and hydrogeology of the source** – this is to determine whether natural substances are likely to be present in significant concentrations. This may be relevant to naturally occurring metals and substances such as arsenic, fluoride, mercury, chloride, iron, manganese or sulphates. The investigations into the geology and hydrogeology should include, as a minimum, an examination of:
    - borehole logs for the well;
    - geological maps;
    - any geochemical data for geological formations;
    - hydrogeological flow regime; and
    - source water quality trends.
- **Identification of potentially polluting activities in the catchment or zone of contribution of the source** – where it is suspected that there are potentially polluting activities in the catchment or zone of contribution, a catchment inspection should be carried out. The investigations into the source of the pollution should include the identification and assessment of the following activities in the zone of contribution or catchment:
    - discharges from waste water treatment plants;
    - storm water over flows;
    - the location and effectiveness of septic tanks or other on-site treatment systems;
    - discharges licensed under Section 4of the Local Government (Water Pollution) Act 1977;

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- discharges from facilities licensed by the EPA under the Environment Protection Act 1992 and the Waste Management Act 1996 (as amended);
- agricultural activities (in particular farm yard management and land spreading activities);
- forestry activities;
- other industrial activities such as waste management, mining, quarrying or other similar activities; and
- source water quality trends.

- **Liaison with the teams implementing the River Basin Management Plan** in carrying out the investigation and in developing measures to improve site specific source protection.
- **Analysis of samples of the source water** to identify the cause and assist in formulating an action plan.

Failures suspected to be caused by problems with treatment or distribution

5.2.2 | If the cause of the **failure is suspected to be a problem with the treatment of the source water or the water distribution network** then the action programme could include any or all of the following actions:

- **Review of the operation of the water treatment plant** – an assessment of the operation of the water treatment plant should be carried out which should include any or all of the following reviews of:
  - recent daily operational monitoring results at the water treatment plant;
  - recent compliance check/audit monitoring results in the distribution network (and at the treatment works where permitted for specified parameters);
  - treatment processes at the plant including chemical dosing regimes, coagulation and clarification procedures, filter operation (backwashing arrangements and media adequacy), disinfection, operational monitoring frequency and process alarms;

- recent operational changes made to the treatment plant including adjustment of chemical dosing, flows, pumps, pipe work and filter media;
- recent operational problems including alarms (which should be recorded in the caretaker's diary and/or on the SCADA system); and
- the ability of the existing treatment plant to treat the water adequately in order to meet the standards and indicator parameter values in the Regulations.

◆ **Review of the management and operation of the distribution network** – the management and operation of the distribution network should be examined including the identification of any or all of the following:

- changes to the operation of the distribution network such as introducing water from a different works or part of the network, flow reversals and pressure changes;
- consumer complaints about drinking water quality (appearance, taste, odour)
- flushing/scouring regime for the distribution network;
- possible contamination following recent pipe replacement or repair of bursts;
- leakage; and
- dead ends, service reservoirs or vulnerable parts of the network.

The action programme should clearly state how the water supplier intends to identify the cause of the failure (if not already known) and should include details of how the investigation is to be carried out. Specific timeframes for the different aspects of the investigation must be included in the action programme.

5.3 Actions to address the cause of non-compliance

5.3.1 | Having identified the cause or suspected cause of the non-compliance the WSA must determine the specific actions that are to be taken to prevent, limit, eliminate or abate the cause of the non-compliance. The following paragraphs provide specific guidance on the actions to deal with common causes of failures.

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Action to improve source protection

5.3.2 | Where the cause of the non-compliance has been identified as originating from pollution of the source of the supply the WSA must take action to prevent, limit, eliminate or abate the source of the pollution, it is not sufficient simply to improve treatment at the plant to compensate for poor raw water quality. The root cause of the problem must be addressed. Actions taken to address the cause of the non-compliance could include:

- implementation of sustainable planning policies to protect source water;
- improvements in waste water treatment plants;
- elimination or relocation of storm water overflows;
- fencing off of the source of the supply;
- restriction of land spreading within the zone of contribution or within the exclusion zones as per the European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2009 (S.I. No. 101 of 2009);
- enforcement action under the Local Government (Water Pollution) Acts 1977-1990 including enforcement of Section 4 licences;
- liaison with the EPA regarding discharges from EPA licensed facilities; and
- working with the teams implementing the River Basin Management Plans to improve source protection measures.

Action to deal with failures caused by natural conditions

5.3.3 | In some cases, such as where the source of the non-compliance is natural or persistent, it may not be possible to take actions to address the cause of the non-compliance within the short to medium term or it may not be possible at all (if the cause of the non-compliance is natural e.g. arsenic). In such cases, replacement of the source may be necessary or alternatively the treatment processes may need to be upgraded or optimised to ensure compliance. However, in all cases every effort must be made to eliminate or reduce the cause of the non-compliance from the source. In many cases this will be done in tandem with the provision of improved treatment.

Action to improve treatment and treatment plant operation

5.3.4 | Where every action has been taken to improve the quality of the source of the water so as to prevent, limit, eliminate or abate the likelihood of non-compliance and these actions are not sufficient, additional actions to improve the treatment process should be detailed in the action programme. Also in cases where the failure of the treatment plant has caused the non-compliance the WSA must outline in the action programme the actions to be taken to improve the treatment process. These actions could include:

- adjustment of chemical dosing regime;
- adjustment of treatment practices and procedures (e.g. coagulation/clarification conditions, filter operation and backwashing frequency, disinfection);
- replacement of filter media;
- addition of new treatment processes or modification of existing processes;
- installation of continuous monitoring and alarms for chlorine and turbidity;
- up-grade of the treatment plant;
- improved maintenance of treatment plant;
- additional training to be given to plant operatives; and
- increased monitoring at water treatment plant.

Action to deal with microbiological failures

5.3.5 | Where there is a failure to meet a standard for a microbiological parameter value or microbiological indicator parameter value, the WSA should examine the operation of the disinfection system as a priority. Where chlorination is used as the means of disinfection, as a minimum, the EPA expects that all treatment plants should be operated in accordance with the following guidance:

- only drinking water that is appropriately disinfected should be distributed;

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- treated water should contain residual chlorine at a concentration of 0.5 mg/l for at least 30 minutes contact time prior to supply to consumers to ensure that the disinfection is complete. The WSA should review the contact time on a site-specific basis. An optimum contact time must be implemented for each treatment plant. Thus direct supply of treated water (i.e. where water is not stored in a contact tank prior to distribution) will not be permitted in most circumstances;

- the final treated water (prior to entry into the distribution network) should have a continuous residual chlorine monitor and this monitor shall be linked to a recording device and alarmed to ensure that a deviation in the levels of residual chlorine from pre-defined upper and lower limits are immediately detected. The alarm should be linked by telemetry to a call out to ensure that the relevant personnel in the WSA are immediately notified of a failure of the system so as to allow immediate corrective action to be taken;

- where the source of the water is surface water (or groundwater influenced by surface water) the treatment of the water should not consist solely of chlorination; and

- the residual chlorine at the extremities of the distribution network must be at a concentration of at least 0.1 mg/l.

5.3.6 | Detailed advice from the EPA on dealing with *E. coli* (and enterococci) failures is given in Advice Note No. 3 "*E. coli* in Drinking Water" which includes:

- determination of whether the presence of E. coli constitutes a potential danger to human health and the implementation of immediate health protection measures;

- determination of the cause of the failure to meet the E. coli parametric value; and

- identification of the measures necessary to improve the security of the supply and implementation of an action programme.

- The advice also includes EPA recommendations on disinfection measures including:

    - **chlorination:** including continuous chlorine monitors, chlorine contact time, duty and standby dosing arrangements and flow proportional or chlorine monitor controlled dosage and re-chlorination within the distribution network; and

- **ultraviolet (UV):** validation certificate for the lamp, monitoring of UV intensity or transmissivity and verification, duty and standby UV lamps or auto shut-down on lamp failure and secondary disinfection (e.g. chlorination) in the distribution network.

Action to deal with turbidity failures

5.3.7 | Turbidity is listed as an indicator parameter in the Regulations which states that the levels must be "Acceptable to consumers and no abnormal change". There is a footnote in the Regulations that states in the case of surface water treatment a parametric value not exceeding 1.0 NTU in the water ex treatment works must be strived for. The turbidity levels (and colour) should be as low as possible prior to chlorination to ensure that disinfection is effective and the formation of disinfection by-products (such as trihalomethanes) is kept to a minimum. Colour should be kept below 20 mgPt.Co/l (Hazen). **Elevated turbidity in the treated water indicates that the treatment process is not operating adequately**.

5.3.8 | Although the indicator parametric value of 1.0 NTU is regarded as an aesthetic value, in practice it is a process control standard. Monitoring for *Cryptosporidium* cannot be used for process control, as it cannot be measured in real time so an alternative surrogate parameter is required. Turbidity is the best available and in order to maximise the removal of *Cryptosporidium* oocysts treatment plants need to be designed and operated to achieve minimum turbidity values in the treated water. Low filtered water turbidity also enhances the performance of *Cryptosporidium* removal or deactivation treatment technology when fitted such as membrane filtration or ultra violet (UV) disinfection. The 1.0 NTU level is an acceptable aesthetic standard so long as the source is not at risk from *Cryptosporidium*. If there is a risk of *Cryptosporidium* in the source water then WSAs should strive to minimise treated water turbidity as far below 1.0 NTU as is reasonably practical. **The EPA recommends that treatment processes should be optimised so that the turbidity in the water leaving treatment works is less than 0.2 NTU**.

5.3.9 | Detailed advice from the EPA on dealing with turbidity failures is given in Advice Note No. 5 "Turbidity in Drinking Water" which includes:

- turbidity levels to be achieved at the water treatment plant;
- action to be taken by the operator including:

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- ensure adequate treatment is in place to remove turbidity;
- improvements in monitoring at the water treatment plant to:
  - assess the adequacy of water treatment plant;
  - set appropriate alarm levels on the stages of the treatment plant; and
  - put in place procedures to deal with elevated levels of turbidity;
- optimisation and improved of the existing treatment processes;
  - assessing the adequacy of filters;
  - management of the backwash cycle; and
  - management of the filter backwash water.

Action to deal with disinfection by-product failures

5.3.10 | The Regulations set standards for the following disinfection by-products (DBPs):

- 100 µg/l for total trihalomethanes (THMs) (the sum of the concentrations of chloroform, bromoform, dibromochloromethane and bromodichloromethane). THMs are formed by the reaction of organic matter in the raw water (such as humic and fulvic acids) and chlorine used for oxidation and disinfection;
- 10 µg/l for bromate. Bromate is formed when ozone, used as an oxidant and disinfectant, reacts with bromide in the raw water. Bromate is also present in sodium hypochlorite used for chlorination; and
- 0.5 mg/l nitrite. Nitrite is formed when chloramination (monochloramine) is used as the disinfectant.

There are many other DBPs that are not regulated at present but may be regulated in the future. These include haloacetic acids formed by reaction of chlorine with organic matter, chlorite and chlorate formed when chlorine dioxide is used as an oxidant and disinfectant.

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5.3.11 | Some public water supplies currently fail to meet the THMs standard and WSAs need to investigate these failures and take action to ensure they comply with the standard. The causes of THM failures and the actions necessary vary with the nature of the raw water, the treatment processes and the way chlorination is used. WSAs must ensure that any action to reduce THM concentrations (and other DBPs) does not compromise the efficiency of disinfection.

5.3.12 | Detailed advice from the EPA on dealing with DBP failures is given in Advice Note No. 4 "Disinfection By-products in Drinking Water" which includes:

- formation of DBPs – conditions of formation, lists of disinfectants and DBPs and the World Health Organisation's guideline values and the US Environment Protection Agency's maximum contaminant levels ;
- investigations into the causes of DBP failures – lists mains causes; and
- measures to reduce DBP concentrations – lists the possible actions and situations where they could be used.

Action to deal with failures caused by the distribution network

5.3.13 | When the cause of the failure may be due to contamination within the distribution network the guidance on water distribution and related matters provided in the section 12 of this handbook should be followed. Where the distribution network has been identified as the cause of the non-compliance the corrective action taken by the WSA may include:

- modification to the operation of the distribution network (such as to avoid high flows and flow reversals;
- flushing/scouring the mains;
- installation of chlorine booster stations in the network;
- installation of automatic continuous chlorine monitors at the outlet from a service reservoir or water tower and at appropriate points in the distribution network;
- replacement/refurbishment of corroded/leaking pipe work;
- maintenance of service reservoirs; and

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- replacement of old pipe work (e.g. lead service mains).

Action to deal with failures of the lead standard

5.3.14 | Sub-section 4.3 of section 4 of this handbook explains why the relatively few compliance audit monitoring samples for lead may not give a true picture of lead concentrations at consumers' taps within the zone because they can be highly variable. The results can depend on:

- the length of any lead distribution mains;
- the length of lead pipe, if any, in the WSA's part of the service connection pipe to the premises (in general the WSA owns the part of the service connection from the mains to the external stop tap located usually just outside the boundary to the premises and the owner of the property owns the part of the service connection from the external stop tap to the internal stop tap within the premises);
- the length of lead pipe, if any, in the property owner's part of the service connection pipe to the premises;
- the length of lead pipe, if any, within the internal plumbing to the kitchen tap in the property;
- the presence of copper pipe work joined by lead based solder;
- the type of sample taken (fully flushed, random daytime or stagnation);
- the time of sampling in relation to previous water use within the property (generally a sample taken following recent water use will have a lower lead concentration than a sample taken after a long period of no water use; and
- the volume of sample collected.

In that sub-section the EPA recommended that WSA's supplement the compliance audit monitoring with **lead surveys** as part as of investigations into non-compliance with the lead standard. The following paragraphs give advice on lead surveys and the subsequent remedial action. WSAs should also consult EPA Guidance Circulars No. 1 (Lead compliance monitoring and surveys) and No.2 (Action programmes to restore the quality of drinking water impacted by lead pipes and lead plumbing).

5.3.15 | The purpose of a **lead survey** is to determine the extent of lead pipes in the distribution network, the supply pipe work (service connections) and the internal plumbing within premises. The survey should comprise the following actions:

- identification of any lead distribution mains in the ownership of the WSA;
- identification of any lead pipe work in the service connection in the ownership of the WSA;
- identification of any lead pipe work in the service connection in the ownership of the property owner;
- identification of the extent of any lead plumbing in public buildings;
- identification of the extent of any lead plumbing in domestic dwellings; and
- targeted monitoring for lead in water supply zones where the information is uncertain or further information is required – this monitoring is the final component of a lead survey.

WSAs should plan their lead surveys in consultation with the local Environmental Health Officers and Specialists in Public Health Medicine of the Health Service Executive (the HSE). Further advice on the actions is given in the paragraphs below.

5.3.16 | Generally it can be assumed that any mains, service connections and properties constructed after 1970 will not contain lead pipes, unless a WSA has specific information to indicate otherwise. WSAs should review available distribution maps and records for each supply zone to determine whether lead was used in the mains or service connections and whether replacement of any lead pipe work has taken place since the original installations. WSAs should consult caretakers, fitters, water conservation teams and other operatives who may have information about lead pipe work that is not documented or readily available. Results of compliance monitoring under these Regulations or the previous Regulations (SI 439 of 2000) and results of any previous investigative monitoring may assist in confirming the presence of lead pipes. Where gaps exist WSAs should commence a programme of investigation.

5.3.17 | Each WSA should review its records to determine whether there are any **lead distribution mains** in any of its supply zones. The EPA understands that the presence of lead distribution mains is rare, but it is aware of a few cases. If a WSA has a lead

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distribution main, it should make arrangements to replace it as quickly as possible as it will not comply with the 10 μg/l lead standard at consumers' taps in any premises supplied through the lead main.

5.3.18 | Each WSA should review its records etc and map each of its supply zones to show the **locations of lead service connections in the ownership of the WSA**. Connections laid before 1970 (properties built before 1970) should be assumed to contain lead pipes unless the WSA has specific information that confirms the absence of lead pipes (such as areas where the connections are known to be of another material or housing estates were all the lead service connections have been renewed). Where gaps exist a programme of inspection of external stop tap types may help WSAs determine the likely presence of lead pipe and if necessary excavation at typical stop taps in the area to confirm the presence or absence of lead pipe. A similar procedure should be followed **for lead service connections in the ownership of the property owner**.

5.3.19 | The WSA should indentify all **public buildings** (for example but not limited to schools, hospitals, restaurants etc) that were constructed prior to 1970 where people may consume water. They should determine whether these **public buildings have lead plumbing**. The owner/manager of the building may have records or knowledge of the plumbing materials or may be aware that the internal plumbing has been replaced. Where there is doubt the owner or the WSA could inspect the plumbing or take an appropriate sample to confirm the presence or absence of lead plumbing. If there is a failure in a compliance sample or any other investigative sample, the WSA must notify the owner/manager of the building and require that person to submit to the WSA a programme of remedial action to rectify the failure and give that person advice on the action he/she can take to protect his/her health and the health of any consumers in the premises. WSAs should have written procedures for carrying out such notifications and for checking that the remedial action has been carried out. Where necessary the WSA should consider using the powers of Direction in regulation 6(3) of the Regulations in the event that action is not being taken by the owner/ manager of the premises.

5.3.20 | It will not be feasible for WSAs to determine the full extent of **lead plumbing in domestic dwellings**. However, a WSA should attempt to identify the areas where such houses with lead plumbing may exist and the proportion of the supply zone these houses comprise. The WSA should assume, unless other information is available (e.g. where the local authority has refurbished local authority houses or local knowledge indicates that lead pipe work was used at a later date), that all houses constructed prior to 1970 are at risk of containing lead plumbing. The WSA should produce a map of the distribution network clearly showing areas of the distribution network where it is known that there is no lead internal plumbing within domestic dwellings (e.g. developments constructed since 1970 or areas which have been refurbished by the local authority or private developer). Public notices and engagement with local community groups may assist in delineating the extent of lead piping in the supply zone. WSAs should develop, in consultation with the HSE, a Frequently Asked Questions (FAQ) leaflet or put appropriate advice on their website outlining how the public can get their water tested and should include advice on what to do if lead is detected in their water supply. The HSE has a FAQ leaflet on lead in drinking water on its website (***www.hse.ie/eng/services/Publications/HealthProtection/Frequently Asked Questions on Lead in Drinking Water.pdf***).

5.3.21 | When the steps in paragraphs 5.3.15 to 5.3.20 have been carried out, the WSA should produce a map of each supply zone showing areas of the supply zone that are supplied through lead pipes or are at risk of being supplied through lead pipes. The map should be dynamic and up-dated as further information becomes available. The WSA should develop an **investigative monitoring programme** targeting monitoring in areas of the water supply zone that are at risk of having lead pipe work in the WSA's or properties' owners system. The main purpose of this monitoring is to confirm the presence or absence of lead pipe work where information is currently unavailable. A subsidiary purpose is provide further information about the extent of failures to meet the 10 µg/l lead standard as this is an important factor to determine the necessary human health advice.

5.3.22 | A key factor in the development of this **monitoring programme** is the method of sampling used. It is important to note that the sampling method for lead as part of the investigative monitoring programme is not the same as that for compliance monitoring under the Regulations. Sampling for compliance monitoring requires WSAs to use *"an adequate sampling method at the tap so as to be representative of the weekly average ingested by consumers and that takes account of the occurrence of peak levels that may cause adverse effects on human health"*. For compliance monitoring, the EPA recommends that the random daytime samples are used. For the purposes of investigative monitoring WSAs should take stagnation samples. For such samples the pipes of the sample location should be flushed and run to waste and the sample should only be taken after a 30 minute stagnation time. Stagnation samples should inform the WSA whether there is lead pipe work present in the service connection or the internal plumbing.

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5.3.23 | In all cases where lead has been detected at levels above 10 µg/l (regardless of the sampling method used), or where the WSA has detected lead pipes in its own pipe work or pipe work belonging to the premises' owner (particularly serving public buildings – including but not limited to schools, hospitals and restaurants), the WSA should promptly consult with the HSE to determine whether there is, or could be, a potential danger to human health arising from the detection of lead. The WSA should inform the HSE of the type of sampling method used. Following such consultation and advice from the HSE, the WSA should inform consumers and give them the appropriate advice. Where relevant the WSA must notify the EPA in accordance with the guidelines in sub-section 4 of this section. Notification is required in all cases where the lead parametric value is exceeded, and where advice is given to consumers.

5.3.24 | The Regulations require that all appropriate measures are taken to reduce the concentrations of lead in drinking water. The long term solution for dealing with failures for lead in drinking water is to replace any lead pipes with a suitable alternative. However, treatment measures to reduce plumbosolvency may be needed in many zones as an interim measure. The EPA recommends a phased approach to dealing with lead pipes giving priority to areas where lead concentrations are highest, whilst taking any opportunities, such as leak detection programmes, mains refurbishment or replacement programmes or pavement improvement works, to replace lead pipes.

5.3.25 | Generally, if lead is present **only in the WSA's pipe work**, then the WSA is required to take action to comply either by providing additional water treatment or by replacing its pipe work. If lead is present **only in the consumer's pipe work and fittings**, then the WSA should provide advice to consumers on the action they can take to reduce their exposure to lead, [but the WSA should also consider additional treatment if other premises in the supply zone also show non-compliance]. If lead is present in **both the WSA's and the consumer's pipe work**, then the WSA should consider additional treatment (particularly if other premises in the supply zone also show non-compliance), replacement of its pipe work if treatment is not effective in securing compliance and provision of advice to consumers on the action they can take to reduce their exposure to lead.

5.3.26 | The following represents the recommended phasing for the replacement of lead pipes:

- lead distribution mains in the network as an urgent priority;

- individual lead service connections in the ownership of the WSA, whose replacement is likely to bring excessive concentrations below an acceptable level (may still not meet the standard), should be replaced as soon as practical;
- a planned annual programme for replacement of lead service connections in the ownership of the WSA which cause failures of 10 µg/l with the long term aim of phasing out such service connections;
- this annual programme should be risk based and should deal progressively with replacements of service connections to premises with vulnerable populations (such as crèches, schools, hospitals etc), the longer service connections and those connections in supplies that are significantly plumbosolvent. In relation to local authority housing stock both the WSA's service connection and the local authority's connection as the premises owner should be replaced;
- the replacement of the lead service connection in the ownership of the WSA whenever the lead service connection belonging to the owner of the premises is replaced by the owner; and
- opportunistic replacement of lead service connections in the ownership of the WSA whenever appropriate work is carried out on the distribution network such as leakage detection programmes, refurbishment or replacement of distribution mains, road and pavement improvement works etc.

5.4 Monitoring programme for non-compliant supplies

5.4.1 | The monitoring frequencies for the audit parameters are relatively low and in some cases WSAs may only need to take only one sample per year to comply with the Regulations. Thus, where non-compliance has been detected for an audit parameter it may be necessary for the local authority to increase monitoring for that parameter in the affected water supply. The purpose of increasing the monitoring frequency is to assist the WSA to determine the cause of the problem (e.g. a THM or nitrate non-compliance may only occur in certain raw water or seasonal conditions). Furthermore, in order to be able to track and confirm the effectiveness of the corrective actions taken, the WSA will need to carry out additional monitoring.

5.4.2 | As part of the action programme to be submitted to the EPA, the WSA should propose an increased monitoring programme which will be assessed by the EPA and amended if necessary. In general, in the case of microbiological non-compliances, daily

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monitoring until the problem has been resolved would be appropriate while in most circumstances weekly monitoring of the chemical parameters would be considered appropriate. Consideration will also need to be given to the sampling locations which in many cases will need to include sampling of the raw water, the treated water leaving the treatment works and water from representative locations in the distribution network.

5.5 Short term interim measures

5.5.1 | In the case of a non-compliance with the parametric values in part 1 of the schedule to the Regulations, WSAs are required by regulation 10(7) to include interim measures in the action programme. In most cases it will not be acceptable to permit the non-compliance to continue for the duration of the implementation of the action programme, which could be up to one year where there is a risk to human health. Thus the WSA must include details of interim measures to ensure that in the short term the risk of non-compliance (and hence the risk to human health) is minimised. These measures may include:

- installation of temporary treatment;
- temporary use of an alternative water supply; and,
- placing of restrictions on the supply (both in terms of water conservation and restrictions/prohibitions on consumption) in consultation and agreement with the HSE.

5.5.2 | The WSA should state which of these measures are to be used as part of the action programme. If none are to be used, it will be necessary for the WSA to justify the reasons for non-inclusion of interim measures.

