

Cyanobacteria (Blue-Green Algae) in Inland and Inshore Waters: Assessment and Minimisation of Risks to Public Health

Revised Guidance 2012



Compiled by the Scottish Government Health and Social Care Directorates
Blue-Green Algae Working Group
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FOREWORD BY SIR HARRY BURNS, CHIEF MEDICAL OFFICER FOR SCOTLAND

In the autumn of 1854, an outbreak of cholera claimed the lives of some 600 residents of the Soho area of London. In studying the distribution of these cases in the areas affected, a local doctor, Dr John Snow, developed a view that the source of the outbreak was the water pump in Broad Street. It is said that, at a subsequent meeting, Dr Snow managed to convince a sceptical board of guardians for the parish of St James that there was sufficient evidence to warrant an appropriate intervention – the removal of the Broad Street pump handle. The handle was removed and the outbreak ended.

The story of Dr John Snow and the Broad Street pump handle holds a prominent place in the history of public health in the UK. Not only did it establish contaminated drinking water as the source of a major killer, it is also credited with marking the birth of modern epidemiology. Now, some 150 years on, protection of the public health relies less on the inspired efforts of individuals but rather on what we often describe as “the organised efforts of society”.

However, ensuring the availability of reliable sources of clean water remains a cornerstone of these efforts.

The original development of this document in 2002 and the subsequent implementation of its guidance have provided an excellent example of successful channelling of the organised efforts of the public health and the environmental agencies in Scotland. This joint working has continued in the development of this 2012 revision which now includes the provisions necessary to address the relevant responsibilities of the Scottish Government under the European Union revised Bathing Water Directive.

I am grateful, therefore, to the members of the Blue-Green Algae Working Group who have contributed to the revision of this document, and I thank them for the opportunity to provide this introduction.

Sir Harry Burns
Chief Medical Officer for Scotland

PREFACE

This is the second revision of the guidance document under the same title that was published initially by the Scottish Executive Health Department in 2002, and revised for the first time in 2007.

The approach advocated for managing the risks to human and animal health of exposure to cyanotoxins continues to centre on production and implementation of “Local Action Plans”. These should be co-ordinated by the NHS Boards in Scotland and should be agreed by the various stakeholders identified herein.

This document includes guidance on the content and structure of these Local Action Plans and should be regarded as a resource to assist in their production, as well as fulfilling the requirements of Article 8 (cyanobacterial risks) of the Bathing Water Directive (2006/7/EC).

The Scottish Government Health and Social Care Directorates (SGHSCD) propose to review and, if necessary, reissue this guidance document every five years. However, it is recognized that the value of this guidance lies in its practical implementation. The SGHSCD would therefore welcome feedback, which should be addressed to the SGHSCD’s Scientific Adviser at St Andrew’s House, Edinburgh EH1 3DG. Should this feedback indicate a specific need, then a further version of this guidance will be produced sooner.

The impact on human health associated with cyanobacterial contamination of recreational and drinking waters in Scotland remains, thankfully, low based on evidence of incident reports. The potential risks to health, however, remain real. Climate change predictions suggest that over a longer term, changes in temperatures and weather patterns may increase the scale of hazard presented by cyanobacterial blooms. This in turn may increase the scale of risk to human health. Planning and preparedness with respect to cyanobacterial contamination will therefore remain important for the foreseeable future.

Dr Colin Ramsay
Chairman of the Blue-Green Algae Working Group

GLOSSARY OF ABBREVIATIONS

CPHM	Consultant in Public Health Medicine
COSHH	Control of Substances Hazardous to Health
DWQR	Drinking Water Quality Regulator
EHO	Environmental Health Officers
FSA	Food Standards Agency
HSE	Health and Safety Executive
HPS	Health Protection Scotland
LPSs	Lipopolysaccharides
LAP	Local Action Plan
LAs	Local Authorities
LAEH	Local Authority Environmental Health
MHSWR	Management of Health and Safety at Work
NPIS	National Poisons Information Service
SAC	Scottish Agricultural College
SACVSD	Scottish Agricultural College Veterinary Science Division
SEISS	Scottish Environmental Incident Surveillance System
SEMD	Security and Emergency Measures Direction
SEPA	Scottish Environment Protection Agency
SGEED	Scottish Government Enterprise and Environment Directorates
SGHSCD	Scottish Government Health and Social Care Directorates
SNARLs	Suggested No Adverse Response Levels
WHO	World Health Organization

1. INTRODUCTION

1.1 This document, prepared by a Working Group established by the Scottish Government Health and Social Care Directorates, provides guidance to Directors of Public Health, to Heads of Environmental Health in Local Authorities (LAs), and to others in Scotland, on possible risks to public health of cyanobacteria (blue-green algae) in inland and inshore waters. It updates previous guidance under the same title that was published by the Scottish Government Health Directorate previously in 2002, and revised in 2007.