5.6 Action programme timescales

5.6.1 | The WSA should prepare a GANTT chart or equivalent timetable outlining when each of the actions proposed in the action programme are to commence and to be completed. The proposed completion dates should be clearly stated. The overall action programme must be completed as soon as possible. Where the non-compliance presents a risk to human health, the action programme must be completed no later than one year from the date of its approval by the EPA. Where there is not a risk to human health, it must be completed no later than two years from the date of its approval by the EPA. The EPA may require a shorter timeframe for the completion of actions proposed in the action programme and the decision to require a shorter timeframe will depend on the nature of the non-compliance, the speed with which it can realistically be resolved and the risk to human health caused by the non-compliance.

5.7 Informing consumers of the action programme

5.7.1 | Regulation 10(9) places an obligation on WSAs to ensure that consumers are informed of any remedial action to be taken to improve the water supply so as to ensure compliance with the standards and indicator parameter values in the Regulations. When informing consumers of the remedial action the WSA should provide the following information:

- a brief summary of the non-compliance and possible causes;
- details of actions consumers can take to reduce the likelihood of further non-compliances (e.g. flushing standing water to reduce lead concentrations);
- details of actions members of the public can take to reduce the likelihood of further non-compliances (e.g. prevention and reporting of pollution of the source);
- a brief summary of actions to be taken by the WSA;
- an indication as to when the supply is likely to be returned to compliance; and
- details of where consumers and members of the public can get access to the full action programme (including any amendments by the EPA).

5.7.2 | WSAs must make all reasonable efforts to make sure all consumers are informed. Consumers should be informed, as a minimum, via an advertisement in the local press and/or public notice on the website of the WSA. The WSA should also consider informing consumers via leaflet drop, radio announcements, teletext notices, notices in prominent locations or other means as may be appropriate for the situation. Regular updates on the situation should also be provided. WSAS should also inform and provide local elected representatives with information and updates on the programme.

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6. Remedial Action List (RAL)

6.1 Introduction

6.1.1 | The EPA, as part of its supervisory role under the Regulations, has prepared a list of public water supplies where remedial or management action is required to ensure compliance with the requirements of Regulations. This list is called the **"Remedial Action List (RAL) for Public Drinking Water Supplies"**. The EPA uses the RAL to focus attention on resolving any deficiencies in public water supplies in order to ensure a supply of clean and wholesome drinking water. The list focuses on those issues and parameters of concern as identified in the EPA's Annual Reports on the Provision and Quality of Drinking Water in Ireland including, in particular, high risk supplies for *Cryptosporidium*, failures of the *E. coli* parameter standard and those supplies where treatment is inadequate.

6.1.2 | The RAL is updated on an ongoing quarterly basis to include any new supplies notified to the EPA under the requirements of regulation 9 and 10 in cases where an action programme or remedial work is required to prevent, limit, eliminate or abate the failure or the risk to human health from the supply (see sub-section 5 of this section). The RAL includes supplies that had reported failures of the priority parameters in paragraph 6.1.3 in the two years prior to the Regulations coming into force where action programmes are needed or are in the process of being completed. In many instances only the primary parameter of concern is listed on the RAL but there are instances where there are compliance issues in relation to several parameters that need to be addressed (despite the fact that only one primary parameter is listed). The up-to-date RAL for public water supplies is published on the EPA's Enforcement Network website (***www.enforcementnetwork.ie***) and the EPA's website (***www.enforcementnetwork.ie***).

6.1.3 | The priority RAL parameters are those for which the overall compliance rate needs to improve (e.g. *E. coli*) or where additional treatment is required to reduce risk to human health (e.g. *Cryptosporidium*) or where treatment is inadequate or inappropriate (e.g. bromate and THMs). A supply will not be included on the RAL where the EPA considers the non-compliance to be trivial. The priority parameters are:

- Table A – microbiological – *E coli*;
- Table B – chemical parameters – nitrate, trihalomethanes (THMs);

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- Table C – indicator parameters – aluminium, turbidity;
- *Cryptosporidium* – high risk supplies based on the *Cryptosporidium* risk screening; and
- Other parameters on a case by case basis which in numbers or concentrations, constitute a potential danger to human health (e.g. arsenic, bromate).

6.2 Purpose of the RAL

6.2.1 | The purpose of the RAL is to ensure that WSAs prepare and implement an action programme for each public water supply on the list. The RAL includes supplies where the primary issue to be addressed is the water treatment plant. This list does not include supplies where there are issues of quality caused by the distribution network (for example lead). The action programme should provide details on actions already taken or planned with completion dates. The action programme chosen in a particular situation should be placed in one of the following categories:

- programme to abandon, supplement or replace the water source;
- programme to up-grade the treatment facilities; or
- programme to improve operational and maintenance arrangements at treatment works.

6.2.2 | Summary details on the action programme for each supply must be submitted to the EPA as part of the WSA's annual reporting of monitoring results and other information See section 9 of this handbook. This report must be submitted by 28 February each year in respect of the previous year.

6.3 Supplies on the RAL

6.3.1 | The RAL is compiled by the EPA in consultation with the Department of Environment, Heritage and Local Government (DoEHLG) and the HSE and includes supplies which (unless the EPA is satisfied with the action taken and removes the supply from the list):

- the EPA has received notification of a failure to meet a standard or indicator parameter value in previous years;

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- are at high risk from *Cryptosporidium* (e.g. surface water treatment works with chlorination only);
- any other failures for the priority parameters noted by EPA in the annual returns on drinking water quality; and
- were found to have deficiencies during the EPA audits.

6.3.2 | Each WSA should review its RAL carefully and ensure that measures are being taken to identify and resolve the reason why the supply is listed. In carrying out this review the WSA should have regard to the guidance in sub-section 5 of this section and it should identify the appropriate solution for each supply. This may involve, inter alia, abandoning, supplementing or replacing sources, upgrading treatment facilities or improving operational and maintenance arrangements. Also each WSA should consider water conservation and leakage reduction strategies when reviewing its solutions as these can lead to reduced stress on treatment works and therefore allow improved treatment. The WSA should develop an action programme for all supplies on the RAL which prioritises the actions to deal with the highest risks first.

6.3.3 | The WSA should keep records on the action programmes for each supply. Progress in upgrading supplies on the RAL should be published on the WSAs' websites in order to keep consumers informed of actions being taken to improve the quality of drinking water. The progress by WSAs in dealing with supplies listed on the RAL will be tracked by the EPA as part of its role under the Regulations. The EPA may review these records during its audits, or may request further information as part of its role in assessing notifications under Regulations 9 or 10. The RAL is used to target enforcement actions including audits. Summary details of the action programme should be submitted to the EPA on the form at Appendix 2 and should include the following details:

- if the supply is to be abandoned, supplemented or replaced, the supplementary or replacement supply;
- if the treatment of the supply is to be up-graded, brief details of the up-grade works (e.g. the type of treatment to be installed or details of specific improvement works); and
- If the treatment works operations are to be improved, brief details of the actions to improve operations.

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6.4 Removal of supplies from the RAL

6.4.1 | The EPA acknowledges that the RAL based on the results over the previous years is historical and that in certain cases actions will already been taken and completed by the WSA to deal with the cause of the failure or reduce the risk. Therefore, the RAL is continuously up-dated by the EPA. As soon as a WSA considers that the necessary remedial action programme to deal with the failure or the risk has been completed, it should submit details of the actions by e-mail to ***drinkingwater@epa.ie*** with "RAL" and name of supply in the title. The EPA will review this information and if the EPA is satisfied that the WSA has rectified the cause of the failure or installed the appropriate treatment or taken other appropriate action, the supply will be removed from the list. It will generally not be sufficient for the WSA to argue that monitoring results alone demonstrate compliance unless action has been taken to prevent a recurrence of the non-compliance with the standard or indicator parameter value.

6.4.2 | Appendix 3 contains guidance to WSAs on the criteria that should be met before the EPA will consider removing a supply from the RAL.

7. Departures from the standards

7.1 | **A departure from the parametric values specified in table B in part 1 of the schedule to the Regulations** may, on application by a WSA and subject to agreement with the HSE, be granted by the EPA in relation to a water supply[3], provided:

- no such departure constitutes a potential danger to human health; and
- that the supply of water intended for human consumption in the area concerned cannot otherwise be maintained by any other reasonable means.

Departures are not available for the microbiological parameters in table A or for the indicator parameters in table C of part 1 of the schedule to the Regulations.

7.2 | A departure is in effect permission to continue supplying water that does not comply with the standards whilst remedial action is taken provided there is not a potential danger to human health. The standards for many of the chemical parameters

3 This does not apply if the failure is due to the condition of the domestic distribution system (pipe work or fittings) in the premises concerned.

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are based on life long consumption and have a wide margin of safety, so that relatively short term non-compliance up to a value that is not excessively higher than the standard is unlikely to be a potential danger to human health.

7.3 | Any departure granted by the EPA must be subject to a maximum value and for a period of not more than three years initially. The EPA must obtain agreement from the HSE that a water supply containing the maximum value for that parameter for that period does not constitute a potential danger to human health. The EPA also needs to be satisfied that the water supply to the supply zone affected cannot be maintained by any other reasonable means.

7.4 | An application by a WSA for a departure must include the information specified by the EPA. This information is set out in the form at Appendix 4.

7.5 | Any departure granted by the EPA must:

- be subject to any conditions specified by the EPA;
- be for as short a period as possible and not exceed three years
- provided the non-compliance is not trivial, specify:
    - the grounds for the departure;
    - the parameter concerned, previous relevant monitoring results, and the maximum permissible value under the departure.
    - the geographical area, the quantity of water supplied each day, the population concerned and whether or not any relevant food-production undertaking would be affected.
    - an appropriate monitoring scheme, with an increased monitoring frequency where necessary.
    - a summary of the plan for the necessary remedial action, including a timetable for the work and an estimate of the cost and provisions for reviewing.
    - the required duration of the departure.
- be reviewed by the EPA prior to the end of the period of the departure to determine whether sufficient progress has been made.

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7.6 | EPA need only specify the maximum value for the parameter and the time allowed for remedying the problem when the following circumstances apply:

- the EPA considers the non-compliance with the parametric value to be trivial;
- the EPA considers that the action taken in accordance with regulation 10(4)(a) is sufficient to remedy the problem within 30 days; and
- the failure to comply with the parametric value in the supply has not occurred on more than 30 days on aggregate during the previous three months.

7.7 | A WSA granted a departure, except for a departure covered by paragraph 7.6 above, must:

- inform the affected population of the departure and the associated conditions (see paragraph 5.7.2 above); and
- give advice, where necessary, to particular population groups if the departure could present a special risk (an example of where such advice may be necessary is when a departure is granted for nitrate. Anyone bottle-feeding infants should be advised to use low nitrate bottled water for preparing infant feeds and not to use the tap water until the remedial action programme is complete).

7.8 | If the WSA cannot complete the remedial action within the specified time, the WSA may make an application to the EPA for a further departure for a period not exceeding three years. Such an application should be in the same form as specified above and must include a full explanation and justification for not meeting the timetable and for requiring a further departure.

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Appendix 1: Model form for notification of failure to meet the parametric values in part 1 of the schedule to the Regulations in accordance with Regulations 9(1) or 10(2)

Water Services Authority	
Name of water treatment works	
Name of water supply zone (s)	
Water supply zone code(s)	
Estimated population affected	
Parameter (s) affected	
Monitoring results (note 1)	
Date and location of failure	
Notification under regulation (please tick one)	Regulation 9(1) Regulation 10(2)
Has the Health Service Executive been consulted	
What advice has been provided by the Health Service Executive?	
Likely cause and duration of the failure	
Has the parameter(s) failed in this supply in the past 12 months (if so give details)?	
Immediate action taken to protect and inform consumers	
Immediate remedial action taken	
Notified by and position	
Date of notification	
Contact telephone number	

Note 1: State whether the sample was a compliance, operational or investigational sample. For microbiological failures indicate the chlorine residual at the time and whether the remedial actions set out in this section of the handbook are being implemented. Also where relevant include the most recent information on raw water quality.

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Appendix 2: form for the submission of action programme for a supply on the Remedial Action List (RAL)

Name of water supply	Water supply zone code	Primary reason supply is on the RAL	Date of exceedence of parametric value1	Proposed action (please indicate a, b or c below) abandon up-grade improve operations	Details of actions proposed	Details of interim measures	Timeframe for completion of action programme2

1 Provide details on the date of the most recent exceedance (if any) of the parametric value for the parameter linked to the primary reason for inclusion of the supply on the RAL. In the case of supplies on the RAL for inadequate Cryptosporidium barriers include details of the date of any positive results for oocysts in the raw or treated water, and in the case of these supplies if Cryptosporidium monitoring is not carried out then this should be detailed.

2 The month and year of completion of works should be inserted here. The action programme in this case means that main programme of works that needs to be carried out in order to demonstrate to the EPA that the supply should be removed from the RAL.

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Appendix 3: Guidance for the removal of supplies from the RAL

This appendix includes the criteria that should be met before the EPA will consider removing a supply from the Remedial Action List (RAL).

1. Supplies on the RAL resulting from failure to meet a microbiological parametric value

1.1 | Where the supply is on the RAL resulting from failure to meet a microbiological parametric value (i.e. E. coli or Enterococci) the supply will only be removed where the cause of the failure has been investigated and the WSA has in place the following:

- For supplies that are chlorinated:
  - continuous chlorine monitor and alarm;
  - adequate disinfection contact time (30 minutes contact time at 0.5 mg/l Cl2);
  - duty/standby dosing arrangements at all chlorine dosing points;
  - flow proportional dosing and/or dosing linked to chlorine residual monitor (this may be waived in exceptional circumstances – e.g., where a good quality borehole supply with a low chlorine demand is being pumped a constant rate); and
  - results of monitoring to demonstrate that the actions undertaken have been adequate (at least 3 compliant microbiological samples on different dates).
- For supplies that are treated by ultraviolet (UV) irradiation:
  - a copy of the validation cert for the UV lamp including details of the validated range of the lamp;
  - confirmation that there is a UVI or UVT monitor on the UV lamp to verify that the UV is within its validated range at all times;
  - verification that the UV has operated within its validated range at all times (i.e. a print out of the UVI or UVT readings from the monitor for the past two months);

- confirmation that there is duty/standby or, if it is a small supply, confirmation that there is an automatic shut off in the event of failure of the UV system (i.e. no undisinfected water enters the mains);
- details of how the WSA ensures there is no contamination in the distribution network (since UV does not provide residual disinfection in the network); and
- results of monitoring to demonstrate that the actions undertaken have been adequate (at least 3 consecutive compliant samples on different dates).

2. Supplies on the RAL resulting from failure to meet a chemical parametric value

2.1 | In the case of supplies on the RAL resulting from failure to meet a chemical standard the supply may only be removed where the cause of the failure has been investigated and the WSA:

- provides details of the actions taken to address the non-compliance with that parameter; and
- provides results of monitoring to demonstrate that the actions undertaken have been adequate (at least 3 consecutive compliant samples for that parameter on different dates).

3. Supplies on the RAL resulting from failure to meet an indicator parametric value

3.1 | In the case of supplies on the RAL resulting from failure to meet an indicator parameter (i.e. aluminum or turbidity) the supply may only be removed where the cause of the failure has been investigated and the WSA:

- provides details of the actions taken to address the non-compliance; and
- provides results of monitoring to demonstrate that the actions undertaken have been adequate. This should comprise two months results of compliant daily (unless agreed otherwise with the EPA) testing at the plant (i.e. either a print out from turbidity monitor or daily manual samples) and at least 3 consecutive compliant samples from the distribution network taken on different dates.

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4. Supplies on the RAL due to the absence of an adequate barrier for the removal of Cryptosporidium

4.1 | In the case of supplies on the RAL because of an inadequate barrier to Cryptosporidium the supply should only be removed where:

- the supply has been replaced by an alternative supply which does have an adequate barrier to *Cryptosporidium*; or
- an adequate barrier (e.g. filtration, UV) has been installed and fully commissioned; and
- there are operational controls to demonstrate the effectiveness of the barrier (e.g. turbidity monitors on filters); and
- it has been demonstrated that the barrier is being operated effectively (e.g. the results of continuous turbidity monitor indicate low levels in the filtered water).

5. Supplies on the RAL following the identification of issues arising from an EPA audit

5.1 | In the case of supplies on the RAL due to the identification of infrastructural, operational or management issues arising from an EPA audit, the supply will only be removed from the RAL where significant recommendations of the audit have been fully implemented and where implementation can be verified (e.g. further audit or photos of equipment to be installed).

6. Supplies on the RAL following identification by the Health Service Executive

6.1 | In the case of supplies on the RAL due to the identification of such supplies by the Health Service Executive (HSE) the supply will only be removed from the RAL where:

- the WSA has demonstrated that it has addressed the concerns of the HSE; and
- the HSE has stated that they are satisfied that the remedial measures implemented have addressed their concerns. In this regard, a letter from the HSE should be submitted to the EPA by the WSA verifying this fact.

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Appendix 4: Model form for application for a departure from the standards in table B of the schedule to the Regulations in accordance with regulation 11

General	
Water Services Authority	
Address	
Telephone no.	
Fax no.	
E-mail address	
Contact person	
Private water supplier	
Address	
Telephone no.	
Fax no.	
E-mail address	
Contact person	
Details of the departure	
Name of water supply	
Grid reference of abstraction point	
Name of treatment works	
Name and code of supply zone	
Volume supplied	
Population served	
Treatment processes (identify any relevant to this application)	

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Details of the Departure	
Parameter(s) applied for (from table B of part 1 of schedule to the Regulations	
Grounds for departure (Include past monitoring results, geological maps or other information in support of the application including justification that the supply of water cannot be maintained by any other reasonable means.	
Duration of departure (must not exceed 3 years)	
Details of other possible alternative sources of water for supply	
Assessment of the Impact of the Departure	
Indicate if any of the opposite use, or will use, water from the supply during departure period and give details	Hospitals/medical centres: Nursing/residential homes: Schools/colleges etc: Food production facilities: Other sensitive users (specify):

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Assessment of the Impact of the Departure	
Details of how the WSA intends to identify particular population groups for which the departure could present a particular risk and how the WSA intends to ensure that appropriate advice is given to such groups.	
Provide the advice from the HSE on whether the departure constitutes a potential danger to human health	
Monitoring	
Details of current compliance monitoring programme (number of samples and results for last 3 years for the parameter(s) above)	
Details of any increased monitoring programme (frequency of sampling for parameter(s) above)	
Remedial action plan proposed to achieve compliance	
Details of remedial action	
Timetable for this action	
Estimated cost of this action	
How the WSA will review progress with the plan to ensure completion by departure date	
State how the WSA will ensure that the population affected is informed of the departure and its conditions	

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Declaration	
I hereby make an application for a departure from the parametric value(s) specified in table B of part 1 of the schedule of the European Communities (Drinking Water) (No.2) Regulations 2007 for the parameter(s) above. I certify that the information given in the application is truthful, accurate and complete.	
Name	
Position	
Signature	
Date	

SECTION 7: DRINKING WATER QUALITY COMPLAINTS

7

Issue No:	1
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Section 7: Drinking water quality complaints

Summary of Section 7

- Describes the importance of consumers' complaints about drinking water quality and the need to investigate and solve them promptly.
- Sets out the procedures that Water Services Authorities (WSAs) should have in place to investigate the cause of complaints, to determine any remedial action that might be necessary, for liaising with the consumers on the progress with the investigation and for giving consumers advice on the action they can take to minimise any risk to their health.
- Describes the circumstances when WSAs must consult and agree with the Health Service Executive (the HSE) on whether there is a potential danger to human health and what WSAs must do if there is such a danger.
- Describes the circumstances when WSAs must inform the Environment Protection Agency (the EPA) about consumers' complaints about drinking water quality.

Contents of Section 7

1. Introduction
2. Procedures for dealing with drinking water quality complaints
3. Liaison with the Health Services Executive (the HSE)
4. Reporting complaints to the EPA

1. Introduction

1.1 | Water Services Authorities (WSAs) will be aware that drinking water quality is very important to consumers. If something has gone wrong with the water supply it could present a risk to consumers' health or affect the appearance, taste or odour of the supply. Therefore complaints about drinking water quality received from consumers should be investigated promptly by the WSA and the results of the investigation given quickly to the complainants. If the cause of the complaint is a problem with the quality of the water supplied by the WSA, then the WSA must take prompt action to remedy the problem. If the cause of the complaint is the condition of the domestic distribution system (the pipe work and fittings) within the premises, the WSA must give the

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complainant advice on how to resolve the problem. Complaints may be received from consumers by telephone, in writing by letter, fax or e-mail or in person. WSAs should have in place comprehensive written procedures for dealing with complaints about the quality of public drinking water supplies.

1.2 | The Environment Protection Agency (the EPA) recommends that all complaints are directed to the WSA in the first instance and that the WSA should liaise with the complainant to address the cause of the complaint whenever possible. When the EPA receives a complaint about drinking water quality that has not been reported previously to the WSA, the EPA will advise the complainant to contact the WSA directly and the EPA will also refer the complaint to the WSA for investigation. However, where the complaint has already been reported to the WSA and the WSA does not appear to have dealt with the complaint in a satisfactory matter, the EPA may request the WSA to carry out an investigation (or a further investigation) and to report the results to the EPA. The EPA may take enforcement action if it appears necessary.

2. Procedures for dealing with drinking water quality complaints

2.1 | The WSA's written procedures for dealing with complaints about the quality of public drinking water supplies should include as a minimum:

- a system of recording the receipt of telephone, written and personal complaints and for collation those complaints;
- a procedure for assigning immediately the management of the investigation of the complaint to one person (usually a member of the WSA's scientific or engineering staff) who will co-ordinate the activities of all personnel involved in the complaint. This person should be capable of determining the nature of the problem, determining appropriate investigations to ascertain the cause and assessing whether there could be wider implications;
- a procedure requiring the assigned person to contact the complainant and explain what the WSA is doing and when the complainant can expect a response. This person should keep the complainant informed, particularly if there is any delay;
- guidance on the investigations that should be carried out which could included as appropriate:

- reviewing the recent operation of the water treatment works, service reservoir and the distribution network to determine whether any action may have contributed to the water quality problem;
- reviewing the results of recent compliance and operational samples from relevant sampling locations;
- taking and analysing samples for appropriate parameters from appropriate locations including the complainants premises; and
- analysing any samples taken by the complainant for appropriate parameters, provided the samples are clearly not compromised (the complainant may have taken a sample in a container that obviously contaminated the sample);

- a procedure for receiving and assessing the results of the investigation and if necessary discussing them with laboratory and operational staff;
- a system initiation of any necessary action by the WSA:
  - taking any appropriate remedial action when the complaint has been caused by the WSA's operations; and
  - giving advice to the complainant on the actions he/she should take when the investigation has established that the cause is associated with the condition of his/her pipe work and fittings;
- a system for reporting the outcome to the complainant as quickly as possible in simple terms (avoid the use of scientific or engineering language that the complainant will not understand);
- a system for reviewing from time to time the procedures and modifying them if necessary; and
- a system for reviewing periodically all complaints by number, type and location to determine whether there are particular difficulties with some aspect of the WSA's operations.

2.2 | The WSA should also have arrangements for checking that the complainant is satisfied with the WSA's investigation, explanation of the cause and the action taken. The complainant may not be satisfied and when this occurs the complainant should

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have the opportunity of the matter being referred to a senior person in the WSA. This person should review the WSA's investigation and handling of the initial complaint and, if necessary, initiate further investigations. The outcome of the review should be reported to the complainant as quickly as possible. If the complainant is still not satisfied, the WSA should refer the complainant to the EPA for investigation of the WSA's actions. Formal complaints can also be made to the EPA in accordance with the Environmental Enforcement Network National Complaints Procedure.

2.3 | The samples taken as part of the investigation into complaints are not **compliance** samples nor can they be regarded as **operational** samples because they may not be representative of the quality of water normally supplied. However the WSA should keep adequate records of these investigative samples and the results of any analysis so that they can be provided to, and inspected by, the EPA on request.

2.4 | Sometimes, particularly when the cause of the complaint is the WSAs operations, there may be several complaints of the same nature from consumers in different premises in the supply zone. If there are a sufficient number of serious complaints, the situation may be regarded as an incident, or even an emergency, affecting drinking water quality. In these circumstances the WSA should follow the procedures set out in section 8 of this handbook.

3. Liaison with the Health Services Executive (the HSE)

3.1 | If the investigation of the complaint finds that there has been a non-compliance with a standard in tables A or B or an indicator parameter value in table C of part 1 of the schedule to the Regulations, the WSA must consult and agree with the HSE on whether the non-compliance is a potential danger to human health. If the WSA has not detected a non-compliance but is concerned that there may be a health risk (for example because some other substance is present) it should also consult the HSE. If the HSE considers that there is a potential danger to human health, then the WSA (with the HSE's agreement) must:

prohibit or restrict the use of the supply and take urgent remedial action when the problem is caused by the WSA's operations; or

provide advice to the complainant about the action he/she can take to minimise the risk to all the consumers in the premises when the problem is caused by the condition of the domestic distribution system (pipe work and fittings) within the premises.