1.2 The remit of the Working Group was:

- i. to review previous guidance in the context of advances in scientific knowledge and, in particular, to consider the implications for the public of exposure during recreation and work and of exposure from food and water;
- ii. to review previous guidance on monitoring and risk assessment in the context of recent experience in Scotland and elsewhere; and
- iii. to provide further guidance.

1.3 The membership of the Working Group is given in **Annex A**.

1.4 The guidance takes account of relevant peer reviewed literature, expert group guidance from international bodies (e.g. WHO) and the expert opinions of the Working Group members. It takes account of current World Health Organisation (WHO) guidance summarised in "Toxic cyanobacteria in water. A guide to their public health consequences, monitoring and management" (eds I Chorus and J Bartram) published in 1999 by E&FN Spon, London, on behalf of the WHO. The guidance given in this report also provides for Scottish compliance with the requirements of Article 8 of the revised *Bathing Water Directive (2006/7/EC)*

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:064:0037:0051:EN:PDF>

A formal systematic review as such was not conducted however, Working Group members updated relevant sections of the report based on their knowledge of relevant literature and issues.

1.5 This document will be updated every five years. It is accepted, therefore, that while certain details (such as contact details in **Annex C**) are correct at the time of issue, they are subject to obsolescence during this period.

2. OCCURRENCE AND APPEARANCE OF CYANOBACTERIA (BLUE-GREEN ALGAE)

2.1 Cyanobacteria occur in fresh, brackish and sea-waters throughout the world. In Scotland, they can occur in quantity in lochs, ponds, canals, rivers, reservoirs and coastal waters. While usually green or blue-green in colour (hence the term blue-green algae), they may be khaki, blue, black, dark brown or red (hence the preferred terminology now used is cyanobacteria).

2.2 When present in high concentrations, colonies of cyanobacteria can often be seen with the naked eye: they may resemble fine grass cuttings or take the form of small irregular clumps or pinhead-sized spheres. Cyanobacteria in high concentrations in the water column can form 'blooms' and, when blown on to a downwind shore, form scums which can be up to a few centimetres thick. Scums may also be seen in slow-flowing rivers and streams downstream from lochs. Decaying scums, due to other naturally-occurring microbes or bright sunlight for example, can appear bleached as sky-blue, grey, or white masses.

2.3 Cyanobacteria may also grow on the bottom of shallow water bodies and on shoreline rocks and sediments. They occasionally form thick gelatinous mats, which may be exposed as the water level falls or may detach from the bottom and reach the shoreline. These mats are usually very dark in colour (black, dark brown or green), are cohesive and are sometimes mistaken for sewage.

2.4 Growths of some varieties of water plants (particularly duckweed) that float on the water surfaces can be mistaken for surface scums of cyanobacteria.

3. PUBLIC HEALTH CONCERNS

3.1 Surveys in different parts of the world have found that between about 45% and 90% of blooms of cyanobacteria produce toxins (cyanotoxins). These toxins are largely retained within the cyanobacterial cells during their development and growth phases and are released, in the main, on cell death (Codd GA & Bell SG (1996)).

3.2 The range of cyanotoxins is diverse and includes neuro- and hepatotoxins, skin irritants, and inflammatory agents. A cyanobacterial bloom may contain more than one species, each producing the same or different toxins, either singly or in combination. In addition, the toxicity of one species might change over time dependent on the nutritional state of the algae, and for different places on a particular water body. Further information on cyanotoxins and their health effects is given in **Annex B**.

3.3 Evidence on toxicity is drawn from reports of the effects of exposure of people and of animals to cyanobacterial blooms and from laboratory investigations of cyanotoxins. Overall there have been relatively few published reports worldwide of significant human health impacts associated directly with exposure to cyanotoxins linked to cyanobacterial incidents. However, surveillance of illness associated with such exposures is likely to be incomplete.

3.4 In 1989, a group of soldiers took part in kayak training, including rolling and swimming exercises, at Rudyard Lake in Staffordshire. Two became severely ill with atypical pneumonia; others reported abdominal pains, vomiting, diarrhoea, blistering of the mouth and sore throats. Further incidents involving human health impacts have occurred after recreational contact with cyanobacterial scums and blooms in UK inland waters in recent years. The effects were probably associated with exposure to cyanobacteria and ingestion of the toxin-containing cyanobacterial scum.

3.5 Gastroenteritis, neurological effects, acute hepatocellular damage and skin irritation have been reported from other countries. Illnesses and deaths of haemodialysis patients, attributed to exposure to cyanotoxins in inadequately-treated water, occurred in Brazil in 1996. Further exposures of haemodialysis patients to cyanotoxins, followed by illness, occurred in Brazil in 2001.

3.6 Ingestion of hepatotoxic and neurotoxic scums of cyanobacteria is reported to have caused the deaths of cattle, horses, sheep, dogs, and a wide range of wild terrestrial animals and domestic and wild birds. There is also evidence that cyanotoxins have been major contributors to fish kills and the deaths of other aquatic animals.

3.7 Another potential source of intoxication for both animals and humans is via bioaccumulation of cyanotoxins in the food chain. The principal concern here would be accumulation of the toxins in shellfish including freshwater and brackish-water mussels and in fish. However, no cases of intoxication from such sources have been reported to date in Scotland.

3.8 Episodes of cyanobacterial contamination of drinking water supplies occur periodically:

(i) In September 1997, a massive cyanobacterial bloom affected the main water supply loch on Westray, Orkney Isles, and resulted in a ban on the use of water for drinking, cooking, and washing. Large quantities of water treatment chemicals were needed to reduce cyanobacterial concentrations to a level where even a reduced throughput could be maintained and aluminium levels in the final water eventually rose to a level considered unfit for consumption. The water had also become unacceptable due to taste and odour. The water authority arranged for potable water to be transported as bottled water and in tankers to serve the human population. Fortunately, the very large cattle herd on the island at the time was able to continue to drink the loch water without apparent ill effect. No cyanotoxins were actually detected in the drinking water.

(ii) In July 2005, consumers of treated water supplied from the Loch of Boardhouse in Orkney complained of an earthy taste and musty odour. A visual check of the loch identified green growth around the loch consistent with an algal or cyanobacterial bloom. Analysis confirmed the presence of mixed cyanobacterial species, predominantly of *Anabaena*, resulting in high concentrations of the taste and odour compounds 2-methylisobornereol and geosmin. Cyanotoxin (microcystin) concentrations were below 1 microgram per litre. A temporary powdered activated carbon dosing plant was installed which improved the taste and odour of the final treated water. The cyanobacteria had virtually disappeared by mid-August. Approximately 4,000 consumers were inconvenienced by disruption to their water supply and were supplied with bottled water. A similar problem with cyanobacteria and geosmin tainting affected the taste and odour of water from the Glenfarg reservoir in 2006, and was managed using activated carbon dosing.

(iii) Cases of cattle, dog, bird and fish deaths have occurred in Scotland in which cyanotoxins have been implicated as a cause or a contributory factor, based on toxicological and veterinary investigations. Further occasional reports of animal deaths attributed by their owners to contact with cyanobacterial scums have occurred. However, objective evidence is not always available to confirm an association with toxin exposure. In summer of 2003 there was good evidence to suggest that the deaths of two dogs in Fife were associated with ingestion of cyanobacterial sludge (detached shoreline mats) at Town Loch near Dunfermline. Restrictions were imposed and were supported by ongoing monitoring. Shoreline deposits were safely removed and disposed of. Another dog death on Shetland reported to SEPA in 2006 was investigated and cyanotoxin analysis suggested that toxin exposure was a strong candidate as the cause of death. However, problems with cyanobacterial recognition, incomplete knowledge of exposure circumstances, and post-event sampling and investigation, continue to constrain clear identification of the role of cyanobacteria and their toxins in some cases of suspected cyanobacterial poisoning.

(iv) The Scottish Environmental Incident Surveillance System (SEISS), operated by HPS includes a report from SEPA of an incident in August 2010 involving a canoeist who reported symptoms (not specified) following contact with water at the James Hamilton Heritage Park Loch in East Kilbride. Cyanobacteria (*Microcystis sp*) were detected in excess of 100,000 cells per ml., but no record of measured toxin levels was reported.

3.9 Although SEPA is able to provide an analytical service and advice, it does not operate a routine cyanobacterial national monitoring system, hence objective evidence is difficult to obtain to confirm specific associations between ill health and cyanotoxin exposure. Moreover, as the record of samples analysed for cyanobacteria tends to be patchy, it is difficult to relate trends in incidents involving cyanobacterial blooms with evidence of climate change. In a recent period 2008 – 2010, between 130-181 samples were received by SEPA for analysis each year, of which between 35%-54% were reported to contain cyanobacteria at concentrations exceeding 20,000 cells/ml. A number of lochs continue to be perennial 'hot spots' containing cyanobacteria at high concentrations throughout summer and into autumn. Cyanobacteria (*Aphanizomenon flos-aquae*) were detected in excess of 100,000 cells per ml. and resulted in the closure of the Great Scottish Swim event in August 2010 in Strathclyde Loch, North Lanarkshire.