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3.2 | Detailed advice on consulting the HSE about the protection of human health and giving advice to consumers and on taking remedial action is given in section 6 of this handbook.

4. Reporting complaints to the EPA

4.1 | If the investigation of the complaint finds that there has been a non-compliance with a standard in tables A or B or an indicator parameter value in table C of part 1 of the schedule to the Regulations, the WSA must notify the EPA using the form at Appendix 1 of section 6 of this handbook. The WSA will be required to take remedial action under the provisions of regulation 10 and may be directed to do so by the EPA. Further guidance on the procedures for remedial action programmes is given in section 6 of this handbook. If the WSA, in consultation and agreement with the HSE, has to prohibit the supply of water or restrict its use, it must notify the EPA.

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SECTION 8: INCIDENTS AND EMERGENCIES

Issue No:	1
Date:	12 April 2010

Section 8: Incidents and emergencies

Summary of Section 8

- Defines incidents and emergencies and gives some examples of common types.
- Sets out the requirement to prepare a Drinking Water Incident Response Plan and provides guidance on how to prepare the Plan and the key contents of the Plan.
- Describes how Water Services Authorities (WSAs) should notify the Health Service Executive (the HSE) and the Environment Protection Agency (the EPA) of incidents and emergencies and provides guidance on what information should be included in the notification.
- Sets out what WSAs should include in their reports to the EPA on incidents and emergencies.
- Describes when an Outbreak Control Team (OCT) may be set up when there is illness, or suspected to be illness, in the community associated with an incident involving water supplies.

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    2.1 Definitions
    2.2 Examples of incidents and emergencies
3. Drinking Water Incident Response Plan (DWIRP)
    3.1 Introduction
    3.2 Guidance on preparing a DWIRP
    3.3 Rehearsal of DWIRP
4. Notification of incidents to the HSE and the EPA
5. Report on the incident/emergency to the EPA
6. Incidents involving outbreaks of illness

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1. Introduction

1.1 | From time to time events occur that affect or threaten to affect the quality of drinking water supplies in a way that puts at risk human health or causes considerable concern to consumers. These events may be caused by some failure of the Water Services Authorities (WSA's) operations or may be caused by something outside of the WSA's direct control. Some events will be sufficiently serious to be classed as incidents or emergencies requiring full investigation; others will be minor and will not require investigation to the same extent.

1.2 | All events that are judged by the WSA to be incidents or emergencies should be notified to the Health Services Executive (the HSE) and the Environment Protection Agency (the EPA). A failure to meet a standards or indicator parameter value in tables A, B and C of part 1 of the schedule to the Regulations is not necessarily an incident or emergency, particularly if it does not put at risk human health or cause concern to consumers and it can be dealt with fully under the notification and other requirements of regulation 10. Some failures will put at risk human health (microbiological) and will cause concern to consumers (iron and manganese causing discoloured water) and may require a fuller investigation than under regulation 10. Other incidents may be identified without there being a sample failing to meet a standard or indicator parameter, for example a pollution incident in the water source, or heavy rain and flooding impacting on raw water quality, or a failure of disinfection at a treatment works.

2. Definition of incidents and emergencies

2.1 Definitions

2.1.1 | An incident or emergency is defined as any event detected by routine compliance monitoring or routine operational monitoring, or any other event that was not necessarily detected by the routine compliance or operational monitoring and has occurred because of something that has happened in the catchment, at the treatment works or in the distribution network, that:

- appears to have caused illness in the community as a result of the quality of the water supplied (reports of illness in the community that could possibly be caused by the water supply); or

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- because of its effect, or likely effect, on the sufficiency or quality of the water supplied, gives rise to, or is likely to give rise to, a significant risk to health of the persons to whom the water is supplied; or
- has caused, or is likely to cause, significant concern to persons to whom the water is supplied; or
- has attracted, or is likely to attract, significant local or national publicity.

2.1.2 | Note that a failure to meet a standard in tables A and B or an indicator parameter value in Table C in part 1 of the schedule to the Regulations that is detected by routine compliance monitoring or routine operational monitoring is not necessarily an incident or emergency. Many such failures do not cause a potential danger to human health or cause concern to consumers and can be dealt with fully under the notification, investigation and remedial action requirements of regulation 10. A failure is only classified as an incident or emergency if it meets one of the criteria set out in paragraph 2.1.1.

2.2 Examples of incidents and emergencies

2.2.1 | Some common examples of incidents and emergencies are:

- a serious pollution of a surface water upstream of an abstraction point that has caused or threatens to cause difficulty with the treatment process and therefore a significant effect on drinking water quality;
- a serious pollution of an aquifer from which water is abstracted for supply (the treatment before supply may only consist of disinfection);
- a failure of an important water treatment process, such as loss of coagulation or filtration or breakdown of disinfection;
- a significant number of complaints of discoloured water or water with an abnormal or offensive taste/odour within a few hours from a particular area of the water supply; and
- a serious loss of water supply for a significant period.

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2.2.2 | The guidance that follows in this section applies to the management of the types of incidents described above. It does not apply to the management of major emergencies, such as terrorist threats, national strikes, major power failures and major flooding of water treatment plants that involve a large number of Government Departments and other stakeholders. Guidance on management of major emergencies is contained in "A New Framework for Major Emergency Management" published by an Inter-departmental Committee (Departments of Health and Children, Justice, Equality, Law Reform and Defence) which covers:

- hazard analysis/risk assessment;
- mitigation/risk management;
- planning and preparedness;
- co-ordinated response; and
- recovery.

3. Drinking Water Incident Response Plan (DWIRP)

3.1 Introduction

3.1.1 | In accordance with the Department of Environment, Heritage and Local Government (DoEHLG) Circular L4/09, each WSA must have a written Drinking Water Incident Response Plan (DWIRP) that sets out in general terms how incidents or emergencies are to be managed, investigated and brought to a satisfactory conclusion. The Water Services Training Group (WSTG) has developed a two day training course to assist WSAs to prepare a DWIRP. The DoEHLG and the EPA recommend that all appropriate personnel from WSAs attend this course. As well as the course notes and supporting documentation, participants in this course receive

- a guidance document on preparing and implementing a DWIRP; and
- a template for a DWIRP.

3.1.2 | WSAs should be aware of the HSE document "Guidelines proposed by the Health Service Executive as a template document between the Health Service Executive and Water Services Authorities for Dealing with Exceedances and Incidents in Water

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Supplies" which is intended to facilitate a standardised framework nationally for dealing with microbiological, chemical and indicator failures and incidents and can be used as a guide for HSE Appendix A5 Protocols in the DWIRP.

3.2 Guidance on preparing a DWIRP

3.2.1 | The guidance in this section sets out the key requirements of a DWIRP. Readers requiring more detail are referred to the guidance document and the template above.

3.2.2 | Each WSA must appoint a senior person within the WSA to be the **manager of the DWIRP** and another person to be the **deputy manager**. These persons should be thoroughly familiar with the organisation, structure and water supply function of the WSA. These persons should have the following main roles:

- preparation of the DWIRP in consultation with other senior personnel in the WSA and other organisations such as the HSE;
- distributing the DWIRP as a controlled document to all relevant personnel in the WSA;
- maintaining the DWIRP up-to-date;
- co-ordination of the resources needed to implement the DWIRP;
- training all relevant WSA personnel to implement the DWIRP;
- rehearsing and testing the DWIRP; and
- reviewing incidents to determine any lessons and, if necessary, modifying the DWIRP.

3.2.3 | The DWIRP should include the following key requirements:

- clear criteria for identifying incidents and emergencies that affect, or threaten to affect, the sufficiency or quality of drinking water supplies or give concern to consumers;
- contact arrangements within the WSA when incidents and emergencies occur outside normal working hours;

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- a planned response to incidents and emergencies with a senior person in the WSA designated as the **incident manager** responsible for managing and co-ordinating all aspects of the response and for deciding when it is necessary to set up an **incident room**;

- the criteria for convening an **Incident Response Team (IRT)** to assist in managing defined aspects of the incident. The incident manager would convene the IRT. Where necessary the IRT, chaired by the WSA, could include external organisations such as the HSE. Sometimes it may be necessary for the HSE and the WSA to discuss and agree a course of action which could include the convening of an IRT. Information about IRTs and their role is given in Chapter 4 of "Drinking Water and Health – a Review and Guide for Population Health, Health Service Executive 2008"(***www.hse.ie/eng/services/Publications/services/Environmentalhealth/HSE_Drinking_Water_and_Health_Review_and_Guide_2008.pdf***);

- clear lines of communication between sampling, laboratory, scientific, engineering, operational, customer services and management staff during the incident;

- contact details (name, telephone, fax, e-mail address) of the appropriate person within the HSE who should be notified of the incident and arrangements for liaison with that person throughout the incident;

- contact details (name, telephone, fax, e-mail address) of the appropriate person within the EPA who should be notified of the incident and arrangements for liaison with that person throughout the incident;

- preparing a report on the incident in consultation with IRT and the HSE contact person if the HSE is not part of the IRT;

- the planned response should contain details of how WSA should deal with typical common types of incident including:

    - how the investigations are to be initiated;

    - what the investigations might consist of;

    - how any information and advice is to be given to consumers and who does it including help lines and automated information messages;

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- criteria for deciding when it may be necessary to supply water by other means such as in bottles or tankers and the arrangements for such supplies;
- who is responsible for dealing with the media (providing information and enlisting their help to broadcast information); and
- the criteria for deciding the incident is over;

- the investigations may include, when relevant;
    - reviewing the recent events in the catchment including any monitoring of the raw water and checking the operation of the treatment works and distribution network;
    - reviewing recent compliance monitoring data and operational monitoring data from relevant points in the treatment and distribution networks;
    - visiting and inspecting relevant parts of the catchment, treatment works and distribution network;
    - taking and analysing samples for relevant parameters from appropriate points in the catchment (raw water source), treatment and distribution networks; and
    - carefully assessing the results of the investigations and deciding whether remedial action is needed;
- for giving advice to consumers on any action they may need to take to protect their health whilst the WSA is investigating the incident or taking remedial action (this advice must be given in consultation and the agreement with the HSE or the IRT if the HSE is part of the IRT):
    - criteria for deciding when advice by leaflet is sufficient and when advice needs to be given by other means such as loud-hailer, media announcements etc;
    - model leaflet for:
        - advising consumers to boil water for drinking and cooking when there is a microbiological problem; and

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- ❖ advising consumers not to use water for drinking and cooking and to use an alternative supply (in bottles or from a tanker) for these purposes when there is a chemical problem;

- how the leaflets are to be distributed;
- these leaflets should be capable of adaptation quickly to any water quality or water supply emergency;
- these leaflets should be very clear and use simple language;
- these leaflets may need to be provided in languages other than English in some cases (e.g. Irish and other languages);
- **when such advice is to be given the WSA should agree with the HSE or the IRT (if the HSE is part of the IRT), if possible before the advice is given, the criteria that would enable the advice to be withdrawn;** and
- model leaflets for withdrawing the advice when the incident/emergency is over;
- what information needs to be provided to the media, who prepares it and who speaks to the media (TV, radio and newspapers) – **it is vitally important that consistent information is given to the media;** and
- reviewing the adequacy of the procedures from time to time as a result of experience in dealing with incidents and emergencies.

3.2.4 | WSAs should have specific emergency procedures for key operational sites such as major water treatment works and major service reservoirs. Hazard assessment studies as part of a Drinking Water Safety Plan should be carried out at all key operational sites to determine which parts of the process would cause major problems if there were a failure. The specific emergency procedures for the site should include contingency plans to deal with failures of those key parts of the process. These plans may include the use of stand-by equipment or processes or the shutting down of the works or reservoir and supplying water by alternative means.

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3.3 Rehearsal of DWIRP

3.3.1 | Each WSA should have a policy for rehearsal of the procedures in its DWIRP so that all personnel involved understand and become familiar with exactly what they have to do when an incident or emergency occurs. The policy should specify who is to organise rehearsals and the type of rehearsal. Ideally the rehearsal should be as realistic as possible and should include the HSE, the EPA and other stakeholders. The outcome of rehearsals should be assessed and recorded and any lessons learned from the rehearsals should result in appropriate revisions to the procedures in the DWIRP.

4. Notification of incidents to the HSE and the EPA

4.1 | The WSA should notify the designated HSE and the EPA contacts by telephone, followed by fax or e-mail with the details of any incident or emergency that falls within the definitions in sub-section 2 of this section as soon as possible after it becomes aware of the event affecting one of its public water supplies. The notification to the HSE is to enable the HSE to consider whether there is a potential danger to human health (the HSE has developed a template for notifications) and if there is to advise the WSA on what action needs to be taken to protect consumers' health. The HSE may require further information through on-going communication with the WSA before it can advise the WSA whether there is a potential danger to human health and the actions required to mitigate the danger. The notification to the EPA is to enable the EPA to consider whether any urgent regulatory action is necessary such as a direction to require remedial action to be taken.

4.2 | This notification should include the following information (if some of the information is not available it should be included as soon as practical):

- the date of the incident, the date and time of the notification and the person making the notification;
- the geographical location, such as the water supply zones affected, and, if relevant, the catchment, the water treatment works and service reservoirs involved;
- a description of the nature of incident;

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- whether a standard for a parameter has been, or is likely to be, breached or whether an indicator parameter value has been, or is likely to be, exceeded. If so the WSA must complete the notification of failure form at Appendix 1 of Section 6 of this handbook;
- whether any other element, organism or substance (not a parameter) is of concern and the effect or likely effect on the quality of water supplied;
- the number of people affected;
- the likely cause(s) of the event;
- the action that has been, or is being taken, to rectify the situation; and
- whether there has been any local or national publicity and details of it.

4.3 | The WSA should consider the HSE draft guidelines for dealing with incidents and consult and agree with the HSE on:

- whether there is a potential danger to human health;
- the nature and extent of any sampling and analysis that might be needed to establish whether there is a potential danger to human health and to establish the cause and extent of the incident;
- any action that might need to be taken to inform and protect consumers and the content of any notice issued to consumers;
- if a notice of advice is to be issued to consumers, the criteria for deciding when to withdraw that advice; and
- any information that should be given to the media relating to any potential danger to human health and advice to consumers about protecting there health.

4.4 | The WSA should liaise with the HSE, the EPA and any other relevant organisations throughout the incident. This liaison could include verbal communications, written communications (fax or e-mail), local meetings or full scale IRTs.

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5. Report on the incident/emergency to the EPA

5.1 | The EPA deals with each incident notified to it on a case by case basis. Usually the EPA will ask the WSA (or the IRT if one is convened) for a response to its initial queries within one week. After considering this response and the individual circumstances of the incident, the EPA may require a further report from the WSA or the IRT. Generally a further report on an incident will be necessary when the quality of the drinking water is compromised or threatened to be compromised and there is a potential danger to human health. This report should be available publicly so that all WSAs can learn the lessons arising from the incident and other stakeholders are kept informed. The EPA needs the report to enable the EPA to consider whether any further regulatory action is required.

5.2 | The WSA or the IRT should include the following information in its report:

- background description of the incident, including details of:
  - the water zones and population affected;
  - water sources and treatment works;
  - service reservoirs and distribution network;
  - any problems or abnormal occurrences in the catchment, the operation of works, service reservoirs and/or distribution network experienced prior to the incident;
  - where relevant, a map of the area and diagrams of the treatment works, distribution networks etc;
- log of events with times and dates, including details of:
  - methods of identifying the supply zones affected, or likely to be affected, and of informing and protecting consumers;
  - the investigations to establish the cause, the extent of the incident, including the samples taken and their locations etc;
  - actions taken to restore water quality or provide alternative supplies;

- notification and subsequent consultation and liaison with the HSE and any other organisations;
- any advice received from the HSE and any other scientific or technical experts, and any action taken as a result of the advice;

- numbers of samples taken and the sampling points associated with the incident and the results of the analysis of those samples;
- discussion where appropriate on:
  - the appropriateness and effectiveness of the investigations and the action taken;
  - the analytical systems and methods used;
  - whether the WSA's procedures in its DWIRP were followed;
  - the adequacy of liaison arrangements with the HSE and other relevant organisations;
  - the adequacy of the communications with the consumers;
  - the adequacy of the communications with the media;
  - on any potential danger to human health and the actions to mitigate any danger; and
  - details of any further action taken or proposed to prevent the incident recurring;
- copies of any press releases, press reports and any information and advice provided to consumers; and
- conclusions of the WSA's handling of the incident and any recommendations for improvements to its procedures in its DWIRP.

5.3 | It follows from the last bullet of paragraph 5.2 above that once an incident is concluded the WSA should review its handling of all aspects of the incident to identify any lessons to be learned from the incident. These lessons may require the WSA to modify parts of its DWIRP for dealing with future incidents.

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6. Incidents involving outbreaks of illness

6.1 | When drinking water is associated or suspected to be associated with an outbreak of illness in the community an outbreak investigation may be triggered. This may involve the convening of an **Outbreak Control Team (OCT) by the HSE** to manage the outbreak. If requested, the WSA should nominate a suitable person to serve on the OCT to provide the members of the OCT with all relevant information relating to the incident involved in the outbreak. The OCT and the IRT (see paragraph 3.2.3 above) should have some common membership. Information about OCTs and their role is given in Chapter 7 of Drinking Water and Health – A Review and Guide for Population Health, Health Service Executive, 2008 (***www.hse.ie/eng/services/Publications/services/Environmentalhealth/HSE_Drinking_Water_and_Health_Review_and_Guide_2008.pdf***).

6.2 | When an OCT is operating, a number of organisations are involved in the management of the incident and the outbreak. It is extremely important that consistent and clear messages and information is given to the public and the media. Generally both the OCT and the IRT (that is both the WSA and the HSE) will be involved. Each should have a dedicated spokesperson for public/media announcements. The OCT and IRT should decide whether any media notices and appearances should be made jointly. Whilst the WSA has the responsibility to advise all consumers, in some situations additional advice may be provided directly to consumers by the HSE.

6.3 | After an incident involving an outbreak of illness is concluded, the OCT should critically review all aspects of its handling of the incident to identify any lessons to be learned and, if necessary, to make any changes to its practices and procedures for future incidents involving outbreaks of illness.

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Section 9: Annual reporting of monitoring results and other information to the EPA

Summary of Section 9

- Describes the requirements on the Environment Protection Agency (the EPA) to report on drinking water quality in Ireland, to keep a register of public water supplies and to verify the monitoring data produced by Water Services Authorities (WSAs).
- Sets out the requirement on WSAs to report the check and audit monitoring compliance results to the EPA.
- Describes the Environmental Data Exchange Network (EDEN) which WSAs use to up-load monitoring data and specific supply details (source, treatment, supply etc.) to the EPA.
- Sets out the monitoring data (sampling and analysis information) to be up-loaded to EDEN and describes how pesticides results are handled.
- Describes how the data is up-loaded to EDEN.
- Sets out how the EPA assesses the monitoring results.
- Sets out the timing for submission of returns by WSAs to the EPA.

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   3.3 Drinking water (DW) schemes
      The type of treatment
      The source of the water supply
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3.7 Submission of returns

Appendix 1: Suggested reporting format for pesticides

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Table 2: Example of completed report

1. Introduction

1.1 | Section 58 of The Environmental Protection Agency Act, 1992 to 2007 (the Act) requires the Environmental Protection Agency (the EPA) to prepare and submit to the Minister (at the Department of Environment, Heritage and Local Government (DoEHLG)) a report on the quality of drinking water in Ireland. This report is to be based on the results of monitoring carried out in accordance with the requirements of the Regulations. In accordance with section 58(1) of the Act, the EPA may require a Water Services Authority (WSA) to submit to it the results of monitoring (sampling and analysis) carried out under the Regulations in such a manner and at such times as it may specify.

1.2 | The Regulations establish the EPA as the supervisory authority in relation to public water supplies. The EPA is obliged under regulation 7 to verify compliance of drinking water supplied by a WSA with the standards and indicator parameter values in part 1 of the schedule to the Regulations and to supervise the performance of each WSA of its monitoring functions under the Regulations. The latter includes an assessment of whether the minimum monitoring frequencies for each water supply have been complied with. The EPA is also required to enforce the regulatory requirements in respect of public water supplies provided by WSAs.

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1.3 | The EPA is also required in accordance with regulation 8(3) to keep a register of water supplies for which it is the supervisory authority. The EPA will need collect this information as part of the annual reporting of monitoring results to the EPA as outlined in this section of the handbook.

1.4 | This section of the handbook provides comprehensive guidance to WSAs on the information to be reported to the EPA in the annual report and on the format of that information in respect of public water supplies. A similar 'Handbook on the Implementation for Private Water Suppliers' contains guidance on the information to be reported to the EPA in respect of private water supplies.

2. Monitoring results and information on supplies to be reported to the EPA

2.1 | Each WSA must report all its **check and audit compliance monitoring results for all its public water supplies** as part of the annual reporting to the EPA. The following monitoring results must not be included:

- monitoring carried out in response to complaints about drinking water quality from consumers;
- operational monitoring carried out to assist in the management of the water supply;
- investigative monitoring carried out in response to a failure to meet a standard or indicator parameter value;
- investigative monitoring carried out in response to a potential problem with the water supply (e.g. breakdown of equipment); and,
- additional monitoring carried out in response to a direction issued by the EPA.

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3. Format for the submission of monitoring results and information on supplies

3.1 Introduction

3.1.1 | The EPA has developed the Environmental Data Exchange Network (EDEN) to assist local authorities (WSAs) in the sharing of water related environmental data with other relevant stakeholders. Monitoring data entered into the WSA's laboratory information system can be directly up-loaded into EDEN. This data can then be collected by the EPA through EDEN. This will enable the WSAs to fulfil their obligations regarding reporting under the Regulations by up-loading their monitoring data to EDEN. From this year on, WSAs need to supply the drinking water supply scheme data direct to EDEN. Thus WSAs no longer have to send drinking water supply scheme data to the EPA via the EPA excel template that was used to collate this data in previous years. Through EDEN the EPA will collect and collate the same drinking water supply scheme data as was previously contained in the excel templates. WSAs should include the contact details of their approver when submitting their annual monitoring results and supply scheme details to the EPA.

3.1.2 | The EPA will collect each WSA's check and audit compliance monitoring results through EDEN. It is essential each WSA ensures that the information inputted to its laboratory information system and up-loaded to EDEN is accurate and does not contain errors.

3.2 General details of the WSA

3.2.1 | The contact details of the person uploading drinking water monitoring and supply scheme details should be included to enable the EPA to contact the WSA in the event of any queries arising from the submission of the results. The WSA contact person is responsible for the sign off of all supply scheme data and monitoring results before uploading to EDEN.

3.3 Drinking water (DW) schemes

3.3.1 | This is a complete list of all public water supplies covered by the Regulations. WSAs must ensure that all scheme details uploaded to EDEN are correct. If a supply is no longer operational then the date that the supply ceased to operate should be entered. WSAs should review this list. All schemes submitted to the EPA as part of the

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2009 drinking water returns have been designated a scheme start date of 01/01/2009 in EDEN. WSAs have the option of amending these scheme start dates in EDEN. WSAs can also add new schemes to EDEN. **Please note that once the supply scheme data has been approved by the WSA, the information is then locked and cannot be amended without the prior approval of the EPA.**

3.3.2 | The EPA uses the information inputted into the DW Schemes sheet to form the basis of its register of public water supplies as required under regulation 8(3). This regulation requires the EPA to include the following information in the register:

- the name and address of the water supplier;
- the volume of water supplied per day;
- the population served by the water supply;
- the type of treatment in place;
- the source of the water supply; and
- the supply zone code.

Further information is collected by the EPA to assist in the collation of statistics for enforcement and reporting purposes.

3.3.3 | Further guidance on what is required in relation to the last three items is given below.

The type of treatment

3.3.4 | The WSA should specify the type of treatment (each of the treatment processes) at each treatment plant including the use of coagulants, pH adjusting chemicals, disinfectants and other chemicals. A treatment plant that might be described as 'conventional coagulation, clarification, filtration and disinfection' should be more fully described as for example "Coagulation using aluminium sulphate, clarification, rapid gravity sand filtration followed by disinfection using sodium hypochlorite and pH correction using sodium carbonate (soda ash)". Details on whether the supply has:

- continuous residual chlorine monitor and alarm:
- duty/assist chlorine dosing

- duty/assist UV dosing
- flow proportional/residual chlorine based dosing
- details of the chlorine contact time to the first consumer on the supply.
- whether turbidity monitors are installed and where (after each filter, on the combined filtrate etc.) must be included.