3.10 Surveillance by HPS using the Scottish Environmental Incident Surveillance System (SEISS), from 2002 to 2010 identified a total of 423 water related cyanobacterial incidents reported across Scotland, ranging from 125 in 2002 (when surveillance started) to a minimum of 14 in 2009, increasing to 48 in 2010. Reporting to SEISS is however, likely to be selective and incomplete.

3.11 Cyanobacterial blooms, mats, and scums are inherently complex (Paragraph 3.2) and assessment of the associated risks to public health is not straightforward. Such assessments should therefore take account of specialist advice (**Annex C**). Where advice is not immediately available, action of the kind described later may still be appropriate.

4. LOCAL ACTION PLANS

4.1 A “local action plan” (LAP) should be drawn up for each NHS Board area or, by arrangement, to cover more than one NHS Board area. NHS Boards should therefore take the lead in co-ordinating the provision of such a plan. LAPs should take account of existing multi-agency plans for managing waterborne hazards associated with the public water supply.

4.2 The LAP should be compiled and agreed by the principal stakeholders. These will normally include the Local Authority Environmental Health, Scottish Water, the local NHS Board and SEPA.

4.3 The LAP should include arrangements for the management of cyanobacterial blooms should be documented in a “local cyanobacteria monitoring and action plan” that includes provision for risk assessment; (i) assessing the nature and intensity of algal blooms, shoreline mats, and scums, and (ii) assessments of the risks to human and animal health, risk management options; (iii) remedial and preventative actions that might arise from these assessments and risk communication; (iv) providing information to the public.

4.4 Provisions in each of these topic areas ((i) to (iv) of paragraph 4.3) should be broadly in line with the respective guidance in Sections 5 to 8 of this document.

4.5 Special consideration should be given to provisions for susceptible groups, particularly patients undergoing home or hospital based haemodialysis (Paragraph 7.3).

4.6 The LAP should state clearly the period of time for which it applies and should include provision for updating and re-issue.

4.7 Article 8(2) of the Bathing Water Directive (2006/7/EC) requires management measures to prevent exposure and inform the public in the event of a bloom or suspected bloom at identified bathing waters. It is intended that LAPs will be used as the management measures to fulfil that requirement.

4.8 The format and content for a sample LAP is provided here as **Annex D**.

5. ASSESSING THE NATURE AND INTENSITY OF CYANOBACTERIAL BLOOMS

General provisions

5.1 Wherever possible, assessment of cyanobacterial populations should be co-ordinated by those with relevant interests. The principal aim should be to identify any need for further action. Provisions for assessments should be defined in the LAP and should include, as appropriate, procedures for visual inspection of the site, monitoring (sampling and analysis), and reporting and assessment of results.

Defining an assessment programme

5.2 The factors; physical, chemical, biological, and climatic, that lead to the development of cyanobacterial blooms in inland waters (or to the growth and detachment of algal mats) are complex. However, for each individual waterbody, the frequency, duration and magnitude of such blooms often (though by no means always) follow a predictable annual cycle.

5.3 In Scotland most blooms occur between April and October, though in some waters, blooms can occur outside this period. Therefore, where activities with a high risk of human exposure take place throughout the year, the possibility of continuing inspection and/or monitoring activities for example from November to March, should be considered. The Bathing Water Directive requires that a profile of each designated inland and coastal site bathing water shall be undertaken to include identification of those bathing waters deemed to be susceptible to cyanobacterial proliferation. The Directive also includes a particular obligation to ensure that any risks identified are properly managed during the official bathing season, which in Scotland runs annually from 1 June to 15 September. This task will be undertaken by SEPA.

5.4 The frequency, duration, and magnitude of blooms will affect the needs for inspection and monitoring. For present guidance purposes, it is therefore useful to categorise waters in accordance with these “occurrence” related factors, as shown in Table 5.1.

5.5 Column 3 of Table 5.1 gives general indications for the likely efficacy and information yield of monitoring for waters in each of the four categories. As a general rule, planned regular monitoring of cyanobacterial cell populations for waters in Categories 1 and 4 will add little to existing knowledge. Planned monitoring might be of use for waters in Categories 2 or 3 but in circumstances where monitoring at fixed time intervals is likely to miss blooms, only frequent visual inspection and monitoring is useful.

Table 5.1:

Categorisation of waters in terms of the frequency and intensity of algal blooms. Column 3 indicates the likely benefits of monitoring and inspections.

Category	Description of algal blooms	Implications for planned regular monitoring
1	Waters that consistently contain large populations of cyanobacteria for many months in every year	Not indicated. Will add little to what is already known.
2	Waters that have algal blooms for short periods in most years	Of value, depending upon use made of waterbody. However, the ability to detect short-lived blooms will depend on frequency of monitoring and some might be missed.
3	Waters that have only intermittent algal blooms in occasional year.	Of value depending upon use made of waterbody. Frequent sampling will yield many negatives and less frequent sampling might fail to detect short blooms.
4	Waters that never have algal blooms	Not indicated. All samples likely to be negative.

5.6 Decisions on the frequency of inspections and/or monitoring will also depend on other factors relating to the nature and frequency of use of the water in question. Circumstances will vary widely but the following general indications might apply:

- i. Where exposure via recreational waters (including designated bathing waters) might be predictably persistent or recurring (Categories 1 or 2), it might be appropriate to provide permanent or semi-permanent warning notices, and to carry out inspections or monitoring to determine the beginning and end of the period of the hazard.
- ii. For Category 3 recreational waters and for designated bathing waters visual inspection at intervals determined by the use of the water, with or without sampling, should be carried out.
- iii. For waters in Categories 3 or 4 where blooms have been transient and infrequent and where there is limited scope for exposure of people or animals, frequent visual inspection and sampling are unlikely to be cost-effective.

5.7 In general, therefore, monitoring and inspection requirements should be determined by local circumstances and should be defined in the LAP.

Visual inspections

5.8 Visual inspections for cyanobacteria should record the appearance and apparent concentration of cyanobacteria in the water or on shorelines. This will normally involve collection of samples of water from the furthest extent of reach from the shore using a suitable container. The presence of cyanobacteria in the samples should be assessed, as distinct from general turbidity, by their characteristic colour and possible particulate appearance. Where possible, samples from a number of points including the lee and windward shores should be assessed and recorded in this way. **Annex E** gives further guidance on recognition and identification of cyanobacterial blooms.

5.9 Visual inspections should particularly note the presence and quantity of cyanobacterial scums on the surface of the water and of stranded scums and mats on the shorelines.

Sampling and analyses

5.10 Methods of sampling and analysis should, wherever possible, follow guidelines provided by SEPA (**Annex E**).

5.11 In some circumstances, depending on the uses made of the body of water, proactive or reactive monitoring for the toxins themselves should be considered. This is also considered in **Annex E**.

5.12 In incidents involving human or animal exposure and reports of associated illness where cyanobacterial poisoning is suspected as a cause or contributing factor, sample collection and analysis for toxins should be carried out to assist identification or elimination.

5.13 SEPA can provide an analytical service to identify and quantify algal blooms (including cyanobacterial blooms) in samples taken by others from recreational waters by others, SEPA itself has specific duties regarding sampling of bathing waters. Scottish Water can also provide a similar service, including sampling of potable supplies that are thought to be at risk.

5.14 The LAP should define procedures for local assessment, recording, reporting, and storage of monitoring data. For public drinking water, Scottish Water should provide customers or users with appropriate information to minimise any health risk from exposure to cyanotoxins. For private water supplies, the owners and users would rely on the Environmental Health Department of the local council and SEPA for advice. For bathing waters, SEPA or the beach owner/operator should provide bathers with appropriate information to minimise the health risk from exposure to the toxins.

5.15 Results from investigations should also ideally be reported, along with details of the incident, to HPS via the electronic surveillance system, SEISS. Given predictions regarding the potential increase in cyanobacterial incidents associated with climate change, an improved capacity to monitor trends in incidents will become increasingly important. The completeness of incident-reporting via SEISS could be improved however. As SEISS is the only multi-agency reporting system covering Scotland, ideally incidents associated with water bodies should be reported and should use the risk categorisation criteria set out in Table 6.1 (high, medium, low) to improve the quality and usefulness of the data. Improved reporting would enable improved tracking of trends and would help in assessing if predictions on climate change impacts are accurate.

6. ASSESSMENTS OF THE RISKS TO HUMAN AND ANIMAL HEALTH

Responsibilities for risk assessments

6.1 Assessments of the risks to human and animal health from cyanobacterial blooms are likely to be made for different purposes – and with different degrees of formality – by different “stakeholders” including:

- owners and employers, including Scottish Water; for their duties in law to employees, customers and to other members of the public;
- regulatory bodies; LAs, for the assessment of risk to public health, and SEPA, for determination of sources of pollutants, their impact and regulation and their duty under the Bathing Water Directive;
- individuals; for their interests as employees or parents, or in connection with their recreational interests.