The source of the water supply

3.3.5 | The template contains a drop down menu from which one of the following should be selected:

- groundwater, include details of the aquifer;
- surface water, include details of the river, lake etc;
- spring water, include details of the spring; or
- mixed, include details of the mixed sources.

The supply zone code

3.3.6 | The Drinking Water National Monitoring Programme (referred to in the Department of Environment, Heritage and Local Government circular letter, WSP11/04, dated 17 December 2004) assigned supply zone codes to all water supply zones in Ireland at the time. The database provided to each WSA with that circular contained a mechanism for assigning new supply zone codes for new water supply zones which came into operation after that date. Each WSA should ensure that each supply zone is assigned a supply zone code of the format xxxxPUByyyy where xxxx is the four digit WSA code and yyyy is the four digit unique supply code.

Cryptosporidium risk screening score

3.3.7 | WSAs must include the *Cryptosporidium* risk screening scores for the catchment, the treatment works and the overall score. WSAs should use the risk screening methodology set out in appendix 1 of section 10 of this handbook to obtain these risk screening scores.

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Other information

3.3.8 | WSAs should enter information on whether a WSP or DWIRP is in place for each supply. If there is no WSP in place for a particular supply the WSA should indicate if they have commenced the preparation phase of the WSP.

3.4 Monitoring results

Introduction

3.4.1 | WSAs must up-load to EDEN the results of the analysis for all of the check and audit compliance monitoring samples for each public water supply monitored during the year. A brief description of the sample information and analysis information required to be up-loaded outlined below.

Sample information

3.4.2 | The following information is required in respect of public water supplies:

Scheme Name/Name of Water Supply – the name of the water supply should be inserted here. Where a supply has multiple colloquial names, only one of these names should be used.

Scheme Code – the complete scheme code should be used. This will be xxxxPUByyyy for public water supplies. Locally used codes (i.e. county specific) should not be reported to the EPA.

Public/Private/Group – enter public water supply.

Location – the sample location should be provided here. The purpose of this is to confirm that the sample was taken at the "point of compliance" as defined in regulation 5 and therefore the information provided here should be sufficient to enable the EPA to confirm this fact.

Sample Type – the type of sample analysed should be provided here. The WSA will select either 'Check Monitoring Public' or 'Audit Monitoring Public' from the four options as the other options refer to private water supplies

Inv/Op/Surv – the surveillance option should be selected for all samples as investigative and complaint samples are no longer required to be submitted as part of the annual returns to the EPA.

Sample Code – the unique sample or laboratory code should be inserted here.

Analysis information

3.4.3 | The WSA should ensure all results of analysis are included and not in separate attachments (with the exception of pesticides – see paragraph 3.4.4). The WSA should flag any failures that it demonstrated were due to the domestic distribution system (condition of the tap or pipe work) within premises that were not under the ownership of the WSA. When completing the analysis results section the WSA must ensure the following:

- **Results are reported in the correct units** – monitoring results reported to the EPA must be of the units specified in the Regulations. If the WSA obtains results from a laboratory in different units the results must be converted to the correct units prior to submission to the EPA. An error message will appear in EDEN if the results are in the incorrect units. In particular WSAs should ensure that nitrate, nitrite and ammonium results are reported as NO_3, NO_2 and NH_4 respectively and not as N. A full list of the parametric values and associated units is included in section 2 of this handbook

- **Methods of analysis are adequate** – section 2 of part 3 of the schedule to the Regulations specifies the performance characteristics that must be achieved by laboratories carrying out analysis of drinking water. The WSAs must ensure that these characteristics are being met by laboratories carrying out analysis. The EPA recognises that results will be obtained and reported using methods that do not achieve these performance characteristics at present. **The EPA recommends that laboratories carrying out analysis for determining compliance with the water quality standards should aim to be accredited by the end of 2012 and that all analysis must be carried out in accredited laboratories by the end of 2015.** The EPA will not accept monitoring results from unaccredited laboratories after the end of 2015. In the meantime, the EPA will accept results from WSAs where the laboratories used do not meet these requirements except in cases where the method used fails to meet the requirement by a large margin. For example where results are reported as less than the limit of detection and the

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limit of detection is either the same as or greater than the parametric value then the results should not be submitted to the EPA (for example if PAH results are reported as <0.10 μg/l when the parametric value is 0.10 μg/l). Where such results are submitted by the WSA an error message will appear in EDEN and the WSA will be required to amend the results as it is not possible to determine compliance with the parametric value on the basis of such results.

Reporting of pesticides

3.4.4 | The Regulations set two standards for pesticides. For each individual pesticide the standard is 0.1 μg/l with the exception of aldrin, dieldrin, heptachlor and heptachlor epoxide for which the standard is 0.03 μg/l. For total pesticides the standard is 0.5 μg/l. In the return the EPA requires that a figure be inserted for total pesticides. This result should be calculated by summing the individual pesticides detected and reporting this result in the template. In calculating total pesticides, all individual pesticides present in concentrations less than the limit of detection should be assumed for the purposes of these calculations as being absent (0.0 μg/l). Where all pesticides monitored are reported as less than the limit of detection, the total pesticides figure should be reported on the template as <0.5 μg/l.

3.4.5 | In cases where individual pesticides have been detected, the WSA should complete a separate summary of the concentrations of all individual pesticides detected. It is not necessary to include individual pesticides that were monitored if they were reported as less than the limit of detection. The recommended format for reporting of individual pesticides and an example of a complete report is at Appendix 1.

3.5 Up-loading of data to EDEN

3.5.1 | WSAS can access the EDEN website at ***https://www.edenireland.ie/***. WSAs need to register as a user of EDEN at ***https://www.edenireland.ie/ Register.aspx*** (the register menu option in EDEN). If any WSAs need assistance to up-load data, there is a comprehensive help facility available at ***https://www.edenireland.ie/Help/Index.html***. When logging onto EDEN, users will also need to request access to the MDS (monitoring data system) application.

3.5.2 | For WSAs using LabInfo, an upgraded version along with an application called LIXIE has been installed in those WSAs. Where the LabInfo PC has access to the Internet, LIXIE will allow automatic connection and transfer of drinking water data selected by the WSA staff to EDEN. If the PC isn't connected to the Internet, then the file can be created on the LabInfo PC and then manually uploaded to EDEN from a PC with an Internet connection.

3.5.3 | For WSAs using a LIMS other than LabInfo, a manual upload to EDEN should be carried out. Work has been completed by certain LIMS vendors so that monitoring data can be exported to the EDEN DET format required. This file will then have to be uploaded to EDEN following the instructions in the EDEN help file.

3.6 Assessment of monitoring results by the EPA

3.6.1 | The EPA will assess the monitoring results submitted and will do one of the following:

- accept the data as submitted without further queries and import the data into the EPA drinking water database;
- revert to the WSA with queries about the returns; or
- return the data to the WSA and request amendment of data and resubmission.

The EPA will return all data to the WSA where there are any errors or omissions from the returns to allow the WSA to correct the data and re-upload the data through EDEN.

3.6.2 | Once the EPA is satisfied that the results are accurate and correct, the data will be imported into the EPA database. The EPA will carry out an analysis of the data to generate statistics for its annual report on drinking water quality. When this analysis is complete the EPA will send out a copy of the analysis to the WSA for verification. The following files will be sent to the WSA:

- a list of all failures in all water supplies;
- a list of all water supplies in the WSA's area;
- a list of any supplies insufficiently monitored; and
- a summary of the statistics for the WSA including the calculations of overall compliance.

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3.6.3 | The WSA will be given a period of two weeks to comment on the accuracy of these files and the calculations. All valid comments or amendments will be incorporated into the statistics used for the preparation of the overall national summary and the WSA report.

3.7 Submission of returns

3.7.1 | WSAs should submit their drinking water quality compliance monitoring results and drinking water scheme details to EDEN by 28 February each year in respect of the previous calendar year.

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Appendix 1: Suggested reporting format for pesticides

Table 1: blank

Water Services Authority	Name of Water Supply	Scheme Code	Sample Code	Date	Pesticide	Result (µg/l)	Pesticide	Result (µg/l)	Pesticide	Result (µg/l)

Table 2: example of completed report

Water Services Authority	Name of Water Supply	Scheme Code	Sample Code	Date	Pesticide	Result (µg/l)	Pesticide	Result (µg/l)	Pesticide	Result (µg/l)
X County Council	Lake Regional WS	4000PUB1001	2007/1024	26/01/2007	Atrazine	0.05	Simazine	0.02	Aldrin	0.02
X County Council	Big Lake PWS	4000PUB1005	2007/251	12/08/2007	Heptachlor	0.01				
X County Council	Big Lake PWS	4000PUB1005	2007/358	12/12/2007	Heptachlor	0.01	MCPA	0.05		
X County Council	Small Well GWS	4000PRI2002	2007/301	20/09/2007	Methoxychlor	0.15				

SECTION 10: DRINKING WATER SAFETY PLANS

Issue No:	1
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Section 10: Drinking water safety plans

Summary of Section 10

- Summarises the drinking water safety plan (DWSP) approach as advocated by the World Health Organisation (WHO) and adopted and recommended by the Environment Protection Agency (the EPA).
- Describes the key steps in developing a DWSP.
- Sets out the general principles of risk assessments and control measures covering catchment/water source, treatment works, distribution networks and consumers' premises.
- Gives examples of risks and control measures for each of these parts of the water supply system.
- Describes the WHO qualitative risk scoring matrix and gives as an example a possible quantitative risk scoring matrix.
- Gives advice on documentation of the DWSP.
- Appendix 1 sets out the risk screening methodology for *Cryptosporidium*, including all the factors that need to be considered for the catchment/water source, treatment works and distribution network risks and how to calculate the risk scores for both surface water supplies and groundwater supplies.

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4.1 Introduction

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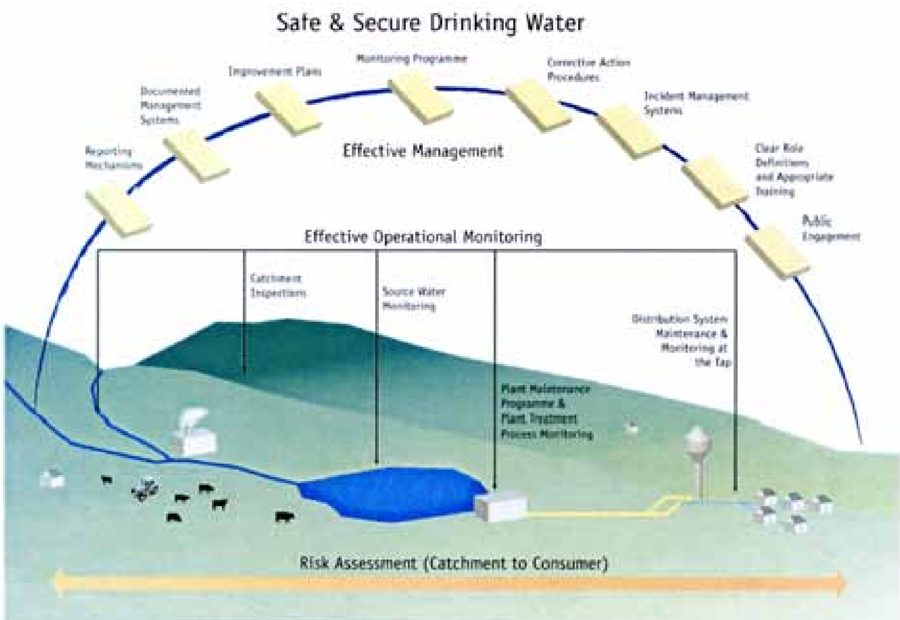
1. Introduction

1.1 | The Environment Protection Agency (the EPA) has adopted a **drinking water safety plan (DWSP) approach** to ensuring drinking water is both "safe" and "secure". A drinking water supply is deemed to be "safe" if it meets the standards and indicator parameter values in part 1 of the schedule to the Regulations each time the supply is monitored. A drinking water supply is deemed to be "secure" if there is in place a management system that has identified all potential risks from the catchment of the source, through the treatment works and distribution network, to the consumers' premises and has procedures in place to manage these risks.

1.2 | The essential components of a DWSP approach are shown in figure 1. This approach is based on the World Health Organisation (WHO) criteria for a safe and secure drinking water supply set out in the 2004 WHO Guidelines for Drinking Water Quality (***http://www.who.int/water_sanitation_health/gdwq3rev/en/index/html***).

Figure 1: The essential components of a DWSP



1.3 | The WHO has set out three essential components for a safe and secure drinking water supply. These are:

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- **Risk assessment of water supplies from catchment to consumer** – Identification and assessment of all risks in the catchment, treatment plant and distribution network up to the tap that may result in a risk to health and/or a breach of the required standard.

- **Effective operational monitoring** – Inspection of the catchment, reservoirs, treatment plant and distribution network to detect pollution, equipment failure or chemical dosing faults; followed by prompt and effective corrective actions where problems have been identified.

- **Effective management** – Competent management of the supply during normal and abnormal conditions, regular and accurate reporting of treatment plant and distribution network operations and personnel trained and resourced to deliver clean and wholesome drinking water.

1.4 | The EPA regards the implementation of the WHO recommendations by WSAs as part of a robust DWSP as a key measure to ensuring the delivery of a safe and secure water supply. The Regulations implement EU Directive 98/83/EC on the quality of water for human consumption. The European Commission has initiated a review of the Directive and it has been proposed that any future revision of the Directive should include a requirement on Member States to ensure that their water suppliers prepare and implement DWSPs. **The EPA therefore recommends that WSAs adopt the DWSP approach to ensuring safe and secure water supplies.** This section provides guidance to WSAs on preparing DWSPs. The EPA circular letter (September 2009) recommends that WSAs also use the new guidance in the 2009 WHO "Water Safety Plan Manual – a step by step risk management for drinking water suppliers" (***http://whqlibdoc.who.int/publications/2009/9789241562638_eng.pdf***).

2. Key steps in developing a DWSP

2.1 The following are the key steps in preparing a DWSP:

- assemble a **small team of experts** from the WSA and when necessary with external organisations, such as relevant organisations involved in River Basin Management Plans for catchment control and the Health Service Executive (the HSE) for health risks, to prepare the DWSP;

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- **document and describe the system** – catchment, water source, treatment works, distribution network and consumers' premises;
- undertake a **risk assessment** by identifying the **hazards** that could occur and assessing the **likelihood** of them occurring at each stage of the water supply process;
- identify the **control measures** to minimise any unacceptable risks for each stage of the water supply process;
- define the **operational monitoring** of the control measures to check that they are minimising risks – this requires setting warning and alarm limits for unacceptable performance;
- establish procedures to **verify** that the DWSP is working effectively to deliver safe and secure water that meets the standards and other requirements, such as inspections, audits and monitoring;
- develop **supporting programmes** such as training, hygienic practices, standard operating protocols etc;
- prepare **management procedures**, including corrective actions, to deal with normal and incident/emergency conditions; and
- **document the DWSP.**

3. General principles of risk assessments and control measures

3.1 Introduction

3.1.1 | There are a number of significant factors that should be taken into account in any risk assessment from water source to consumers' taps. These factors are outlined below. A specific example of the application of these factors to risk assessment for *Cryptosporidium* is given in Appendix 1.

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3.2 Catchment and water source

Catchment factors

3.2.1 | The nature of the catchment and activities and events in the catchment can have a significant effect on the quality of water source in the catchment. Important factors are:

- **geology and hydrogeology** – determines whether potentially harmful natural substances are likely to be present in significant concentrations in water sources such arsenic, fluoride, uranium and radon and whether substances that could affect the aesthetic quality of water supplies are likely to be present such as peat colour, iron and manganese;
- **animals** – high numbers of farmed or wild animals including birds roosting on raw water reservoirs can cause a deterioration of the microbiological quality of water sources, particularly in relation to *Cryptosporidium*;
- **other agricultural practices** – such as:
  - storage of slurry or dung presents a risk of microbiological contamination, particularly as many stores are not secure from leakage from rainwater;
  - widespread slurry or dung spreading presents a risk of microbiological contamination; and
  - use of fertilisers and pesticides presents a risk of contamination by nitrate and pesticides;
- **discharges** – such as:
  - sewage works effluents, septic tank effluents and other small on-site sewage treatment systems can present a risk of microbiological contamination, particularly when not operated satisfactorily;
  - effluents from industrial premises can present a risk of chemical and other types of contamination depending on the nature of the industrial process and the substances used;

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- from mining, quarrying and similar activities, particularly when abandoned, can present risks of chemical contamination; and
- surface water and storm water overflows in urbanised areas.

Type of water source

3.2.2 | Some types of water source are at greater risk of contamination than other types for example:

- **deep boreholes and wells** – generally they are secure and present little risk unless the hydrogeology is considered vulnerable to activities on the surface;
- **shallow boreholes and wells** – generally these are less secure and present more of a risk unless the hydrogeology is considered not to be vulnerable to activities on the surface;
- **springs** – risk depends on the security of the spring, which in turn depends on whether the hydrogeology is considered vulnerable;
- **upland surface waters** – risk depends on the nature of, and activities in the catchment and whether collected in an impounding reservoir (less risk – balancing of quality) or abstracted directly from the river/stream (more risk of contamination and variable quality); and
- **lowland surface waters** – risk depends on nature of, and activities in, catchment and whether long-term storage (lower risk), bank side short-term storage (medium risk) or direct abstraction (higher risk).

Monitoring of the water source

3.2.3 | Risk is reduced when there is appropriate continuous or semi-continuous monitoring of the quality of the water source and that information is used either:

- to automatically or manually shut the intake under poor source water quality conditions; or
- to adjust the treatment processes in order to cater for deteriorating source water quality

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3.2.4 | Such monitoring would normally be used on direct abstraction surface water sources and significant surface water sources with short-term bank side storage. However, they could also be used on vulnerable boreholes, wells and springs.

Catchment control measures

3.2.5 | Whenever possible and practical catchment control measures should be used to minimise catchment risks to avoid having to install expensive treatment processes. Some examples of effective catchment and source protection and control are:

- developing and implementing a catchment management plan which includes control measures to protect ground waters and surface water including for example discharge consents, restriction on the use of chemicals, restriction on certain activities etc;
- use of planning Regulations to avoid activities that could pollute catchments, lakes and raw water reservoirs;
- management of raw water reservoirs such as mixing and destratification to minimise algal blooms and solubilisation of sedimentary iron and manganese; and
- Promoting awareness in the community of the impact of human, agricultural and industrial activity on water quality and where necessary controlling such activity.

3.2.6 | Some of these measures are not within the control of the WSAs and will require co-operation and liaison with other organisations that have a responsibility for catchment controls such as the local authority or other relevant organisations involved with the River Basin Management Plans.

3.3 Treatment works

Treatment processes

3.3.1 | 3.3.1 Risk is considerably reduced when there are appropriate water treatment processes to deal with the full range of variations in microbiological, chemical and physical water quality of the water source. An assessment needs to be made about whether the treatment processes provided are likely to inactivate or remove the organisms and substances likely to be present in the water source at the range of concentrations present. If the treatment processes are inadequate there is clearly a risk.

3.3.2 | For example a secure good quality groundwater or spring source may only require disinfection whereas a less secure poorer quality groundwater or spring water source may require coagulation, filtration and disinfection. Ground waters subject to chemical pollution may require additional treatment such as ion exchange to remove nitrate and granular activated carbon adsorption to remove pesticides. Some ground waters may require special processes to remove natural contaminants such as arsenic.

3.3.3 | Surface water sources usually require as a minimum coagulation, filtration and disinfection or for small surface water sources membrane filtration and disinfection. Some surface water sources will require additional treatment such as ozonisation and granular activated carbon adsorption to remove various organic contaminants, including pesticides. As surface water sources can potentially be contaminated with a wide range of micro-organisms, including *Cryptosporidium*, and chemicals it is important that a multi-barrier approach is adopted for effective treatment and removal of contaminants. Also it is important to minimise the formation of disinfection by-products such as the trihalomethanes whilst not compromising microbiological quality.

Hazards and risks

3.3.4 | Hazards may be introduced during treatment or hazardous circumstances may allow contaminants to pass through treatment in significant concentrations. Some common examples are:

- sporadic significant variations in source water quality overwhelming the treatment processes and allowing potentially harmful micro-organisms to enter the distribution network;
- flow variations outside the design limits for the process or the whole treatment works allowing sub-optimal treatment and contaminants to pass through the works;
- process failure/malfunction caused by equipment or process control failure, such as dosing pump breakdown or process monitor malfunction; and
- power failures.

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Operational monitoring and controls

3.3.5 | Risk is considerably reduced if there are standard operation protocols (SOPs) for the operation of all treatment processes and there is appropriate operational monitoring of the individual treatment processes and the final treated water linked to action if treatment performance deteriorates. For example filtration is a very important barrier for removing contamination. A continuous turbidity monitor should be installed on the filtrate from each filter, and as a minimum a monitor should be installed on the combined filtrate. The monitors should have appropriate warning and alarm limits so that appropriate action can be taken quickly if filter performance deteriorates. Similarly when chlorination is used as the disinfection process, apart from having an adequate dose and contact time, there should be a continuous chlorine monitor with appropriate warning and alarm limits so that action can be taken if there is a problem with the disinfection process. The actions that could be taken if performance deteriorates include:

- to adjust the treatment conditions or processes to deal with a trend indicating a deterioration in performance, such as increasing the coagulant dose or backwashing a filter; or
- automatically or manually shutting down the supply whilst urgent remedial action is taken for example when there was a significantly low or zero chlorine residual indicating a disinfection failure and a potential danger to human health.

Treatment works operation and maintenance

3.3.6 | The risk of failures of treatment processes and poor treated water quality is considerably reduced when the operators of the treatment works follow good operating and maintenance practice and procedures. These practices and procedures should be part of a quality management system. Operational practices that may give rise to increased risk of treated water quality failures include for example:

- by-passing a stage of treatment;
- operating a treatment process or the treatment works close to or above its design capacity;
- frequent and significant flow variations through the works

- returning filter backwash water to works inlet without monitoring or treatment; and
- putting backwashed filters back into operation without slow start or a ripening period.

3.4 Distribution network

Hazards and risks

3.4.1 | The protection of the distribution network is essential for providing safe drinking water. Many potential risks exist in the network (opportunities for contamination) because of its nature involving service reservoirs/water towers, many kilometres of pipe work and inter-connections. Some examples of how contamination may enter the distribution network are:

- ingress of contaminated water from the ground as a consequence of low pressure or pressure waves;
- back flow from industrial and domestic premises without adequate backflow prevention devices;
- through service reservoirs/water towers with structural defects or poor security;
- through pipe bursts when existing mains are repaired or new mains are installed;
- when petrol, diesel or oil spillages diffuse through permeable plastic (uPVC or polyethylene) mains;
- disturbance of deposits (for example iron and manganese) through changes in flow velocity or flow reversals; and
- illegal or unauthorised tampering, such as illegal or unauthorised use of fire hydrants.

Control measures

3.4.2 | The following are some examples of control measures to minimise these risks:

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- Standard operating procedures (SOPs) for all operational activities in the network;
- monitoring and maintaining positive pressure throughout the distribution network;
- regular inspection of high risk premises to ensure backflow prevention devices are fitted;
- regular internal and external inspection of service reservoirs/water towers to make sure there are no structural defects and that access hatches, vents and other openings are either locked or covered to prevent ingress;
- written hygienic procedures for repairing burst mains and laying new mains, including disinfection before return to service;
- inspection of garages and other fuel storage facilities and education of the owners/managers about the risks from fuel spillage;
- avoiding disturbance of deposits by avoiding sudden increases in flow and flow reversals and a programme to routine flushing and maintenance; and
- reducing the time water is in the network and maintaining a chlorine residual (or other disinfectant such as chloramine) throughout the network;

3.5 Consumers' premises

3.5.1 | Water quality can deteriorate within the pipe-work and fittings in consumers' premises. If the water supply is not treated to minimise plumbosolvency (and cuprosolvency) and there are lead (or copper pipes) within the consumers' premises then there is a risk that the water at consumers' taps will not meet the standards for lead (or copper) in samples taken from consumers' taps. There can also be failures to meet the standards or indicator parameter values for microbiological parameters in samples from consumers' taps that are due to the unhygienic condition of the consumers' pipe-work and fittings. There can also be failures to meet the standards resulting from cross-connections between water supply and other water systems and from backflow from water using devices if an appropriate protective device is not fitted.

3.5.2 | The main control measures for risks within consumers' premises are education about the risks and provision of advice on how to control these risks. This is often best achieved through education/advisory leaflets.

3.6 Risk scoring matrix

3.6.1 | It is necessary to have a method of assessing the risk of any hazard identified in order to complete a DWSP. This means developing a risk scoring matrix that relates the likelihood (estimated frequency) of occurrence of the hazard to the potential severity of the effect of that hazard should it occur. WHO in its Water Safety Plan Manual on DWSPs offers a simple semi-quantitative risk scoring matrix for ranking risks which is summarised in Table 10.1 below.

Table 10.1: semi-quantitative risk scoring matrix

		Severity of consequence				
		Insignificant or no impact – rating 1	Minor compliance impact – rating 2	Moderate aesthetic impact – rating 3	Major regulatory impact – rating 4	Catastrophic public health impact – rating 5
Likelihood or frequency	Almost certain – once a day – rating 5	5	10	15	20	25
	Likely – once a week – rating 4	4	8	12	16	20
	Moderate – once a month – rating 3	3	6	9	12	15
	Unlikely – once a year – rating 2	2	4	6	8	10
	Rare – once every 5 years – rating 1	1	2	3	4	5
Risk score Risk rating		< 6 6-9 10-15 > 15 Low Medium High Very high				

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3.6.2 | Many countries and water suppliers developing DWSPs modify this matrix to fit with their regulatory system and human health advice and make the matrix quantitative. An example of a possible quantitative risk scoring matrix for a treatment works is given in table 10.2. Similar risk scoring matrices can be constructed for source water quality, distribution networks and consumers' premises. Different scoring systems can be used.

Table 10.2: example of quantitative risk scoring matrix for a treatment works

Severity of consequence Likelihood of occurrence	No impact (all targets met)	Treatment compromised but no regulatory failure	Treatment compromised regulatory failure but no health risk	Treatment compromised regulatory failure and minor health risk	Treatment compromised regulatory failure and major health risk
Certain – once a day	5	10	15	20	25
likely – once a week	4	8	12	16	20
Moderate – once a month	3	6	9	12	15
Unlikely – Once a year	2	4	6	8	10
Rare – once every 5 years	1	2	3	4	5

3.6.3 | This risk scoring matrix is supplemented by an action matrix. An example of a possible action matrix for a treatment works is given in table 10.3. Similar action matrices can be constructed for source water quality, distribution networks and consumers' premises. Different scoring systems can be used.

Table 10.3: example of an action matrix for a treatment works

Risk score	Action
1-2	No action required
3-5	Action required/keep under review/consider further treatment measures
6-10	Further treatment required/possible capital investment required if existing treatment cannot be optimised

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Risk score	Action
12-16	Fairly urgent further treatment required and probable capital investment required (priority)
20-25	Urgent further treatment required and probable capital investment required (high priority)

3.6.4 | The EPA is considering the most appropriate risk scoring matrices and action matrices for catchment/source, treatment works, distribution network and consumers' premises based on the WHO Water Safety Plan Manual for the circumstances that exist in Ireland and will issue further guidance to WSAs in due course.

4. Documenting the DWSP

4.1 | For each of the four aspects of water supply – catchment/source water, treatment works, distribution network and consumers' premises – the water supplier needs to document the following:

- a description of the aspect supported by diagrams/maps showing all the important features, for example for a treatment works – a schematic diagram showing all the processes, the dosage chemicals, rates and points, the operational monitoring points, the warning and alarm limits etc;
- a description of the hazard with the likelihood of its occurrence and the severity of the consequence if it occurs and the risk score if using a quantitative scoring method;
- the control measures in place to minimise the risk and the action required if the control measures are insufficient;
- the operational monitoring to check whether the control measures are operating effectively to minimise the risk;
- the warning and alarm levels to initiate action when the control measures are not performing adequately;
- an action programme including additional control measures and the timetable to implement them.

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4.2 | The documented DWSP is supported by other existing documentation, such as catchment management and control plans, treatment works manuals and standard operating procedures for treatment processes, standard operating procedures for the distribution network and policy on inspection of consumers' premises.

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Appendix 1: Risk screening methodology for *Cryptosporidium*

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4. Groundwater risk screening methodology

4.1 Introduction

4.2 Delineation of the source protection area

Conceptual model: source – pathway – receptor

4.2 Delineation of the source protection area

Source (pressure) factor: animals within the catchment

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Source (pressure) factor: agricultural practices within the catchment

Table 16: agricultural practices risk score

Source (pressure) factor: discharges to the catchment/source protection area

Table 17: discharges risk score

Source (pressure) factor: catchment/source protection area inspections

Table 18: catchment/source inspections risk score

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Table 19: geology/hydrogeology risk score

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Table 20: by-pass of unsaturated zone risk score

Reception factor: water source type

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Table 22: sanitary protection risk score
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Groundwater treatment and supply risk score
Table 27: groundwater treatment and supply risk score
Final weighted groundwater risk assessment score
Table 28: final weighted groundwater risk assessment score

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1. Introduction

1.1 | Contamination of water supplies with the parasite *Cryptosporidium* presents a significant threat to the safety of drinking water in Ireland. The first outbreak associated with a public water supply in Ireland was in Mullingar in 2002. Improved awareness of the disease and a requirement on notification of the disease to the Health Protection Surveillance Centre has led to increased reporting of the disease and hence more outbreaks of the disease have been detected. Several outbreaks associated with water supplies have occurred in Ireland since 2002 including supplies in Ennis, Roscommon, Carlow, Portlaw and most recently Galway in 2007.

1.2 | The purpose of this risk screening methodology is to assist WSAs in prioritising supplies that are at a high risk of contamination with *Cryptosporidium* and identify high risk factors, which can be mitigated to reduce the risk associated with the supply. This risk screening methodology is based on the Scottish model as outlined in "The *Cryptosporidium* (Scottish Water) Directions, 2003" as published by the Scottish Executive. The Scottish model is a semi-quantitative risk assessment, which sets out a scoring system to enable determination of whether a supply is low, medium or high risk. The methodology involves calculating a risk score for the catchment factors and for the treatment, operational and management factors, which is then population weighted to give a final risk score. This original methodology was recommended for use in Ireland by the in the "European Communities (Drinking Water) Regulations, 2000: A Handbook on Implementation for Sanitary Authorities" published in 2004. More recent information and research as well as widespread use of the risk assessment methodology has identified some deficiencies in the methodology for use in Ireland, particularly with respect to groundwater.

1.3 | The EPA established a *Cryptosporidium* Working Group under the Environmental Enforcement Network. A Risk Assessment Sub-group was established and consisted of Darragh Page (the EPA) (Chair), Frank Griffen (Department of Agriculture Laboratory), Geraldine Duffy (Teagasc), Margaret Keegan (the EPA), Mary Keane (the HSE) and Paul Carroll (Waterford County Council). This Sub-group examined the risk assessment in detail and recommended that the risk assessment be amended. The amended version of the risk assessment as presented below should be used by the Water Service Authorities (WSAs) on all public water supplies to determine the risk category of the supply. It was decided by the Sub-group that a risk screening methodology should be developed, which allows supplies to be ranked relative to each other. Therefore, allowing time and resources to be spent on the high risk supplies.

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1.4 | Where a supply has been identified as high risk the WSA should develop an action programme to reduce the risk to low. The risk category for each water supply should be reviewed on an annual basis and the methodology re-applied where there is any change to the catchment factors or a change in treatment, operational or management factors.

1.5 | Prior to applying the risk screening methodology an assessment of the catchment factors and the treatment, operational and management factors should be carried out for each source. Where the level of uncertainty is high in relation to the information being used in any of the sections then a precautionary approach should be adopted and the highest score should be used. However, this uncertainty should be noted and further examination of the item should be carried out prior to undertaking the risk screening process.

1.6 | Filling out of the forms should be as a result of an assessment of the catchment and the treatment plant. The WSA should keep a report on this assessment for inspection by the EPA.

1.7 | This Risk Screening Methodology is seen as a pre-cursor to the application of a Drinking Water Safety Plan (DWSP) approach to the management of drinking water. The World Health Organisation (WHO) has set out three essential components to a water safety plan. These are:

- A risk assessment of the water supply – this is an assessment of the water supply from catchment to consumer. It should include the identification and assessment of all risks in the catchment, treatment plant and distribution network (up to the tap). The purpose of this assessment is to identify all potential risks, which may result in the supply of water that does not meet the drinking water standards or may otherwise pose a risk to health.

- Effective operational monitoring – this includes not only carrying out testing of the quality of the water in the catchment, treatment plant and distribution network but should also include monitoring risks to the safety of the water supply e.g. catchment inspections, regular checking of equipment/chemical dosing, service reservoirs, inspections etc. WSAs must monitor risks to determine if the relative threat of the risk is increasing. Operational monitoring is only effective where followed by effective corrective actions where problems have been identified.

- Effective management – Having identified and monitored all relevant risks to the safety and security of the water supply, effective management of the risks is essential. This includes development of documented management systems outlining what measures are to be taken during normal and incident management conditions and should include regular reporting mechanism. The roles of various personnel involved in the supply of water should be clearly outlined and reviewed on a regular basis.

1.8 | The engagement of the public in the management of water supplies in terms of the protection of water resources and communication of quality issues is an essential component of any DWSP approach. The EPA encourages and promotes the DWSP approach to the management of drinking water supplies and will be issuing guidance in relation to it in the future.

2. Risk screening methodology

2.1 Introduction

2.1.1 | For a risk to exist there must be a source (or pressure), a pathway and a receptor (or target) (Daly, 2004). This is the basis for the Source-Pathway-Receptor (S-P-R) conceptual model widely used for environmental management. A conceptual site model (CSM) is a textual or graphical representation of the relationship that exists between the pressure and the receptor.

2.1.2 | The risk screening methodology facilitates a clear decision-making process in devising a strategy to control any potential risks evident in the conceptual model. It has been divided into Catchment Factors and Treatment, Operation and Management Factors. The scores for these factors are additive and then population weighted.

2.2 Catchment factors

2.2.1 | There are a number of factors that have to be considered in relation to both surface water and groundwater water supplies. The pressure on the receptor is in effect the same therefore factors such as animal densities, agricultural practices, wastewater treatment facilities within the catchment or source protection area need to be examined. The pathway element has been taken into consideration for groundwater

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supplies as groundwater is afforded some protection by the overlying subsoils. The receptor factors relate to the inherent vulnerability of different types of water sources and the protection factors that may be incorporated into the supply.

2.2.2 | The information obtained through a desk study and walkover survey of the catchment area will inform the decision on the extent of measures, which are required to manage the risk. This may involve breaking the pathway (e.g. provision of adequate treatment) or removal of the source (e.g., restriction in land use in the catchment) or in some cases additional monitoring of the receptor.

2.3 Treatment, operation and management factors

2.3.1 | The level of treatment and associated operations and management should be such as to reduce the risk posed by the catchment factors to the consumer.

Water treatment process factors

2.3.2 | These depend on raw water and unprotected/vulnerable supplies should have higher levels of treatment than protected and less vulnerable supplies.

Operation and Management Factors

2.3.3 | While a water treatment plant may have the appropriate treatment system in place, the operational and management of the system is critical to ensure that the treatment of the supply is optimal and provides adequate protection to the source. This influences the allocation of the appropriate risk score.

2.3.4 | During a number of audits and inspections carried out by the EPA, it was observed that many supplies were operating well over their design capacity, thus resulting in by-pass of parts of the treatment system; filters operating sub-optimally and other issues such as inadequate settlement prior to treatment. Therefore it is critical that these factors be taken into account in a realistic manner when applying the risk screening methodology. Some factors to consider are as follows:

- alarmed continuous turbidity monitors;
- Plant designed to treat the peak turbidity and colour loading;

- recycling of backwash (avoided at times of intense rainfall);
- abnormal operation – i.e. overloaded plants, etc
- bypassing part of the treatment process;
- rate of introduction of filters after cleaning;
- monitoring of filter head loss;
- sludge removal practices;
- operation and maintenance plans in place;

2.4 Suitability of use of the methodology

2.4.1 | This risk screening methodology should not be used on certain types of supplies. Where a supply falls into any one of the three categories below the supply should be immediately considered as high risk and therefore it is not necessary to apply the methodology. These conditions are:

- A supply originating from surface water (i.e. a river, lake or reservoir) that has no treatment other than disinfection.
- A supply originating from groundwater (i.e. a spring, well or borehole) that has no treatment other than disinfection and where there is evidence that the source is influenced[4] by surface water and has a history of microbial contamination in the untreated water.
- Where there is evidence of a past outbreak of cryptosporidiosis associated with the supply where the reason was unexplained and no specific steps have been taken to prevent a reoccurrence.

4 Groundwater can be influenced by surface water where surface water can enter the aquifer through preferential flow paths, karst features or flow down the well casing. In such cases the quality of the groundwater will vary with that of the surface water and may sometimes have high turbidity.

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2.4.2 | In such circumstances an action programme must be developed to address the issue and only when such action programme has been implemented should the risk screening methodology be applied. However, in developing the action programme the water supplier should have regard to the measures in the risk screening model, which can reduce the overall risk score.

2.4.3 | For the purposes of clarity this risk screening methodology has been broken into two separate risk screening methodologies:

- surface water supplies (i.e. those, which originate from a river, lake or reservoir[5]); and
- groundwater supplies (i.e. those, which originate from a spring, well or borehole).

2.4.4 | Where there is an uncertainty about the information or inadequate information available then a conservative approach must be taken and the worse case scenario chosen.

The final risk screening score is the sum of the Catchment Factor risk score and the Treatment, Operation and Management Factors risk score. This score is then weighted according to the population served by the supply. The population-weighting factor is 0.4 x log10 (population served by the supply). The final weighted risk screening score is the final risk screening score multiplied by the population-weighting factor.

2.5 Water supply risk classification

2.5.1 | The classification depends on the final risk screening score. It should be noted that the high risk classification used by the Scottish Executive has been renamed very high risk and the moderate risk classification split into two classifications – high risk and moderate risk. The same classification system shown in table 1 should be used for both the surface water and groundwater risk screening methodologies.

Table 1: water supply risk classification

Water Supply Risk Classification	Final Risk Assessment Score
Very high risk	>100
High risk	76-100

5 This includes infiltration galleries.

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Water Supply Risk Classification	Final Risk Assessment Score
Moderate risk	50-75
Low risk	<50

2.6 Approach to applying the risk assessment methodology

2.6.1 | The application of the risk screening methodology should be considered as an iterative process, which will enable the highest risk supplies to be identified by the water supplier and appropriate measures to be taken in a prioritised manner.

Step 1: Identify all water supplies and allocate the relevant information in relation to supply code, water type and population served.

Step 2: Delineate the catchment (or source protection area) for the water supply.

Step 3: Collate all relevant data sources and identify data gaps. In the case of a groundwater supply develop a conceptual site model (CSM).

Step 4: Apply the methodology (if sufficient information is available to do so) to all supplies and prioritise in order of risk. This should be considered an initial risk screening.

Step 5: Carry out catchment survey and an assessment of the treatment plant, its operation and management in accordance with the guidelines set out in the EPA manuals, in a prioritised manner on the supplies identified in Step 4, to gather additional information as necessary and to validate information used in the initial risk screening.

Step 6: Re-apply the risk screening methodology using the information obtained from a catchment survey and inspection. A brief report should be written on each supply outlining the assumptions made and a summary of the findings.

Step 7: Prioritise the supplies in order of risk, propose and implement measures to be taken to reduce the risk.

Step 8: Re-apply the methodology on completion of the measures to determine the new risk screening score for the supply.

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2.6.2 | In very high and high risk supplies consideration should be given to refining the information used in the risk screening so detailed assessment of the catchment should be undertaken such as farm surveys and on-site wastewater treatment system surveys. In cases where there are non-compliances with best practice then measures should be proposed to reduce the risk to the supply.

2.6.3 | In cases where there is currently insufficient water treatment then an assessment of the level of treatment required is dependent on the characteristics of the raw water and the catchment characteristics as well as the risk category. In all surface water supplies a barrier to *Cryptosporidium* is considered the minimum requirement for treatment. In the case of a groundwater source that is fed from a karst spring, the groundwater source should be treated as a surface water source due to the direct connection with surface water.

3. Surface water risk screening methodology

3.1 Introduction

3.1.1 | Surface water is defined as water that is open to the atmosphere and subject to surface run off. It includes rivers, streams, lakes and reservoirs (impounding and pumped long term and bank side storage). Where there is more than one source supplying a treatment works, each source should be assessed individually and the highest score used to calculate the combined catchment and treatment and supply score, and the final, population weighted score.

3.2 Catchment factors

3.2.1 | Paragraphs 3.2.2 to 3.2.7 outline the factors that influence the overall catchment risk score for the supply.

Animals within the catchment

3.2.2 | Sheep and cattle, particularly when lambing or calving, are significant sources of *Cryptosporidium*. The higher the density of animals in the forage area, the higher is the potential risk. Forage areas are defined as grass, open woodland, rape for stock feed, rough grazing, turnips/swedes for stock feed and other crops for stock feed. Deer (also when high numbers in the wild) and pigs, particularly if farmed close to

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water sources, can also be a source of *Cryptosporidium*. The risk is higher when animals have direct access to water. High numbers of birds, particularly when roosting on or near water sources, can also be a source of *Cryptosporidium*. Animal densities can be obtained from Department of Agriculture[6]. The information is not available at farm scale and therefore is considered to be a broad brush conservative dataset. More detailed assessments including farm surveys following the application of the risk screening methodology may be required for very high and high risk supplies. One score from each of the Sections below in table 2 should be inserted into the Actual Score column. However if the factor is not present in the catchment then a zero score should be inserted. These scores should be summed and the total of these scores should be inserted in the Total for Section 1 box.

Table 2: animal risk score

Section No.	Catchment Factor	RA Score	Actual Score
1.1	Cattle/calves at less than or equal to one livestock unit per hectare of forage area *	5	
	Cattle/calves at more than one livestock unit per hectare of forage area*	10	
	No cattle/calves in the catchment	0	
1.2	Sheep/lambs at less than or equal to one livestock unit per hectare of forage area *	5	
	Sheep/lambs at more than one livestock unit per hectare of forage area *	10	
	No sheep/lambs in the catchment	0	
1.3	Wild or farmed deer in the catchment	2	
	No wild or farmed deer in the catchment	0	
1.4	Pig farms in the catchment	2	
	No pig farms in the catchment	0	

6 Animal density information can be obtained from the Department of Agriculture. 5 year averages on a DED basis were made available to the River Basin Districts for the purposes of the diffuse pollution risk assessments.

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Section No.	Catchment Factor	RA Score	Actual Score
1.5	Animals have direct access to water sources including feeder streams	4	
	Fencing prevents access to water sources including feeder streams[7]	-4	
1.6	High numbers of birds	2	
1.7	Any other farmed animals or birds	1	
Total for Section 1			

* If density not known assume more than one animal per hectare of forage area.

Agricultural practices within the catchment

3.2.3 | Slurry spraying and dung spreading, particularly the former, pose a high risk of *Cryptosporidium* contamination of water sources. Although well-kept and managed slurry stores can allow oocysts to die off, there is no way of knowing how effectively they are being operated and therefore a risk should be assumed. Sheep pens and cattle sheds and lambing or calving on the catchment also present a potential risk. The total score for Section 2 is the sum of the scores for each of the risk factors in the table below that is taking place on the catchment. One score (where appropriate) from each of the Sections in table 3 below should be inserted into the Actual Score column if the activity is not undertaken in the catchment then a zero score should be inserted. These scores should be summed and the total of these scores should be inserted in the Total for Section 2 box.

Table 3: agricultural practices risk score

Section No.	Catchment Factor	RA Score	Actual Score
2.1	Slurry or sewage sludge[8] spreading within the catchment	6	

7 This score should only be given where the entire catchment is fenced or animal access to the source water or feeder streams is not possible.

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Section No.	Catchment Factor	RA Score	Actual Score
2.2	Dung spreading within the catchment	3	
2.3	Slurry or dung stores	3	
2.4	Sheep pens or cattle sheds	6	
2.5	Lambing or calving on the catchment	8	
2.6	Full compliance with the Good Agricultural Practice Regulations[9] verified by catchment inspection	-6	
Total for Section 2			

Discharges to the catchment/water source

3.2.4 | Sewage works and septic tanks may not remove oocysts if there is cryptosporidiosis in the community, so there could be oocysts in the sewage works or septic tank effluent and that effluent could enter a raw water source. The impact of septic tanks and sewage works is scored separately on the basis of the total population served by all tanks or works in the catchment. Storm water overflows and discharges from intensive agricultural activities such as abattoirs/livestock markets are also a potential source of *Cryptosporidium* and each should be scored only once even when there is more than one of each discharging into the catchment. One score (where appropriate) from each of the Sections in table 4 below should be inserted into the Actual Score column however, if there are no such discharges in the catchment then a zero score should be inserted. These scores should be summed and the total of these scores should be inserted in the Total for Section 3 box.

8 Land spreading of sewage sludge should be in accordance with the requirements of the Waste Management (Use of Sewage Sludge in Agriculture) (Amendment) Regulations, SI No 267 of 2001.

9 Article 17 of the European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2009 (S.I. No. 101 of 2009).

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Table 4: discharges risk score

Section No.	Catchment Factor	RA Score	Actual Score
3.1	Population equivalent served by individual on-site wastewater treatment systems ≤ 100 PE	4	
	Population equivalent served by individual on-site wastewater treatment systems > 100 PE	6	
3.2	On-site wastewater treatment systems all known to be functioning properly[10]	– 2	
3.3	Flooding of septic tanks on flood plains	4	
3.4	Population equivalent served by all wastewater works[11] < 500	4	
	Population equivalent served by all wastewater works 500 to 5,000	5	
	Population equivalent served by all wastewater works 5,001 to 20,000	6	
	Population equivalent served by all wastewater works 20,001 to 50,000	7	
	Population equivalent served by all wastewater works > 50,000	8	
3.5	Storm water overflows	2	
3.6	Section 4[12] or Integrated Pollution Prevention Control (IPPC) Licence discharge from intensive agricultural activity or agricultural related discharge	2	
3.7	All wastewater treatment plants complying with the UWWT Regulations quality standards	-1	
3.8	UV inactivation at outlet of wastewater treatment plants	-2	
Total for Section 3			

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Water source type

3.2.5 | Surface water sources present the highest risk from *Cryptosporidium*, particularly when there is direct abstraction from a river or stream. Lowland rivers present a greater risk than upland reservoirs. The total score for Section 4 consists of one score from the list of sources in the table 5 below (no adding of scores).

Table 5: water source risk score

Section No.	Catchment Factor	RA Score	Actual Score
4.1	Upland reservoir/lake	2	
	Lowland long term storage reservoir/lake	4	
	Upland river or stream – bank side storage	5	
	Upland river or stream – direct abstraction	6	
	Lowland river or stream – direct abstraction or bank side storage	8	
Total for Section 4			

Catchment inspections

3.2.6 | Regular catchment inspections and procedures to deal with any identified irregularities reduce the risk from *Cryptosporidium*. Routine catchment inspections should include water quality monitoring of key river channels and feeder streams. The nutrients ammonia, nitrate and phosphate and recording of the presence/absence of sewage fungus or excess algal growth in stream channels will give an indication of water quality at various points on the catchment. Observations should also be made on land-use practice, particularly slurry spreading practices. Use should be made of local knowledge such as farmers, water supply consumers, anglers and local authority area workers, whose vigilance can alert water treatment plant staff to risks to the abstraction source. Cooperation with such local stakeholders should be encouraged. If unsatisfactory issues are noted then more detailed investigation procedures should be applied, such as detailed investigative monitoring and farm, wastewater and industrial

10 Survey carried out by local authority in the catchment of the groundwater source.

11 Wastewater Works – means sewers and their accessories (or any part thereof) and all other structural devices including wastewater treatment plants ….. for the collection, storage, treatment or discharge of wastewater.

12 Section 4 Discharge to Water Licence under the Local Government (Water Pollution) Act, 1977. This could include discharges from piggeries, abattoirs, food production facilities etc.

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facilities inspections, as appropriate. Once the cause of the water quality problem is identified, then improvement and enforcement measures can be applied. One score (where appropriate) from each of the Sections in table 6 below should be inserted into the Actual Score column however, if the activity is not undertaken in the catchment then a zero score should be inserted. These scores should be summed and the total of these scores should be inserted in the Total for Section 5 box.

Table 6: catchment inspection risk score

Section No.	Catchment Factor	RA Score	Actual Score
5.1	Catchment inspections[13] carried out at least monthly	-3	
	Catchment inspections carried out less frequently	6	
5.2	Procedures in place to deal with irregularities on the catchment	-3	
Total for Section 5			

Raw water intake management

3.2.7 | Risk is reduced when water quality monitors are installed at the intake and further reduced when the monitors are alarmed and the intake shut when poor water quality conditions are detected. Poor water quality conditions are defined for each plant and are dependent on local conditions and plant operation and are based on daily monitoring results. The total score for Section 6 consists of one score from the list of sources in the table 7 below (no adding of scores).