6.2 The roles and responsibilities of these and other stakeholders are outlined in Section 9.

6.3 The responsibility for risk assessments by the owners of waters and by employers relates to their responsibilities to protect employees and others under the Health and Safety at Work etc Act 1974. (<http://www.legislation.gov.uk/ukpga/1974/37>) and related legislation, and, for Scottish Water, their customers.

6.4 Risk assessments by LAs and SEPA are likely to be directed in part to determining inspection and monitoring priorities and schedules (Section 5). The interest of local authorities is primarily in determining the existence, or otherwise, in their areas of nuisances or hazards to health, and this should include the risks associate with private water supplies. That of SEPA is primarily in determining the state of the environment and in the regulation and control of sources of pollutants, or in its duty under the Bathing Water Directive. A shared approach should be possible on specific waters where these interests require similar information.

Types of risk assessment

6.5 Risk assessments in respect of cyanobacterial hazards in inland and inshore Scottish waters can be considered under three general headings: (i) generic assessments of the risk for the whole of each of the areas covered by the LAPs, (ii) pro-active assessments for individual waters, similar to and including those required under the Bathing Water Directive and (iii) reactive assessments in response to identified occurrence or consequences of cyanobacterial blooms.

6.6 Each LAP should include an overall assessment of cyanobacterial problems for the whole of the NHS Board area. This should provide a general summary of cyanobacterial problems for the area and identify the waters that present the greatest risks because of their history of algal blooms and/or their use.

6.7 Proactive individual assessments for all inland and inshore waters would be neither practical nor cost effective. These should normally be confined to those waters identified in the LAP as presenting the greatest risks. However, the responsibilities identified in

Paragraph 6.1 and Section 9 (for example, those for employers) are not affected by any classification of waters in the LAP.

6.8 Stakeholders receiving reports on occurrences or consequences of algal blooms for waters relating to their interests should consider the need for a reactive risk assessment. This should aim to identify the magnitude and nature of the risks and define any interventions that might be required to lessen these risks.

Content of risk assessments for individual waters

6.9 Proactive risk assessments should include consideration of inspection and monitoring programmes and the need for appropriate action (such as erection of signs). They should take account, in structured ways, of information relating to any previous algal blooms (Table 5.1) and to the nature and intensity of use for the water in question.

6.10 Subsequent interventions would normally depend on the results of inspections and/or monitoring or the outcomes of any reactive risk assessments.

6.11 Reactive risk assessments (made in reaction to reports from the public of the appearance or consequence of algal blooms, suspected health incidents, or to inspections or monitoring) should consider how the water in question is used (for example as a source for drinking water) and the resultant risk to human and animal health (not the probability of occurrence of a bloom).

6.12 For either proactive or reactive risk assessments, therefore, assignment of waters to high, medium and low risk categories according to their use can help to prioritise the needs for inspection and/or monitoring and action. Table 6.1 gives outline descriptions of the features of waters falling into each of these categories.

6.13 A reactive risk assessment should define clearly the need for, and nature and comparative merits of any interventions to mitigate the risks identified and for further inspection and/or monitoring.

Table 6.1: Categories of risk related to the use of waters (and hence the probability and extent of exposure)

Risk category	Nature and intensity of use
High	Waters that are either consumed by people or animals or used for activities involving immersion or appreciable skin contact.
Medium	Waters for which the risk of ingestion of cyanobacterial material or of cyanotoxins is small and appreciable skin contact with blooms is unlikely. Standing Waters that are used for spray irrigation of crops.
Low	Waters that are inaccessible or not used, or are used only for angling, or other non-contact activities.

Defining categories for frequency of occurrence or risks for cyanobacterial blooms

6.14 It is essential that different views about criteria for the assignment of waters to each of the categories defined in Tables 5.1 and 6.1 are discussed by bodies seeking co-operative action on monitoring.

Templates for risk assessments

6.15 Examples of templates for proactive and reactive risk assessments are provided in **Annex F**. Stakeholders might prefer to use their own formats but, if so, the information contained in the risk assessment should be at least that indicated in **Annex F**.