Table 7: raw water intake management risk score

Section No.	Catchment Factor	RA Score	Actual Score
6.1	No appropriate water quality monitor[14] on intake	3	
	Appropriate water quality monitor on intake that is alarmed and connected to telemetry	-2	

13 Inspections should take into account the compliance with Article 17 of the European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2009 (S.I. No. 101 of 2009).

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Section No.	Catchment Factor	RA Score	Actual Score
6.2	Automatic intake shut down when poor water quality	-4	
	Manual intake shut down when poor water quality[15]	-1	
	No intake shut down when poor water quality	3	
Total for Section 6			

Surface water catchment risk score

3.2.8 | Calculate the surface water catchment risk score by adding the scores from Sections 1 to 6 as in table 8.

Table 8: surface water catchment risk score

Surface Water Catchment Risk Scores	Section Score
Section 1 – Animals within the Catchment	
Section 2 – Agricultural Practices within the Catchment	
Section 3 – Discharges to the Catchment/Water Source	
Section 4 – Water Source Type	
Section 5 – Catchment Inspections	
Section 6 – Raw Water Intake Management	
Total Surface Water Catchment Risk Score	

3.3 Treatment, operation and management factors

3.3.1 | If there is more than one treatment process stream at the water treatment works, each treatment process stream should be scored separately and the highest scoring treatment process stream should be used to calculate the treatment and supply risk score and the combined catchment and treatment and supply risk score and the final population weighted score.

14 Monitor may include parameters such as turbidity, ammonia etc.

15 Includes actions taken as a result of manual monitoring at appropriate frequency.

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Water treatment processes

3.3.2 | It is well established that some treatment processes are much more effective in removing *Cryptosporidium*, and therefore reducing the risk, than others. The most effective processes are those that use membrane filtration or coagulation followed by sedimentation or dissolved air flotation and filtration. Membrane filtration is particularly effective when the membrane is capable of removing or retaining particles greater that one micron diameter. The UK Drinking Water Inspectorate (DWI) publishes lists of membrane products that achieve this performance. Ultraviolet disinfection can also be an effective means of inactivating *Cryptosporidium* oocyts but only where there is adequate pre-treatment. UV on its own in surface water supplies is not a suitable means of inactivating *Cryptosporidium* oocysts. Simple disinfection and micro-straining are not effective treatment types to remove *Cryptosporidium* and hence do not reduce the risk. Where disinfection and micro-straining are the only form of treatment in place the water supplier should immediately develop an action programme to improve treatment. The risk screening methodology should not be carried out on such supplies until the action programme has been completed. The total score for Section 7 is one of the scores from the risk factors in the table 9 below based on the principal treatment at the works.

Table 9: water treatment process risk score

Section No.	Water Treatment Factor	RA Score	Actual Score
7.1	Simple sand filtration[16] (not slow sand filtration)	8	
	Simple sand filtration (not slow sand filtration) with UV treatment	6	
	Coagulation followed by DAF/sedimentation and filtration	-10	
	Coagulation followed by DAF/sedimentation and filtration followed by UV treatment	-16	
	Coagulation followed by rapid gravity or pressure filtration (no flotation or sedimentation)	-7	
	Coagulation followed by rapid gravity or pressure filtration (no flotation or sedimentation) followed by UV treatment	-13	
	Slow sand filtration	-9	
	Slow sand filtration followed by UV treatment	-15	
	Membrane filtration (DWI[17] approved)	-16	
	Membrane filtration (Not DWI approved)	-2	
Total for Section 7			

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Treatment works monitoring of coagulation and filtration

3.3.3 | This section only applies when coagulation and filtration or filtration only is part of the water treatment process. Where UV treatment is used in conjunction with the either of these the relevant section should also be scored. Turbidity meters/particle counters provide a good indication of filtration efficiency. Where turbidity meters/ particle counters are fitted and are alarmed so action can be immediately taken, the risk from *Cryptosporidium* is reduced. Similarly a residual coagulant monitor on the outlet of the works, particularly when alarmed, provides an indication of the efficiency of the coagulation and filtration process. When membrane filters have an alarm to monitor the integrity of the membrane or have particle counters to monitor performance, the risk from *Cryptosporidium* is also reduced. Routine discrete monitoring of treated water quality is also important. Only one of the three sections on rapid gravity and pressure filters, slow sand filters or membrane filters should be scored in table 10 below. The total score from either Section 8a, 8b, 8c, 8d or 8e should be summed and added to the total from Section 8f (UV treatment) if UV treatment is one of the treatment processes.

Table 10: monitoring of coagulation/filtration risk score

Coagulation			
Section No. 8a	Management Factor	RA Score	Actual Score
8.1	Manual coagulant dose control – not flow proportional	5	
	Manual coagulant pH control	5	
	Coagulant pH monitored and alarmed	-5	
Total for Section 8a			

Clarification			
Section No. 8b	Management Factor	RA Score	Actual Score
8.2	Clarified water turbidity monitor/particle counters	-1	
	Clarified water turbidity monitors/particle counters with alarm	-2	

16 This includes rapid gravity filters with no chemical treatment, infiltration galleries and pressure filters

17 DWI – Drinking Water Inspectorate of England and Wales http://www.dwi.gov.uk/

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Clarification			
Section No. 8b	Management Factor	RA Score	Actual Score
Total for Section 8b			

Rapid gravity and pressure filters			
Section No. 8c	Management Factor	RA Score	Actual Score
8.3	Turbidity meter/particle counter on each filter with alarm on telemetry	-5	
	Turbidity meter/particle counter on each filter but no alarm on telemetry	0	
	One turbidity meter/particle counter shared by more than one filter with alarm on telemetry	-2	
	One turbidity meter/particle counter shared by more than one filter but no alarm on telemetry	2	
	No turbidity meters/particle counters monitoring filter performance	10	
8.4	Final water turbidity meter/particle counter with alarm on telemetry	-2	
	Final water turbidity meter/particle counter but no alarm on telemetry	2	
	No final water turbidity meter/particle counter	5	
8.5	Continuous residual coagulant monitor on combined filtrate or works outlet with alarm	-5	
	Continuous residual coagulant monitor on combined filtrate or works outlet but no alarm	-1	
	No continuous residual coagulant monitor on combined filtrate or works outlet	5	
8.6	Routine discrete monitoring of treated water for turbidity/ residual coagulant	-2	
	No routine discrete monitoring of treated water for turbidity/ residual coagulant	2	
8.7	Turbidity of backwash supernatant monitored when recycled	-2	
	Turbidity of backwash supernatant not monitored when recycled	2	

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Rapid gravity and pressure filters			
Section No. 8c	Management Factor	RA Score	Actual Score
Total for Section 8c			

Slow Sand Filters			
Section No. 8d	Management Factor	RA Score	Actual Score
8.8	Turbidity meter/particle counter on each filter with alarm on telemetry	-5	
	Turbidity meter/particle counter on each filter but no alarm on telemetry	0	
	One turbidity meter/particle counter shared by more than one filter with alarm on telemetry	-2	
	One turbidity meter/particle counter shared by more than one filter but no alarm on telemetry	2	
	No turbidity meters/particle counters monitoring filter performance	10	
8.9	Final water turbidity meter/particle counter with alarm on telemetry	-2	
	Final water turbidity meter/particle counter but no alarm on telemetry	2	
	No final water turbidity meter/particle counter	5	
8.10	Filters matured and filtrate analysed for turbidity, coliforms and *Cryptosporidium* during maturation	-4	
	Filters matured but no analysis carried out on filtrate	5	
	Filters not matured	15	
Total for Section 8d			

Membrane Filtration			
Section No. 8e	Management Factor	RA Score	Actual Score
8.11	Plant monitored and alarmed for integrity	-10	
	Plant monitored for integrity but not alarmed	0	
	Plant not monitored for integrity	10	

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Membrane Filtration			
Section No. 8e	Management Factor	RA Score	Actual Score
8.12	Particle counter used continuously to monitor filter performance	-5	
Total for Section 8e			

UV Inactivation			
Section No. 8f	Management Factor	RA Score	Actual Score
8.13	Plant monitored for integrity and correct UV dosage	0	
	Plant monitored and alarmed for integrity and correct UV dosage	-10	
	Plant neither monitored nor alarmed	10	
8.14	Influent turbidity consistently < 0.2 NTU	-6	
	Influent turbidity consistently < 1.0 NTU	-3	
	Influent turbidity consistently > 1.0 NTU	-1	
Total for Section 8f			

Rapid gravity and pressure filter performance

3.3.4 | This section only applies to treatment works with rapid gravity or pressure filters. Final water turbidity is a good indicator of filter performance. Filter condition, particularly loss of filter media and cracking of filter bed, the effect of filter backwashing on final water turbidity, and filter maintenance are also relevant. One score from each of the Sections in table 11 below should be inserted into the Actual Score column. These scores should be summed and the total of these scores should be inserted in the Total for Section 9 box.

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Table 11: filter performance risk score

Section No.	Risk Factor	RA Score	Actual Score
9.1	Final water turbidity increases by more than 50%, excluding normal backwash period or turbidity in the final water >1.0 NTU[18]	4	
	Treated water turbidity increases by less than 50%, excluding normal backwash period and turbidity in the final water <1.0 NTU	0	
9.2	Media loss from any filter has brought media depth below design level	6	
	Media depth above minimum design level with audit trail maintained	-2	
9.3	Signs of media cracking on any filter or any other damage to the filter	4	
9.4	All filters have been drained, inspected and any necessary remedial action taken within last year	-2	
9.5	Air scour and backwash maintained and operating efficiently as per maintenance manual	-2	
Total for Section 9			

Treatment works operation

3.3.5 | When a treatment works is operated in accordance with good practice with quality assured procedures, the risk from *Cryptosporidium* is reduced, particularly when there are auditable action plans to deal with any deviations from expected quality. The methods of returning filters to service following backwashing (following skimming and cleaning in the case of slow sand filters) and dealing with filter backwash water have an effect on the risk. Other relevant factors are significant short-term variations in flow through the works and whether the works has operated above its design flow. One

18 Monitoring equipment at the plant must be capable of measuring levels of turbidity of at least 0.1 NTU

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score from each of the Sections in table 12 below should be inserted into the Actual Score column. These scores from each section should be summed and the total of these scores should be inserted in the Total for Section 10 box.

Table 12: treatment works operation risk score

Section No.	Risk Factor	RA Score	Actual Score
10.1	Plant with documented management systems that includes procedures and process control manuals	-2	
	Process control manuals specific to works available	-1	
	Process control manuals specific to works not available	1	
10.2	Auditable action plans available for dealing with deviations in quality and evidence of implementation of the plan	-1	
	Auditable action plans not available for dealing with deviations in quality	1	
10.3	Slow start facility on filters operational	-4	
	No slow start facility on filters, or slow start facility not operational	4	
10.4	Filters run to waste for appropriate period after backwash	-6	
	Filters run to head of works for a period following backwash	-4	
	Filters not run to waste or head of works for a period following backwash	4	
10.5	Backwash water and/or sludge supernatant has to be recycled	2	
	Other disposal route available for backwash water and sludge supernatant	-2	
10.6	Water flow through works when operating has not increased by >10% in <30 minutes in last 12 months	-2	
	Water flow through works when operating has increased by >10% in <30 minutes in last 12 months	2	

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Section No.	Risk Factor	RA Score	Actual Score
10.7	Flow through works above design flow for >10% of time in last 12 months	4	
	Flow through works above design flow for ≤10% of time in last 12 months	0	
	Flow through works >130% above design flow for >50% of time in last 12 months	6	
10.8	Filters bypassed during the year	6	
Total for Section 10			

Distribution network

3.3.6 | The risk screening methodology does not deal with the distribution network. It considers the inherent risk of the water supply up to the point at which it has received treatment. However, issues relating to the distribution network may pose a risk to the consumer of the treated drinking water and need to be considered by the water supplier. Some issues of concern are uncovered reservoirs, broken water mains with low water pressure etc. Measures should be put in place to reduce the risk due to the distribution network and these should be documented as part of the risk screening report for each supply.

Surface water treatment, operation and management risk score

3.3.7 | The surface water treatment and supply risk score is the sum of the scores for Sections 7 to 10 (where relevant) in the table 13 below.

Table 13: surface water treatment, operation and management risk score

Surface Water – Treatment and Supply Risk Score	Section Score
Section 7 – Water Treatment Processes	
Section 8 – Treatment Works Monitoring of Coagulation and Filtration	
Section 9 – Rapid Gravity and Pressure Filter Works Performance	
Section 10 – Treatment Works Operation	
Total Surface Water – Treatment, Operation and Management Risk Score	

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Final weighted surface water risk screening score

3.3.8 | The final surface water risk screening score is the sum of the surface water catchment risk score and the surface water treatment and supply risk score. This score is then weighted according to the population served by the supply. The population weighting factor is 0.4 x log10 (population served by the supply). The final weighted surface water risk screening score is the final surface water risk screening score x the population weighting factor. The calculation is shown in table 14 below.

Table 14: final weighted surface water risk screening score

Total Surface Water – Catchment Risk Score	
Total Surface Water – Treatment, Operation and Management Risk Score	
Surface Water Risk Screening Score	
Population	
Population Weighting Factor (0.4 x log10(population))	
Final Weighted Risk Screening Score	
Water Supply Risk Classification	

4. Groundwater risk screening methodology

4.1 Introduction

4.1.1 | Groundwater is water that is found underground in the cracks and spaces in soil, sand and rock. Groundwater supplies include springs, wells, boreholes and well fields. It does not include infiltration galleries as these are more appropriately described as surface water supplies for the purposes of this risk assessment. Some groundwater supplies such as karst springs are influenced by surface waters and will require a high level of treatment, others however, have good natural protection through overlying subsoils.

4.2 Delineation of the source protection area

4.2.1 | One of the main methods/approaches to protect groundwater in Ireland is through the use of Groundwater Protection Schemes (GSI/DEHLG/EPA, 1999), which involves delineation of groundwater protection zones. These zones are sub-divided into source protection zones, which encompass the catchment area of the groundwater source, and aquifer (resource) protection areas, which are the remaining areas. The

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source protection area for public groundwater supplies is divided into the Inner Source (SI) Protection Area and the Outer Source (SO) Protection Area. The source protection area, aquifer type and vulnerability information are integrated to give source protection zones (SPZs). These source protection zones provide valuable information for the purposes of the *Cryptosporidium* risk assessments.

4.2.2 | Approximately 52% of the country has groundwater protection schemes developed, which include approximately 160 source protection zones. The remaining public groundwater supplies will have to delineate these SPZs to allow the area for the risk screening methodology to be applied. A 2-tiered process is suggested, the preferred option is where the SPZ is delineated and 2nd option is where the catchment is roughly delineated using recharge co-efficient and abstraction rates. The River Basin District Projects (RBD) are in the process of delineating source protection zones for supplies that are used as part of the National Groundwater Monitoring Programme. It is essential that a consistent approach be taken to delineate source protection zones across the country. The SPZs are required to be delineated to assist in the implementation of the Good Agriculture Practice Regulations, Water Framework Directive, safeguard zones in the Drinking Water Regulations and the groundwater – monitoring programme.

4.2.3 | A conceptual site model (CSM) should be prepared for all groundwater sources at the start of the application of the risk screening methodology as it can be used to identify all possible sources and pathways as well as the processes that are likely to occur along each Source-Pathway-Receptor (S-P-R) linkage.

Conceptual model: source – pathway – receptor

4.2.4 | The following should be considered when developing a conceptual model for the catchment of the groundwater supply.

4.2.5 | Source factors. The principle sources of *Cryptosporidium* in the source protection area will need to be identified on a catchment basis. The majority of human infections are caused by C. hominis and the cattle genotype C. parvum.

The type of land use including animal type and density (C. parvum).

Location of wastewater treatment systems including urban wastewater treatment systems discharging to groundwater and un-sewered septic tanks (C. hominis)

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4.2.6 | Pathway factors. The inherent geological and hydrogeological factors that occur within the source protection area that influences the relationship between the source and the receptor need to be examined. The hydrogeological setting determines the likelihood of transmission of the *Cryptosporidium* from the source to the receptor.

Aquifer type or groundwater flow regime (rapid flow rates in karst aquifers as opposed to slower more uniform flow rates in sands and gravel aquifers).

Vulnerability Category (due to their small size *Cryptosporidium* oocysts are less efficiently removed during passage through soil, in bank filtration and in rapid or slow sand filtration – No attachment to loam or sand particles (WHO 2006[19])). The travel time in low vulnerability areas is much greater than 6 months thus allowing time for the *Cryptosporidium* to die off.

Connectivity between surface water and groundwater (Karst features (e.g. swallow holes, sinking/loosing streams (GSI Karst database))

4.2.7 | Receptor factors. The type of water source and the protection afforded to it influences the risk of contamination of the supply. The population served by the supply is also an important factor that is taken account of during the risk screening methodology.

Spring or Borehole (shallow/deep)

Wellhead protection factors

4.3 Groundwater risk screening (source – pathway – receptor)

4.3.1 | Each of the factors is dealt with in more detail in the following paragraphs 4.3.2 – . Where there is more than one source supplying a treatment works, each source should be assessed individually and the highest score used to calculate the combined catchment, treatment and supply score, and the final, population weighted score.

Source (pressure) factor: animals within the catchment

19 WHO Guidelines for Drinking Water – *Cryptosporidium* January 2006 (EHC *Cryptosporidium* draft 2)

4.3.2 | Sheep and cattle, particularly when lambing or calving, are significant sources of *Cryptosporidium*. The higher the density of animals in the forage area, the higher is the potential risk. Forage areas are defined as grass, open woodland, rape for stock feed, rough grazing, turnips/swedes for stock feed and other crops for stock feed. Deer (also when high numbers in the wild) and pigs, particularly if farmed close to water sources, can also be a source of *Cryptosporidium*. The risk is higher when animals have direct access to water. High numbers of birds, particularly when roosting on or near water sources, can also be a source of *Cryptosporidium*. Animal densities can be obtained from the Department of Agriculture[20]. The information is not available at farm scale and therefore is considered to be a broad brush conservative dataset. More detailed assessments including farm surveys following the application of the risk screening methodology may be required for very high and high risk supplies. One score from each of the Sections in table 15 below should be inserted into the Actual Score column. These scores should be summed and the total of these scores should be inserted in the Total for Section 1 box.

Table 15: animals risk score

Section No.	Pressure Factor	RA Score	Actual Score
1.1	Cattle/calves at less than or equal to one livestock unit per hectare of forage area *	5	
	Cattle/calves at more than one livestock unit per hectare of forage area*	10	
	No cattle/calves in the catchment	0	
1.2	Sheep/lambs at less than or equal to one livestock unit per hectare of forage area *	5	
	Sheep/lambs at more than one livestock unit per hectare of forage area *	10	
	No sheep/lambs in the catchment	0	
1.3	Wild or farmed deer in the catchment	2	
	No wild or farmed deer in the catchment	0	

20 Animal densities information to be obtained from the Department of Agriculture. 5 year averages on a DED basis were made available to the River Basin Districts for the purposes of the diffuse pollution risk assessments.

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Section No.	Pressure Factor	RA Score	Actual Score
1.4	Pig farms in the catchment	2	
	No pig farms in the catchment	0	
1.5	Animals have direct access to sinking streams	4	
	Fencing preventing access to sinking streams	-2	
1.6	High numbers of birds	2	
1.7	Any other farmed animal or bird	1	
Total for Section 1			

Source (pressure) factor: agricultural practices within the catchment

4.3.3 | Slurry spraying and dung spreading, particularly the former, pose a high risk of *Cryptosporidium* contamination of water sources. Although well kept and managed slurry stores can kill oocysts, there is no way of knowing how effectively they are being operated and therefore a risk should be assumed. Sheep pens and cattle sheds and lambing or calving on the catchment present a potential risk. The total score for Section 2 is the sum of the scores for each of the risk factors in the table below that is taking place on the catchment.

One score (where appropriate) from each of the Sections in table 16 below should be inserted into the Actual Score column. These scores should be summed and the total of these scores should be inserted in the Total for Section 2 box.

Table 16: agricultural practices risk score

Section No.	Pressure Factor	RA Score	Actual Score
2.1	Slurry spraying in the source protection area	6	
2.2	Dung spreading in source protection area	3	
2.3	Slurry or dung stores	3	

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Section No.	Pressure Factor	RA Score	Actual Score
2.4	Sheep pens or cattle sheds	6	
2.5	Lambing or calving on the catchment	8	
2.6	Full compliance the Good Agricultural Practice Regulations[21] verified by inspections	-6	
Total for Section 2			

Source (pressure) factor: discharges to the catchment/source protection area

4.3.4 | Sewage works and septic tanks may not remove oocysts if there is cryptosporidiosis in the community, so there could be oocysts in the sewage works or septic tank effluent and that effluent could enter in some cases groundwater. The impact of septic tanks and sewage works is scored separately on the basis of the total population served by all tanks or works in the catchment. Storm water overflows and discharges from intensive agricultural activities such as abattoirs/livestock markets if discharging to groundwater are also a potential source of *Cryptosporidium*. Each should be scored only once even when there is more than one of each discharging to groundwater. One score (where appropriate) from each of the Sections in table 17 below should be inserted into the Actual Score column. These scores should be summed and the total of these scores should be inserted in the Total for Section 3 box.

Table 17: discharges risk score

Section No.	Pressure Factor	RA Score	Actual Score
3.1	Population equivalent served by individual on-site wastewater treatment systems $\leq$ 100 PE	4	
	Population equivalent served by individual on-site wastewater treatment systems > 100 PE	6	

21 Article 17 of the European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2009 (S.I. No. 101 of 2009)

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Section No.	Pressure Factor	RA Score	Actual Score
3.2	On-site wastewater treatment systems all known to be functioning properly[22]	– 2	
3.3	Population equivalent served by all wastewater treatment plants discharging to groundwater < 500	6	
	Population equivalent served by all wastewater treatment plants discharging to groundwater 500 to 5,000	8	
3.4	Storm water overflows discharging to groundwater	2	
3.5	Section 4[23] or Integrated Pollution Prevention Control (IPPC) Licence discharging to groundwater from intensive agricultural activity or agriculturally related discharge	2	
3.6	All wastewater treatment plants discharging to groundwater complying with the UWWT Regulations quality standards	-1	
3.7	UV inactivation at outlet of wastewater treatment plants	-2	
Total for Section 3			

Source (pressure) factor: catchment/source protection area inspections [22][23]

4.3.5 | Regular catchment inspections and procedures to deal with any identified irregularities reduce the risk from *Cryptosporidium*. Routine catchment inspections should include observations made on land-use practice, particularly slurry spreading practices. Use should be made of local knowledge such as farmers, water supply consumers, anglers and local authority area workers, whose vigilance can alert water treatment plant staff to risks to the abstraction source. Cooperation with such local stakeholders should be encouraged.

If unsatisfactory issues are noted then more detailed investigation procedures should be applied, such as detailed investigative monitoring and farm, wastewater and industrial facilities inspections, as appropriate. Once the cause of the water quality problem is

22 Survey carried out by local authority in the catchment of the groundwater source.

23 Section 4 Discharge to Water Licence under the Local Government (Water Pollution) Act, 1977

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identified, then improvement and enforcement measures can be applied. One score (where appropriate) from each of the Sections in table 18 below should be inserted into the Actual Score column. These scores should be summed and the total of these scores should be inserted in the Total for Section 4 box.

Table 18: catchment/source inspections risk score

Section No.	Pressure Factor	RA Score	Actual Score
4.1	SPA inspections carried out at least monthly	-3	
	SPA inspections carried out less frequently	6	
4.2	Procedures in place to deal with irregularities on the SPA	-3	
Total for Section 4			

Pathway factor: geology/hydrogeology

4.3.6 | Role of Aquifer Category. In Ireland, the bedrock aquifers have fissured permeability and the flow is through fractures, fissures and in the case of karst, through conduits. This implies that there is very little, if any, attenuation after a contaminant reaches the bedrock. In the case of sand and gravel aquifers, which have an inter-granular permeability, some filtering of the groundwater may occur depending on the grain size of the sands. The rate of flow of the groundwater in these aquifers varies from very rapid in karstified aquifers to slower in poor unfractured aquifers. Work carried out by the Geological Survey of Ireland and the River Basin District Project (RBDs) in relation to the implementation of the Water Framework Directive (WFD) has resulted in aquifers being grouped into four groundwater body types based on similarities in flow regime – karstic aquifers, gravel aquifers, productive fracture aquifers and poorly productive aquifers.

4.3.7 | Role of Vulnerability Category. The overlying subsoil, depending on its lithology and thickness, may provide some protection for groundwaters. The type and thickness of subsoils are factors that have been used to develop groundwater vulnerability maps in Ireland. These are used along with the aquifer maps to delineate groundwater protection zonation maps, which form part of a county Groundwater Protection Scheme. Areas where there is less than 3m of subsoil are described as extremely vulnerable and do not provide a lot of protection to the underlying groundwater. Karst features provide a direct connection between surface and groundwater (e.g.

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sinking streams, swallow holes etc.) and are also afforded an extreme vulnerability classification. In general it is considered that the overlying subsoil (>3m thickness) provides very good protection of the groundwater as the time of travel through the subsoil is much greater than the die off time for *Cryptosporidium*.

4.3.8 | As there is variability in both the aquifer type and vulnerability across the source protection area some element of professional judgement is required to allocate the appropriate risk score. It is advisable that source protection zone that is predominant over the inner and outer source protection area is used, however, a conservative approach should be taken and the decision making process documented. The total score for Section 5 consists of one score from the matrix in table 19 below (no adding of scores). The scores in Section 5a relate to supplies where the source protection zones have been delineated in accordance with the GSI methodology. The scores in Section 5b related to the estimated catchment of a supply that has not been sub-divided into Inner and Outer Source Protection Areas.

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Table 19: geology/hydrogeology risk score

Section No. 5	Pathway Factor						
	Section 5a		Section 5b				
Vulnerability Rating	Source Protection Area		Aquifer Categories (for supplies with no source protection areas delineated)				
	(SI)	(SO)	Karst (Rk & Lk)	Fissured (Rf & Lm)	Sand/ gravel[24] (Rg & Lg)	Ll	Poor (Pu & Pl)
Extreme (0-1 m soil/ subsoil)	4	2	4	2	0	2	2
Extreme (1-3 m subsoil)	2	0	2	0	0	0	0
High	-30	-30	-30	-30	-30	-30	-30
Moderate	-45	-45	-45	-45	-45	-45	-45
Low	-50	-50	-50	-50	-50	-50	-50
Total for Section 5							

Pathway factor: rapid by-pass of unsaturated zone

4.3.9 | There is an additional risk to groundwater where there is a direct link between the surface and groundwater; this is where the protecting subsoil (unsaturated zone) is by-passed. This occurs where there are sinking streams or swallow holes, which are karst features. Information on karst features may be obtained from the Groundwater Section of the Geological Survey of Ireland, Dublin 4. The total score for Section 6 consists of one score (where appropriate) from the list of sources in the table 20 below (no adding of scores).

24 Vulnerability of sand/gravel aquifers is based on depth to the water table and not depth of subsoil

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Table 20: by-pass of unsaturated zone risk score

Section No.	Pathway Factor	RA Score	Actual Score
6.1	Presence of karst feature[25] such as swallow holes, sinking streams	6	
	Likelihood[26] of karst features or direct transmission of surface run-off to groundwater	3	
	Direct transmission of surface run-off unlikely	0	
Total for Section 6			

Reception factor: water source type

4.3.10 | Groundwater sources may present a risk from *Cryptosporidium*, particularly as they receive minimal treatment in most cases. The different water types have inherent risks associated with them and so they have different scores. Factors such as sanitary protection of groundwater supplies and natural groundwater vulnerability are important factors that will be considered in later sections. The total score for Section 7 consists of one score from the list of sources in the table 21 below (no adding of scores).

Table 21: water source risk score

Section No.	Receptor Factor	RA Score	Actual Score
7.1	Spring	6	
	Well (<3m depth of well)	4	
	Borehole (> 3m depth of borehole)	2	
	Well field[27]	2	
Total for Section 7			

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25 Information on karst can be obtained from the Groundwater Section of the Geological Survey of Ireland, Dublin 4.

26 There is generally a likelihood of direct connection between the surface and the groundwater where you have karstified bedrock aquifers such as regionally important karstified aquifers (Rk) or locally important karstified aquifers (Lk)

27 A well field is made up of a number of individual boreholes that contribute in different proportions to the water supply. These boreholes are usually located in close proximity to each other. The worse case scenario/ most conservative should be assumed.

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Reception factor: sanitary protection of groundwater supply

4.3.11 | Additional protection should be given to a groundwater source at the point of abstraction. In the case of a spring supply access to the spring itself should be prohibited and appropriate secure fencing and covering put in place. In the case of a borehole or well the immediate area around the borehole should be constructed in such a way as to prevent any by-pass of the subsoil and to prevent any contaminated material or liquid getting into the groundwater through the water supply structure (i.e. through the wellhead or casing). One score from each of the Sections in table 22 below, where appropriate, should be inserted into the Actual Score column. The scores should be summed, where applicable and the total of these scores should be inserted in the Total for Section 8 box.

Table 22: sanitary protection risk score

Section No.	Receptor Factor	RA Score	Actual Score
8.1	Inadequate protection of spring source	12	
	Spring receptor adequate protection	6	
8.2	Borehole with known or suspected poor casing integrity or no grouting20	12	
	Borehole with suspected, not proven good casing integrity or grouting	4	
	Borehole with proven good casing integrity and good grouting	-8	
8.3	Headworks in outside chamber and/or below ground level – liable to flooding or leaking structure	12	
	Headworks in outside chamber but sealed and dry	9	
	Headworks with cover flush to floor or imperfectly sealed	6	
	Headworks with completely sealed raised cover	-8	
Total for Section 8			

Groundwater source – pathway – receptor (catchment) risk score

4.3.12 | This risk score is calculated by adding the risk scores from Sections 1 to 8 as shown in table 23.

28 Casing integrity should be determined through visual inspection and from borehole logs

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Table 23: groundwater source – pathway – receptor risk score

Groundwater Source – Pathway – Receptor Risk Scores	Section Score
Section 1 – Animals in the catchment	
Section 2 – Agricultural Practices within the Catchment	
Section 3 – Discharges to the Catchment/source Protection Area	
Section 4 – Catchment/source Protection Area Inspections	
Section 5 – Geology/hydrogeology	
Section 6 – By-pass of unsaturated zone	
Section 7 – Water source type	
Section 8 – Sanitary protection of groundwater supply	
Total Groundwater Source – Pathway – Receptor Risk Score	

4.4 Groundwater risk assessment (water treatment score)

4.4.1 | The risk management factors to consider are the water treatment processes that are employed to reduce the risk. The type of treatment process being used, as well as the operation and management of the treatment plant need to be considered. If there is more than one treatment process stream at the water treatment works, each treatment process stream should be scored separately and the highest scoring treatment process stream should be used to calculate the treatment and supply risk score and the combined catchment and treatment and supply risk score and the final population weighted score.

Risk management factors – water treatment processes

4.4.2 | It is well established that some treatment processes are much more effective in removing *Cryptosporidium*, and therefore reducing the risk, than others. Membrane filtration is particularly effective when the membrane is capable of removing or retaining particles greater that one micron diameter. The Drinking Water Inspectorate publishes lists of membrane products that achieve this performance. Ultraviolet disinfection can also be an effective means of inactivating *Cryptosporidium* oocyts but only where there is adequate pre-treatment or where there is a clear groundwater source.

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4.4.3 | In most groundwater supplies simple disinfection is the only form of treatment and this is not an effective form of treatment to remove *Cryptosporidium* and hence does not reduce the risk from *Cryptosporidium*. Where it is the only form of treatment in place and there is evidence of direct connection between the surface water and the groundwater then the water supplier should immediately develop an action programme to improve treatment. The risk assessment should not be carried out on such supplies until the action programme has been completed. The total score for Section 9 is one of the scores from the risk factors in table 24 below based on the principal treatment at the works.

Table 24: water treatment processes risk score

Section No.	Risk Factor	RA Score	Actual Score
9.1	Disinfection (not including UV)	16	
	UV Inactivation	-15	
	Membrane filtration (DWI approved)	-16	
	Membrane filtration (Not DWI approved)	-2	
Total for Section 9			

Risk Management factors – treatment works monitoring of filtration

4.4.4 | This section only applies when filtration only is part of the water treatment process. Where UV treatment is used in conjunction with filtration, it should also be scored. When membrane filters have an alarm to monitor the integrity of the membrane or have particle counters to monitor performance, the risk from *Cryptosporidium* is reduced. Routine discrete monitoring of treated water quality is also important. The total score from either Section 10a or 10b should be summed as shown in table 25 below.

Table 25: monitoring of filtration risk score

Membrane Filtration			
Section No. 10a	Risk Management Factor	RA Score	Actual Score
10.1	Plant monitored and alarmed for integrity	-10	
	Plant monitored for integrity but not alarmed	-3	
	Plant not monitored for integrity	10	

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Membrane Filtration			
Section No. 10a	Risk Management Factor	RA Score	Actual Score
10.2	Particle counter used continuously to monitor filter performance	-5	
Total for Section 10a			

UV Inactivation			
Section No. 10b	Risk Management Factor	RA Score	Actual Score
10.3	Plant monitored for integrity and UV dosage	-3	
	Plant monitored and alarmed for integrity and UV dosage	-10	
	Plant neither monitored nor alarmed	10	
10.4	Influent turbidity consistently < 0.2 NTU	-6	
	Influent turbidity consistently < 1.0 NTU	-3	
	Influent turbidity consistently > 1.0 NTU	-1	
Total for Section 10b			

Water treatment factors – treatment works operation

4.4.5 | When a treatment works is operated in accordance with good practice with quality assured procedures, the risk from *Cryptosporidium* is reduced, particularly when there are auditable action plans to deal with any deviations from expected quality. The methods of returning filters to service following backwashing and dealing with filter backwash water have an effect on the risk. Other relevant factors are significant short-term variations in flow through the works and whether the works has operated above its design flow. One score (if appropriate) from each of the Sections in table 26 below should be inserted into the Actual Score column. These scores should be summed and the total of these scores should be inserted in the Total for Section 11 box.

Table 26: treatment works operation risk score

Section No.	Risk Factor	RA Score	Actual Score
11.1	Process control manuals specific to works available	-2	
	Process control manuals specific to works not available	1	

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Section No.	Risk Factor	RA Score	Actual Score
11.2	Auditable action plans available for dealing with deviations in quality	-2	
	Auditable action plans not available for dealing with deviations in quality	1	
11.3	Water flow through works when operating has not varied by >10% in <30 minutes in last 12 months	-2	
	Water flow through works when operating has varied by >10% in <30 minutes in last 12 months	2	
11.4	Flow through works above design flow for >10% of time in last 12 months	4	
	Flow through works above design flow for ≤10% of time in last 12 months	0	
	Flow through works >130% above design flow for >50% of time in last 12 months	6	
11.5	Membrane or UV filters bypassed during the year	6	
Total for Section 11			

Groundwater treatment and supply risk score

4.4.6 | The groundwater treatment and supply risk score is the sum of the scores for Section 9 to 11 (where relevant) as shown in table 27.

Table 27: groundwater treatment and supply risk score

Groundwater treatment and supply risk scores	Section Score
Section 9 – Water treatment processes	
Section 10 – Treatment works monitoring of filtration	
Section 11 – Treatment works operation	
Total Groundwater Source – Pathway – Receptor Risk Score	

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Final weighted groundwater risk assessment score

4.4.7 | The final surface water risk assessment score is the sum of the groundwater Source – Pathway-Receptor (SPR) risk score and the surface water treatment and supply risk score. This score is then weighted according to the population served by the supply. The population weighting factor is 0.4 x log10 (population served by the supply). The final weighted surface water risk assessment score is the final surface water risk assessment score multiplied by the population weighting factor as shown in table 28 below.

Table 28: final weighted groundwater risk assessment score

Total Groundwater – Catchment Risk Score	
Total Groundwater – Treatment, Operation and Management Risk Score	
Groundwater Risk Assessment Score	
Population	
Population Weighting Factor (0.4 x log10(population))	
Final Weighted Risk Assessment Score	
Water Supply Risk Classification	

SECTION 11: WATER TREATMENT AND RELATED MATTERS

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Section 11: Water treatment and related matters

Summary of Section 11

- Describes the importance of quality management systems including written procedures and training for all aspects of treatment works operation.
- Describes the importance of risk assessment of the catchment and raw water quality, the monitoring of raw water quality and the action to be taken if raw water quality deteriorates.
- Sets out some key features of treatment works operation including site security, risk assessment of failure of treatment processes, written procedures for operation of the processes including criteria for satisfactory performance, use of approved chemicals and materials and regular maintenance of equipment.
- Sets out the importance of training of operators and gives some examples of available training courses.
- Describes the importance of on-line monitors for the control of dosage of chemicals and for providing warning and alarm limits to detect deterioration in process performance.

Contents of Section 11

1. Introduction
2. Raw water quality
3. Water treatment works operation
4. Training of operators
5. Use of on-line monitors and control systems

1. Introduction

1.1 | It is vital to ensuring drinking water quality that water treatment works are designed, operated and maintained properly. This means that Water Services Authorities (WSAs) should adopt a quality management systems approach, for example to the management, operation and maintenance of water treatment works. As part

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of a quality management system, WSAs should have written procedures (Standard Operating Procedures – SOPs) that set out how each part of the process and other related matters are to be operated and maintained at each treatment works so that the water leaving the treatment works meets the standards and other requirements of the Regulations. These procedures should include adjustments to processes when there are changes in circumstances such as deterioration of raw water quality and when abnormal circumstances exist. Managers and operators should be fully trained in each part of the process that they are expected to manage or operate.

1.2 | The Department of Environment, Heritage and Local Government (DoEHLG) has developed a Performance Management System (PMS) to assist WSAs as employers to manage the performance of private service providers in respect of Design, Build and Operation (DBO) and Operation Contracts. These contracts mainly concern the provision of private water supplies. The Water Services Training Group has issued comprehensive guidance to WSAs on these contracts (Volume 3 – Water Treatment Plant). No such guidance has been issued in respect of public water supplies. However, the DoEHLG and the Environment Protection Agency (EPA) consider that WSAs should take account of the principles of that guidance where it is relevant to WSA's operations on public water supplies.

1.3 | The Regulations require that a WSA takes all necessary measures to ensure that no substances (including any impurities in these substances) used in the treatment of water remain in concentrations higher than is necessary for the purpose of use and that they do not directly or indirectly reduce the protection of public health provided for in the Regulations. They also require a WSA to verify the efficiency of disinfection, when disinfection is practised, and ensure that the concentration of disinfection by-products is kept as low as possible without compromising disinfection.

1.4 | This section provides general guidance to WSAs on water treatment and related matters. More detailed guidance is provided in the following EPA Water Treatment Manuals, which can be freely downloaded from the web-site (***http://www.epa.ie***), and any subsequent up-date of these manuals:

- Filtration (1995);
- Disinfection (1998) (currently under review); and
- Coagulation, flocculation and clarification (2002).

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2. Raw water quality

2.1 | Raw water quality, particularly variations in raw water quality, for example following heavy rainfall, can have a significant effect on the performance of the treatment processes and hence compliance with the standards and indicator parameter values in part 1 of the schedule to the Regulations. It is important that each WSA monitors key parameters in the raw water so that appropriate action can be taken, for example adjustments to the operation of treatment to ensure the regulatory requirements are met.

2.2 | The WSA should have:

- carried out a risk assessment of the catchment, as part of a Drinking Water Safety Plan (DWSP) (see section 10 of this handbook), to determine whether there is a significant risk to the operation of the water treatment processes and the quality of drinking water supplies and to determine which parameters to monitor in the raw water. If there is a risk that cannot be dealt with by the treatment processes, the WSA must consider with the organisations responsible for the catchment whether any controls are possible or it must improve treatment;
- liaised with the EPA and other departments of the WSA to be informed of the results of any sampling and analysis they have carried out under the 1989 Regulations (S.I. 294 of 1989) or the 2003 Regulations (S.I. 722 of 2003) on the raw water;
- appropriate operational monitoring arrangements to ascertain raw water quality, including the parameters to be monitored and the frequency of monitoring. Whenever possible this should include continuous monitoring of key parameters, such as turbidity and conductivity, with appropriate alarm levels to give early warning of deteriorating raw water quality;
- appropriate treatment processes to treat the raw water, including all reasonably expected variations in raw water quality, to ensure compliance with the standards and indicator parameter values in part 1 of the schedule to the Regulations, to ensure the effectiveness of disinfection and to minimise the concentrations of disinfection by-products; and
- written criteria and arrangements for ceasing abstraction of raw water if its quality is such that the installed treatment processes are unlikely to be effective and therefore the treated water quality gives rise to, or is likely to give rise to, a

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potential danger to human health. If cessation of abstraction is not practical, the WSA must, in consultation and agreement with the Health Services Executive (the HSE), have other arrangements to protect consumers.

3. Water treatment works operation

3.1 | Each water treatment works site should be secure from unauthorised access. The level of security will depend on the location of the site (urban or rural etc) and a risk assessment of the location. The immediate surroundings of the site should not present a potential risk to the raw water arriving at the works or to the operation of the treatment processes (for example a nearby railway line or road). The site should not present a risk to nearby residents (for example should there by an accidental release of chlorine gas when used in the disinfection process).

3.2 | The WSA should have a detailed map of the water treatment works site showing clearly the location of each treatment process, including any sludge treatment, and the routes of the pipe work connecting each process and the location of ancillary equipment such as dosage systems, pumps valves etc. There should be a schematic diagram of each process showing the equipment, such as tanks, pumps and valves and chemical dosage systems, needed to operate the process. The diagram should also show the monitoring points to control each process.

3.3 | The WSA should carry out a risk assessment of the water treatment works, as part of a DWSP (see section 10 of this handbook), to determine whether there are any risks to the operation of the treatment processes that are not controlled adequately and, if there are, to take appropriate action to reduce the risks. This risk assessment should include consideration of:

- the effect of unexpected variations in raw water quality and what actions might be taken, for example adjustments to treatment such as increasing coagulant dose, reducing flow through the works, reducing intervals between filter backwash etc;
- the risks of failure of coagulation/clarification and what actions might be taken such as duplication of coagulation dosing systems (duty/standby), reducing flow through works etc;

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- the risks of failure of filtration and what actions might be taken for example regular inspection of filters for cracks, mud balls etc, reducing filtration rates and reducing backwashing intervals etc; and
- the risks of failure of the disinfection system and what actions might be taken such as duplication of disinfectant dosing systems (duty and standby), if practical automatic shut down of the works etc.

3.4 | The WSA should have a detailed procedure, as part of a quality management system, for the operation of each process, and each part of the process, that sets out what the operators should do in normal circumstances and how the operators should respond to unusual or abnormal circumstances. These procedures should be readily available to the operators at the site. As part of these procedures, there should be criteria that describe the satisfactory operation of each process, such as a physical or chemical measurement (continuous or intermittent monitoring). These criteria should include warning levels that indicate when the performance of a process is deteriorating and requires investigation and alarm levels that indicate when performance is unacceptable and urgent action needs to be taken. These procedures should set out the tests that the operators are expected to carry out and the frequency of those tests and the frequency that the operators should read or check process monitors. The unusual or abnormal circumstances may be a significant change in raw water quality, a problem with the operation of a particular process, a result from a process monitor that is outside the specified criteria, or a failure to meet a drinking water quality standard.

3.5 | Operators should keep an operational log of all action taken at the treatment works including, but not restricted to:

- all chemical dosage rates and the reason for any changes to dosage rates;
- all on-site measurements made by operator and routine readings of monitors;
- any other changes made to the operation of processes such as deliberate changes in flow rates;
- records of filter backwashes if initiated manually; and
- other relevant information relating to the processes at the site.

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3.6 | The WSA should have a detailed programme for the regular calibration of all dosage systems and monitoring equipment and a system for recording the results of calibration. The WSA should have detailed schedules for the maintenance, by WSA maintenance staff or by the manufacturers/suppliers, of all key items of process equipment, a system for ensuring that these schedules are met and a system for recording that maintenance has been carried out.

3.7 | The WSA should have robust procedures controlling the use of substances (chemicals), products and materials at treatment works including:

- that only products approved by the Drinking Water Inspectorate for England and Wales (list of approved products can be found on the DWI website (***http://www.dwi.gov.uk/31/approvedProducts.shtm***) (or other equivalent European approval system) are used and any conditions associated with the approval are met;
- that only products certified by an independent third party (approval body) as manufactured in accordance with the relevant European Standard are used;
- that purchasing departments should take into account the recommendations in the CEN Report "IS CR 14269:2001: Chemicals used for the treatment of water intended for human consumption – guidelines for purchase";
- that contractors are aware of the need to use approved products;
- that contracts for new treatment works or new equipment at existing treatment works specify that only approved products must be used;
- maintaining an up to date list of products approved by the Drinking Water Inspectorate for England and Wales (or other equivalent European approval system); and
- acceptance of deliveries to the site, labelling and security of the delivery point and checking the quality of deliveries against the specification.

4. Training of operators

4.1 | All operators should be fully trained in the processes that they are expected to operate. The training should include normal process operation, identification of faults in the process, how to rectify faults and how to react in emergency situations. Each

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operator should have a copy of the site map, the schematic diagrams of the processes at the works, the works operating manual and the operating instructions for the relevant processes. A supervisor of operators should review each operator's performance regularly and consider whether training needs to be up-dated. Full records should be kept of operator training including the training courses attended, the processes they are trained to operate and the dates of the training and any refresher training.

4.2 | All operators, maintenance staff and samplers (and any contractors and sub-contractors) working at the treatment works where they could come into contact with partially or fully treated drinking water or come into contact with equipment that is in contact with drinking water, should have been **fully trained in hygienic practices** commensurate with their duties. Where appropriate, this training should include the actions required if one of these personnel has an illness (for example gastroenteritis or Hepatitis A) that could pose a risk of contamination of the drinking water supply or spread of the illness to other personnel. Hygienic practices are particularly important for multifunctional personnel who may work on both water supply and sewage. As an example, in the UK there is a national water hygiene training scheme that all operators and contractors are required to pass to obtain the "National Water Hygiene Card" before they can work on a water treatment works (operation, repair and maintenance). This scheme consists of completing a health questionnaire, receiving comprehensive water hygiene training and successfully passing a multi-choice test paper. The scheme is operated by Energy and Utility Skills Register (EUSR) on behalf of the UK water industry (***http://www.eusr.co.uk/eusr/the-eusr-card/the-national-water-hygiene-card***). The EPA recommends that WSAs develop, through the Water Services Training Group (WSTG), a hygiene training course for operators, contractors and others (such as samplers) working on water treatment works and distribution networks.

4.3 | The WSTG has training programmes for water treatment works operators and supervisors and details can be found at ***http://www.wsntg.ie/courses/courses.asp?id=all***. These include the following courses relevant to water treatment works operation (other suitable courses may be available from other training providers):

- Chlorine handling;
- Filter operations;
- Fluoridation of water supplies;
- Water clarification and trihalomethane (THM) removal;

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- Water treatment dealing with problems;
- Water treatment plant maintenance;
- Water treatment revision programme;
- Water treatment programme; and
- Water conservation

5. Use of on-line monitors and control systems

5.1 | At some treatment works WSA use on-line monitors to measure raw water quality, to monitor and control individual processes and to monitor the final output of the works. With the encouragement of the EPA, WSAs generally have programmes to install monitors at treatment works, particularly to monitor and control individual treatment processes. Some examples of important on-line monitors and control systems are:

- continuous monitoring of turbidity and conductivity in the raw water to provide warning of deterioration of raw water quality so that action can be taken, such as to adjust treatment;
- discrete monitoring of aluminium or streaming current potential to monitor the performance of the coagulation/clarification process, so that adjustments to coagulation conditions (alum dose or pH value) can be made if performance deteriorates;
- continuous monitoring of turbidity of the filtrate from each individual filter so that attention can be given to filter integrity, operation or backwashing when elevated turbidity is found. Also there should be continuous monitoring of the combined filtrate from the filters;
- continuous monitoring of the pH value of the combined filtrate so that, if necessary an acid or alkali can be added to ensure that the pH value is optimised for effective disinfection; and

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- continuous monitoring of disinfectant residual (usually chlorine), to control the disinfectant dose and to ensure that an appropriate minimum chlorine residual is present in the water entering supply. At some treatment works continuous chlorine monitors are installed at more than one point such as after the chlorine contact tank and in the final water leaving the works after the treated water reservoir.

5.2 | It is important that the monitors and the control systems are properly set up and calibrated with appropriate control limits when controlling the dosage of chemicals, appropriate warning and alarm limits so that they adequately monitor the individual processes to detect deterioration in process performance and appropriate warning and alarm limits to detect deterioration of quality.

5.3 | The WSA should have written instructions for the operation of on-line monitors and the associated control systems that include:

- regular calibration of the monitor with an appropriate calibration range and recording of the results of calibration;
- setting of the control limits and the warning and alarm limits and regular review of those limits;
- regular testing of the control system to ensure it responds to out of control limits;
- regular testing of the alarm system to ensure that it is activated when the alarm limit is exceeded;
- when used to monitor and control key processes, there are back-up facilities in case of failure of the monitor or control system;
- arrangements to deal with power failures at the works or at the remote control centre;
- adequate arrangements for responding to alarms, including automatic cascade systems, whether locally or at a remote control centre including that:
  - alarms cannot be ignored or switched off or by-passed;
  - key alarms are clearly identified;
  - written procedures exist for responding to alarms and it is clear what each relevant member of staff is required to do; and

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   - records are kept of all alarms and the action taken and the results of that action; and

- monitors, control systems and telemetry systems are maintained regularly by WSA staff or the manufacturers/suppliers and all maintenance carried out is recorded.