Specific considerations for public drinking water supplies

6.16 There are a number of Scottish public water supply reservoirs where problems associated with cyanobacterial growth recur. At these, the water treatment systems in place have been designed to cope, or the water authority is able to use an alternative water source. Should circumstances arise where neither of these provisions applies, appropriate alternative measures would be put in place to ensure the safety of the water supply. If an incident occurred where there was an actual or potential risk of contaminated water entering a supply, the provisions of the multi-agency *Scottish Waterborne Hazard Plan (SWHP)* should be used to coordinate a public health response and ensure that the local NHS Board and local authorities are involved in the health risk assessment and decisions on safeguarding public health

6.17 Scottish Water is required to comply with the Security and Emergency Measures (Scottish Water) (Scotland). Direction 2002 (SEMD). This requires it, amongst other things, to have emergency plans in place to cover such eventualities as loss of water supply (Paragraph 3.8) and to have routine liaison meetings about emergency issues with LAs and Health Boards. These emergency plans are subject to an annual audit and certification by an independent consultant approved by the Scottish Government. An audit report is submitted to the Scottish Government by 31st March each year.

6.18 Consultation with Scottish Water in the production of LAPs for management of cyanobacteria should ensure that these are compatible with any emergency plans drawn up under the SEMD, and should also be consistent with the provisions of the SWHP.

6.19 About 3 % of the population of Scotland are on a private water supply. However, it is very unlikely that any of these will be affected by cyanobacteria due to the nature of the source waters for those supplies. Most (99%) of private water supplies come from wells or springs or running surface water (small burns etc.) which should not be affected, and only about 1% are sourced from lochs which possibly could be affected by cyanobacteria. Local authorities are responsible for monitoring the quality of private water supplies, and they should include cyanobacteria in their monitoring provisions if they consider it to be a risk.

7. RISK MANAGEMENT AND RISK COMMUNICATION

General requirements

7.1 Actions intended to reduce the probability of acute or delayed effects of cyanotoxins on people or animals are directed at reducing the probability of:

- i. skin contact with or ingestion of algae in, or on the shore of inland waters;
- ii. ingestion of drinking water containing algae or cyanotoxins, and exposure to such water during bathing and showering;
- iii. exposure to toxins by eating fish or shellfish from algae-rich waters; and
- iv. delivery of contaminated water to patients undergoing haemodialysis.

7.2 Of these, 7.1(i) is the most likely. Acute effects from ingestion of publicly supplied drinking water containing cyanotoxins are considered unlikely in Scotland due to the effects of volume dilution and also the removal and degradation of the toxins during normal water treatment processes. Scottish Water will take appropriate action to ensure the safety of supplies where cyanobacterial blooms are identified. The risk of longer-term exposure to cyanotoxins from contaminated private supplies can be reduced by practical measures discussed later in this section or, if necessary, by substitution of an alternative supply or bottled water. Action may however also be required to provide substitute supplies in situations where taste or odour problems render drinking water unacceptable, even in the absence of risk from toxins.

7.3 Particular attention should also be paid to the health risks for patients undergoing haemodialysis. In normal circumstances, cyanotoxins are effectively excluded by the reverse osmosis units that are used to treat the water supply to dialysis units in Scotland. However, the possible consequences of exposure to cyanotoxins (and indeed to other pollutants) due to system failure should be addressed. Local NHS Boards should ensure appropriate resilience for this threat.

7.4 It is prudent to consider possible health concerns about ingestion of cyanotoxins in affected foods. This includes consideration of: (i) whether fish from heavily affected waters should be eaten, (ii) the possibility of accumulation of microcystins on or in plants irrigated with water from sources containing cyanobacterial blooms and their toxins, and (iii) the potential for accumulation of the toxins on the external surfaces of edible plant material, for example, on salad plants.

7.5 Any proposed restrictions on the use of water because of the presence of a cyanobacterial bloom should be based on a careful assessment of the resulting benefits and detriments. This assessment should, among other matters, take account of the circumstances of use and of the relevant guidance documents for drinking water and for recreational waters referred to in Paragraphs 7.6, 7.7, and 7.8, as well as the requirements of the Bathing Water Directive 2006/7/EC.

Triggers for action

7.6 *The WHO (2011) Guidelines for Drinking Water Quality. Fourth Edition. (WHO, Geneva, Switzerland, ISBN: 978 92 4 154815 1)*

http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/index.html define a provisional value of 1µg/l of microcystin-LR (one of the commonly found cyanobacterial hepatotoxins, in drinking water) for drinking water that is intended for lifelong consumption.