SECTION 12: DISTRIBUTION NETWORK AND RELATED MATTERS

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Section 12: Distribution network and related matters

Summary of Section 12

- Describes the importance of quality management systems including written procedures and training for all aspects of distribution networks operation.
- Describes the importance of risk assessment of the distribution network.
- Sets out some key features of distribution network operation including security and integrity of service reservoirs/water towers, risk assessment of failure/ contamination of the network, written procedures for operation of the network including risk assessments and method statements for major changes to network operations, use of approved chemicals and materials and regular maintenance of equipment.
- Describes the importance of written procedures to avoid contamination when installing new mains, repairing burst mains and re-lining existing mains including references to Codes of Practice for re-lining procedures.
- Sets out the importance of training of operators and gives some examples of available training courses.

Contents of Section 12

1. Introduction
2. Service reservoirs and water towers
3. Operation and maintenance of the distribution network
4. New mains, repaired mains and re-lined mains
    4.1 Introduction
    4.2 Installation of new mains
    4.3 Repair of burst mains
    4.4 Re-lining of existing mains
5. Training of operators

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1. Introduction

1.1 | The water that leaves treatment works has been treated to remove impurities and to enable the standards and indicator parameter values in part 1 of the schedule to the Regulations to be met. However, it is important that the treated water does not deteriorate significantly within the distribution network before it is supplied to consumers. Water can become contaminated through ingress of environmental water into the distribution network, particularly if there are structural defects in service reservoirs and water towers or low pressures and bursts in the water mains in the network. Contamination can also occur through the use of inappropriate materials in contact with water in the distribution network.

1.2 | Water Services Authorities (WSAs) should adopt a quality management systems approach to the management, operation and maintenance of the distribution network. As part of a quality management system, WSAs should have written operating and maintenance procedures for the distribution network that aim to maintain the supply of water to consumers and that minimise the risk of contamination whilst the water is being distributed. The length of time the water is kept in the distribution network should be kept to a minimum taking into account the need to maintain a reserve of water in the network to meet peaks of demand. Managers and operators should be fully trained in each facet of the distribution network that they are expected to manage or operate.

2. Service reservoirs and water towers

2.1 | If a service reservoir or water tower is not properly operated and maintained, it can present a serious risk of contamination. The following advice should assist WSAs to avoid contamination of water in service reservoirs and, where appropriate, in water towers.

- The service reservoir (or water tower) site should be:
- secure from unauthorised access with an appropriate alarm system;
- as secure as possible from livestock (fenced) and other animals;
- secure from water run-off from the surrounding land; and
- secure from damage from nearby trees or other large plants.

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2.2 | The structure of the service reservoir (or water tower) should be kept in a good condition in particular there should be:

- no cracks in the floor, walls or the roof;
- adequate drainage for the roof with no place that external water could infiltrate into the reservoir or tower;
- no signs of animal activity on the roof, covers on access hatches and other exposed parts of the reservoir or tower;
- good seals on all access hatches and all holes in the structure for pipes, cables, sampling lines etc; and
- suitable mesh covers on all vents to prevent ingress of birds and small animals.

2.3 | The operating procedures for the service reservoir/water tower, in particular for a reservoir/tower with more than one compartment, should ensure that there is no accumulation of stagnant water and that the water is turned over as quickly as possible consistent with maintaining adequate reserves of water. It is equally important to ensure that the service reservoir/tower does not run dry because, in addition to there being no supply of water, when the water supply is restored there are likely to be water quality problems through disturbance of deposits in the reservoir and downstream pipe work. The operating procedures should cover the setting of level probes and maintenance of probes including testing to make sure they are working properly.

2.4 | The WSA's procedures should include regular external inspection of the service reservoir structure and the surrounding site. They should also include less frequent but regular internal inspection of the structure of the reservoir when the opportunity should be taken to remove any accumulated debris and to clean and disinfect the internal surfaces. Records of these inspections should be kept. Any defects identified during inspections should be rectified as quickly as possible and records of these actions kept.

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3. Operation and maintenance of the distribution network

3.1 | The WSA should have a **detailed map and schematic diagram** of the distribution network showing the location of each service reservoir and water tower, each break pressure tank, all distribution mains, all valves including pressure reducing valves and all hydrants and washouts. Increasingly water suppliers are using GIS systems to record their distribution networks. It is also vitally important WSAs know, and keep accurate records of, the status of all valves (closed, open, partially open), so that when changes need to be made to the operation of the network, the water travels in the direction intended.

3.2 | The WSA should carry out a **risk assessment of the distribution network** as part of a drinking water safety plan (DWSP) to determine whether there are any risks in the networks that are not controlled adequately and if there are to take appropriate action to reduce the risks. This risk assessment should include consideration of, for example:

- the security and integrity of service reservoirs and water towers;
- the length of time water remains in the service reservoirs/water towers and the network – time should be minimised to avoid deterioration of quality and “stale” water, but consistent with maintaining adequate supplies;
- what might happen if it is necessary to alter the distribution of water in the network, for example flow increases or flow reversals resulting in disturbance of any deposits in the networks causing discoloured water to be supplied to consumers;
- potential back-siphonage of contaminated water into the distribution network from industrial, commercial and domestic premises; and
- unauthorised or improper use of hydrants and washouts resulting in opportunities for direct contamination through the open hydrant or washout or indirect contamination through reduction in pressure in the network.

3.3 | Distribution networks inevitably contain some deposits arising from inadequate treatment in the past and from corrosion of the materials of the distribution network. These deposits tend to accumulate in low flow parts of the distribution network. If these deposits are disturbed consumers could be supplied with discoloured water containing particulate matter. WSAs should have written procedures for the operation of the network that minimise the risk of disturbance of these deposits. Before a WSA makes any significant change to the operation of the distribution network, it should carry out a **risk assessment** of the consequences of making that change on drinking water quality, particularly discoloured water. The risk assessment should lead to a **method statement** (for example the order of opening and closing valves and the rate at which they are opened and closed) in order to minimise any risk. These operational procedures should include for example:

- the way in which a new or stand-by treatment works is brought into supply to avoid surges in flow in distribution (increase the flow from the works slowly);
- the way in which the distribution network is managed to satisfy changes in demand to avoid sudden increases in flow and to avoid as far as possible flow reversals (moving of water from one area of the network to another by careful shutting and opening of appropriate valves);
- the way in which the distribution network is managed when it is necessary to change its operation to deal with for example internal inspection and repair of a service reservoir, repair of burst mains and mains rehabilitation so as to avoid sudden increases in flow and to avoid as far as possible flow reversals; and
- maintaining adequate pressure within the system to avoid ingress of environmental water surrounding the water mains.

3.4 | Deterioration of water quality during distribution can also occur if the water remains in the distribution network for an excessive period of time. Typically the water can develop an offensive taste or odour when it becomes stale and has been in contact for a long time with the materials of the distribution network, any biofilms on the internal surfaces of the system and any deposits in the system. The WSA's procedures should include managing the distribution network in a way that minimises the time water is resident within the network or sections of the network.

3.5 | Automatic continuous chlorine monitors installed at the outlet of the service reservoir/water tower/tank and/or appropriate points in the distribution network with appropriate low chlorine warning and alarm limits can provide a useful guide on whether contamination may have entered the system.

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3.6 | The procedures should also specify that only materials of construction that have been approved by the Drinking Water Inspectorate (list of approved products can be found on the DWI website ***http://www.dwi.gov.uk/31/approvedProducts.shtm***) (or other equivalent European approval system) should be used within the distribution network in contact with water and any conditions associated with the approval are met.

3.7 | The WSA should have procedures for the inspection of distribution networks (opening of hydrants to observe any deposits, observing the condition of mains when repairing bursts etc) as part of its criteria for deciding when maintenance is needed. Other criteria for determining when maintenance is needed should include the frequency of burst mains and the frequency of consumer complaints about drinking water quality, small animals in the water (ascellus, gammarus, chironamids, worms etc) or low water pressure. The WSA should have a programme of routine flushing of the network through wash-outs that concentrates on those parts of the network where deposits are known to accumulate. For those parts of the distribution network where there are regular difficulties that cannot be adequately controlled by flushing, the WSA will need a mains rehabilitation programme. This programme could include mechanical cleaning of mains, re-lining of mains and replacement of mains. Advice on the precautions to be taken when carrying out such programmes is given in sub-section 4 below.

4. New mains, repaired mains and re-lined mains

4.1 Introduction

4.1.1 | Whenever work is carried out on the distribution network that involves opening a main there is a risk of contamination during the process that could result in contamination of the water supply when the main is returned to service. Indeed many drinking water contamination incidents have been caused by WSAs failing to follow good practice and take adequate precautions during such work to minimise the risk. Such work could involve the installation of a new main, the repair of a burst in an existing main and the cleaning and re-lining of an existing main.

4.1.2 | It is recommended that the WSA has written procedures and instructions for carrying out these processes to ensure that there is no contamination during them. These procedures should include checking that the operators or contactors carrying

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out the work have followed the written procedures and instructions and that operators and contractors keep documented records of all actions taken within the distribution network.

4.1.3 | Frequently when these processes are carried out on the distribution network, there will be a need to discharge significant quantities of super-chlorinated water (water with higher than normal levels of chlorine used to disinfect the new, repaired or re-lined mains) or flushing water containing deposits from the cleaning process. Such chlorinated water may kill fish and other life if discharged to a water course and may interfere with the operation of sewage treatment works if discharged to a sewer or surface drain. Super-chlorinated water must not be discharged to a water course or to a surface drain that might lead to a water course without the consent of the local fisheries unit. It may be possible to discharge such water following de-chlorination. Similarly super-chlorinated water must not be discharged to a sewer or a surface drain leading to a sewage treatment works without the consent of the local authority. Flushing water containing deposits may deoxygenate or partially deoxygenate a water course or may interfere with sewage treatment processes and should not be discharged without the consent of the local fisheries unit or the local authority respectively. Any super-chlorinated or flushing water that cannot be discharged at the working site will need to be taken by tanker to a suitable disposal site.

4.2 Installation of new mains

4.2.1 | The following aspects are important for avoiding contamination during the installation and for ensuring that the drinking water quality standards are met once the main is brought into service and they should be included in the WSA's procedures:

- the mains are designed and sized carefully so that:
    - they are large enough to meet the demand for water but not so large as to result in excessive residence time of water in the mains;
    - dead ends and water stagnation are avoided, but if this is not possible adequate flushing points are provided;
    - drainage of chambers for valves, meters, hydrants etc takes water away from the mains;

- air valves are at the highest point in the relevant parts of the distribution network; and
- the material of main in contact with the water is approved by the Drinking Water Inspectorate (list of approved products can be found on the DWI website ***http://www.dwi.gov.uk/31/approvedProducts.shtm***) (or other equivalent European approval system) and is used in accordance with any approval conditions;

- following laying the mains must be cleaned and disinfected. As an example some suitable procedures are:
  - fill the mains with water containing 20 mg/l free chlorine;
  - flush the mains then refill with water containing 20 mg/l free chlorine and leaving in contact for 24 hours; and
  - displacing the chlorinated water with mains water and leaving for a further 24 hours pending the results of microbiological analysis;
- during and following the cleaning and disinfection process samples are taken and analysed as quickly as possible as follows:
  - free chlorine residuals to ensure that an adequate residual has been maintained throughout;
  - qualitative taste and odour of the displacement water to ensure that nothing offensive has leached before putting the main into supply;
  - visual appearance to check that all samples look satisfactory; and
  - microbiological analysis, particularly coliforms, from a number of points along the mains including the extremities to check that all samples are free from coliforms **before the main is put into supply;**
  - disinfection of the services connections if there is any doubt about their cleanliness;
  - if all tests are satisfactory, careful introduction of the new mains into supply; and

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- a nominated person should be responsible for checking that everything has been carried out according to the procedures before giving permission for the new mains to be brought into supply.

4.3 Repair of burst mains

4.3.1 | The following aspects are important for avoiding contamination during the repair and for ensuring that the drinking water quality standards are met once the repaired main is brought back into service (in some circumstances a main can be repaired whilst still in service) and they should be included in the WSA's procedures.

4.3.2 | For repairs that involve cutting open the main these should include:

- that water should be kept out of the trench surrounding the repair; that special precautions are taken should there be any significant risk of pollution from for example sewage because of a nearby sewer;
- if practical, disinfecting the main in a similar manner to new mains but, for example, with a minimum contact period of 2 hours with 20 mg/l free chlorine or 30 minutes with 50 mg/l chlorine;
- if the above is not practical, disinfecting all surfaces that will come into contact with the treated water with a solution containing, for example, 1000 mg/l chlorine;
- after flushing, taking microbiological samples for coliforms;
- returning the main to service after flushing, provided there is no reason to suspect that contamination has entered the main (no need to wait for the results of microbiological samples);
- when there is reason to suspect that contamination may have entered the main, keeping the main out of service until the results of microbiological samples are available and are satisfactory; and
- and making a nominated person responsible for checking that everything has been carried out according to the procedures before giving permission for the main to be returned into supply.

4.3.3 | For repairs that involve using a collar and keeping the main in service whilst the repair is made these should include:

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disinfecting the collar and the area of the fracture with a solution containing, for example, 1000 mg/l free chlorine; and

taking a microbiological sample for coliforms to confirm that there was no contamination during the procedure.

4.4 Re-lining of existing mains

4.4.1 | There are a number of generic materials that can be used for re-lining existing mains to prolong their life. The most common ones are polyurethanes, epoxy resins, cement mortar and polyethylene or other type of plastics. The following aspects are important for avoiding contamination during the re-lining operation and for ensuring that the drinking water quality standards are met once the re-lined main is brought back into service and they should be included in the WSA's procedures.

4.4.2 | For mains that are re-lined with polyurethane and epoxy resin materials particular care has to be taken to ensure that the components of these relining materials are thoroughly mixed in the correct proportions and that the applied mixture is adequately cured before the main is returned to service. The procedures should include:

- using only polyurethane and epoxy resin components that have been approved by the Drinking Water Inspectorate (list of approved products can be found on the DWI website ***http://www.dwi.gov.uk/31/approvedProducts.shtm***) (or other equivalent European approval system) and is used in accordance with any approval conditions;

- using contractors that are competent to carry out the process. The contractors should apply these approved materials in accordance with strict operational requirements such as those documented in the UK Water Industry Information and Guidance Note IGN 4-02-2 "Code of Practice: In-situ resin lining of water mains" (***http://www.wis-ign.org/downloads/IGN%204-02-02.pdf***) and Water Industry Specification WIS 4-02-01 "Operational Requirements: In-situ resin lining of water mains" (***http://www.wis.ign.org/downloads/WIS%204-02-01.pdf***); and

- that a nominated person in the WSA is responsible for supervising the contractor, checking that all procedures have been followed satisfactorily and giving permission for the re-lined main to be returned to supply.

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4.4.3 | Generally cement mortar re-lining is suitable for large diameter mains because the residence time of the water is very short and there is unlikely to be significant leaching of the components of the cement. However, cement mortar re-lining is not suitable generally for other sizes of mains when the water to be supplied through the mains is soft, with say an alkalinity less than about 50 mg/l as calcium carbonate, because components of the cement are likely to be leached out to some extent causing high pH values. Cement mortar re-lining is suitable generally for other sizes of mains when the water is hard above about 50 mg/l as calcium carbonate. Particular care also has to be taken to ensure that the cement mortar is applied and cured properly before the main is returned to service. It is not possible to be specific about the sizes of mains because the suitability of a cement mortar product will depend primarily on the composition of the cement mortar, the size of the main and the alkalinity of the water. The procedures should include:

- using only cement mortar components that have been approved by the Drinking Water Inspectorate (list of approved products can be found on the DWI website ***http://www.dwi.gov.uk/31/approvedProducts.shtm***) (or other equivalent European approval system) and is used in accordance with any approval conditions; and

- using contractors that are competent to carry out the process. The contractors should apply these approved materials in accordance with strict operational requirements such as those documented in the Water Research Centre publication "In-situ cement mortar lining – Operational Guidelines and Codes of Practice", Water Research Centre plc,1990 (ISBN 0902156 84 5).

5. Training of operators

5.1 | All operators should be trained in the processes that they are expected to operate within the distribution network. The training should include normal operation, identification of faults, how to rectify faults and how to react in incident and emergency situations. The operator should have a copy of the relevant distribution map showing the position of service reservoirs, water towers, distribution mains and all valves, hydrants and other equipment. The operator should have operating instructions for the relevant parts of the distribution network. A supervisor of the operator should review the operator's performance regularly and consider whether training needs to be up-dated. Records should be kept of operator training.

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5.2 | All operators, maintenance staff and samplers (and any contractors and sub-contractors) working on the distribution network (including service reservoirs and water towers) where they could come into contact treated drinking water or come into contact with equipment that is in contact with drinking water, should have been **fully trained in hygienic practices** commensurate with their duties. Where appropriate, this training should include the actions required if one of these personnel has an illness (for example gastroenteritis or Hepatitis A) that could pose a risk of contamination of the drinking water supply or spread of the illness to other personnel. Hygienic practices are particularly important for multifunctional personnel who may work on both water supply and sewage. As an example, in the UK there is a national water hygiene training scheme that all operators and contractors are required to pass to obtain the "National Water Hygiene Card" before they can work on the distribution network. This scheme consists of completing a health questionnaire, receiving comprehensive water hygiene training and successfully passing a multi-choice test paper. The scheme is operated by Energy and Utility Skills Register (EUSR) on behalf of the UK water industry (***http://www.eusr.co.uk/eusr/the-eusr-card/the-national-water-hygiene-card***). The EPA recommends that WSAs develop, through the Water Services Training Group (WSTG), a hygiene training course for operators, contractors and others (such as samplers) working on water treatment works and distribution networks.

5.3 | The WSTG has training programmes for distribution network operators and supervisors and details can be found at ***http://www.wsntg.ie/courses/courses.asp?id=all***. These include the following courses relevant to distribution operation (other suitable courses may be available from other training providers):

- Distribution system;
- Leakage control;
- Location underground services; and
- Safety at excavation.

SECTION 13: AUDIT OF WSAS BY THE EPA

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Section 13: Audit of WSAs by the EPA

Summary of Section 13

- Describes the regulatory requirement for the Environment Protection Agency (the EPA) to audit supplies made by the Water Services Authorities (WSAs) to verify that they are complying with the regulatory requirements.
- Sets out the risk based approach that the EPA uses to formulate its annual plan for audit of WSAs.
- Describes the areas of the WSA's water supply operations that could be included in an audit.
- Sets out what may be included in the EPA's reports on audits and the timetable for issue of reports and for WSAs to reply to reports.

Contents of Section 13

1. Introduction
2. The EPA's audit policy
3. Format of audits
4. Reports on audits

1. Introduction

1.1 | Regulation 17 of the Regulations requires each supervising authority to undertake an **audit** of water supplies for which it has supervisory responsibility to ensure that the provisions of the Regulations are met by the relevant water supplier. This means that in respect of public water supplies the Environment Protection Agency (the EPA), as the supervisory authority, is required to audit the performance of Water Services Authorities (WSAs) to verify that they are complying with the regulatory requirements. This section sets out the EPA's policy on the content and frequency of its audits of public water supplies.

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2. The EPA's audit policy

2.1 | The EPA prepares an annual plan for the audit of each WSA. The EPA adopts a **risk based approach** to the audit of WSAs and their water supplies. Consequently, this plan may, as a minimum, include all water supplies operated by the WSA that:

- have water restrictions (advice to boil water, advice not to drink water etc) in place; or
- have persistent non-compliance with the health based standards in tables A and B of part 1 of the schedule to the Regulations, particularly the microbiological standards; or;
- have no treatment; or
- have treatment plants that are over-loaded; or
- have been categorised as high or very high risk in relation to Cryptosporidium.

2.2 | The EPA also makes provision in its annual plans for audit of supplies included in the "Remedial Action List (RAL)" and for unscheduled audits in response to significant notifications by WSAs of incidents affecting public water supplies.

2.3 | The effect of this risk based approach to audits will be that WSAs that are performing relatively poorly in respect of drinking water quality will have a greater degree of audit (more supplies and higher frequency) and those that are performing better will have a lesser degree of audit (fewer supplies and lesser frequency).

3. Format of audits

3.1 | The format of the audit will depend on the individual supply and the reason for carrying out the audit. The following areas are likely to be included in audits:

- identification of the risks and measures for the protection of the raw water source;
- protection of the abstraction point of the raw water source;
- quality of the raw water;
- suitability of the treatment processes for the raw water quality;

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- *Cryptosporidium* risk screening and appropriate barriers for the level of risk;
- throughput of works compared to the safe operating/design capacity of the works;
- operation of treatment processes such as coagulation, clarification, filtration and disinfection with particular attention to operational monitoring and control;
- condition of treatment systems including maintenance;
- review of chemicals used to ensure they are suitable for drinking water treatment and are delivered, stored and used appropriately;
- review of the efficiency of the disinfection process and adherence to the operating criteria set out in sub-section 5 of section 6 of this handbook;
- corrective action procedures when there is a failure to meet a standard or other regulatory requirements;
- review of monitoring results, record keeping and reporting of drinking water quality;
- operation and maintenance of the distribution network;
- unaccounted for water levels (leakage etc);
- progress in developing and implementing Drinking Water Safety Plans (DWSPs);
- progress with action programmes for supplies on the RAL; and
- any other matter considered necessary by the EPA, such as handling of consumers' complaints and incident and emergencies procedures.

4. Reports on audits

4.1 | Once it has completed an audit, the EPA holds a short debriefing meeting with the WSA at which it will give the WSA a verbal summary of the main findings of the audit. The EPA prepares a final report of the audit as soon as practical after completion of the audit. This report generally will set out the purpose of the audit, what was audited, who was present, summary of the main findings/recommendations, description of

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what was found and observed and recommendations. The WSA is required to reply within the time frame specified in the final audit report to the recommendations setting out what it has done, or proposes to do, to satisfy those recommendations.

4.2 | Each WSA is recommended by the Department of Environment, Heritage and Local Government (Circular letter WSP 6/09) to place a copy on its web-site of all EPA audit reports on the WSA's performance.

Glossary: list of acronyms

AQC	Analytical quality control
BS	British Standard
CD	Compact disc
CEN	Comité Européen de Normalisation (European Committee for Standardisation)
CSM	Conceptual site model
DBO	Design, build and operate
DBPs	Disinfection by-products
DED	District electoral division
DoEHLG	Department of the Environment, Heritage and Local Government
DWI	Drinking Water Inspectorate of England and Wales
DWIRP	Drinking Water Incident Response Plan
DWNMP	Drinking Water National Monitoring Programme
DWSP	Drinking Water Safety Plan
EC	European Communities
E. coli	Escherichia coli
EDEN	Environmental data exchange network
EEC	European Economic Community
EPA	Environment Protection Agency
EU	European Union
EUSR	Energy and Utility Skills Register
GAC	Granular activated carbon
GANNT	Chart named after Henry Gannt
GCMS	Gas chromatography/mass spectrometry
GIS	Geographic Information System
HSE	Health Service Executive
IGN	Information guidance note (UK)

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INAB	Irish National Accreditation Board
IPPC	Integrated pollution prevention control
IRT	Incident response team
ISO	International Standards Organisation
LIMS	Laboratory information management system
LIXIE	A data conversion and transfer tool
NTU	Nephelometric turbidity unit
OCT	Outbreak control team
PAH	Polycyclic aromatic hydrocarbons
PE	Population equivalent
PMS	Performance management system
PrGWS	Private Group Water Scheme
PuGWS	Public Group Water Scheme
RAL	Remedial action list
RPII	Radiological Protection institute of Ireland
SCADA	Supervisory control and data acquisition
S.I.	Statutory Instrument
SOP	Standard operating procedure
SPA	Special protection area
S-P-R	Source-pathway-receptor
SPZ	Source protection zone
THMs	Trihalomethanes (disinfection by-products)
TID	Total Indicative Dose (radioactivity parameter)
TOC	Total organic carbon
UK	United Kingdom
uPVC	Unplasticised polyvinyl chloride
US	United States
UV	Ultra-violet
UWWT	Urban waste water treatment
WFD	Water Framework Directive
WHO	World Health Organisation
WIS	Water industry specification (UK)
WSA	Water Services Authority
WSTG	Water Services Training Group

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