7.7 In addition to the WHO lifetime exposure guideline value, short term exposure values for toxins have been proposed by the UK Water Industry Research's Water Research Centre (UKWIR/WRc) for several toxins. These 'Suggested No Adverse Response Levels' (SNARLs)* have been included in the HPS document "*Short-Term Health Risk Action Values for Drinking-Water in Scotland (SHRAVS)*"

(<http://www.documents.hps.scot.nhs.uk/environmental/general/shravs-v6.0-2011-11.pdf>).

These may be of assistance in assessing the risk of acute adverse effects (as opposed to chronic effects) from contaminated drinking water supplies.

Cyanotoxins - UKWIR/WRc SNARL levels

Toxin	Units	24 hour	7 day	Health Effects
Anatoxin-a	µg/L	1.0		Neurotoxin. Neuromuscular blocker and nicotinic agonist. Causes respiratory muscle paralysis and asphyxiation.
Cylindrospermopsin	µg/L	9.0	4.5	Hepatotoxin and genotoxin.
Microcystin-LR	µg/L	12.0	6.0	Hepatotoxin; microcystin-LR is one of the most toxic of the microcystin.

* These SNARLs values are included with permission from UKWIR/WRc. Before using them as a basis for a specific risk assessment it would be prudent to check with HPS or with Scottish Water whether these have been updated.

7.8 The equivalent WHO guidance document for recreational water is the 2003 Guidelines for safe recreational-water environments. Volume 1: Coastal and fresh-waters.

WHO Geneva, Switzerland. ISBN 92 4 154580 1

(http://www.who.int/water_sanitation_health/bathing/srwe1/en/).

7.9 The 2003 WHO guidelines for recreational waters state that "Health impairments from cyanobacteria in recreational waters must be differentiated between chiefly irritative symptoms caused by unknown cyanobacterial substances and the potentially more serious hazard of exposure to high concentrations of known cyanotoxins, particularly microcystins. A single guideline value therefore is not appropriate." For recreational waters, therefore, the document recommends "a series of guideline values associated with incremental severity and probability of health effects" and these values are then defined for low, moderate or high probabilities of adverse health effects.

7.10 A copy of the relevant section from this WHO document [Section 8.7 Guideline Values] is appended here as **Annex G**. The guidance levels recommended by the WHO are

summarised in Column 1 of Table 7.1. However, the advice given in Column 2 of Table 7.1 differs from that in the WHO Guidance document (**Annex G**) by recommending that, as an additional precaution, all four of the “typical actions” defined by the WHO for 100,000 cells cyanobacteria/ml be adopted at the lower level of 20,000 cells cyanobacteria/ml. (It should be noted here that the general equivalence implied in the final row of Table 7.1 between cell numbers and chlorophyll-a concentration (1µg chlorophyll-a per 2,000 algal cells) actually depends on cell type. Also, for some types, such as filamentous cyanobacteria, individual cells are not easily identified or counted. These issues are considered in more detail in **Annex E**)

Table 7.1: Guidance levels and related "typical actions" derived from current WHO guidance

Guidance level or situation	Typical Actions
Cyanobacterial scum formation in bathing areas	<ol style="list-style-type: none"> 1. Immediate action to control contact with scums; possible prohibition of swimming and other water-contact activities 2. Public health follow-up investigation 3. Inform public and relevant authorities
20,000 cells cyanobacteria/ml or 10 µg chlorophyll-a/ l with dominance of cyanobacteria	<ol style="list-style-type: none"> 1. Watch for scums or conditions conducive to scums 2. Discourage bathing and further investigate hazard 3. Post on-site risk advisory signs 4. Inform relevant authorities

Specific actions in response to a cyanobacterial bloom

- 7.11** Column 2 of Table 7.1 summarises the "typical actions" that should be taken to protect people who might come into contact with recreational waters affected at the extent indicated in Column 1. The WHO guidance also notes that "actual action taken should be determined in light of extent of use and public health assessment of hazard". Section 4 of this document refers to the need for LAPs to make provisions for such public health (risk) assessments and Section 6 gives general requirements.
- 7.12** Actions defined in Table 7.1 relate mainly to the provision of information and advice and to discouraging or prohibiting water-contact activities. Responsibility for these actions will vary according to ownership and use of the waters in question and these responsibilities should be defined in LAPs and in pro-active risk assessments (**Annex F**).
- 7.13** Information and advice might be provided by leaflets, warning notices, letters to stakeholders or public announcements (for example on local radio and by local press notices). Leaflets can provide more information to water-users than is possible in a warning notice and might be particularly appropriate (in addition to warning notices) in circumstances where there is extensive recreational use of a waterbody. More detailed consideration of public information provisions is given in Section 8.
- 7.14** In addition to advice aimed at minimising public health risks, advice should also be given to dog-owners to protect dogs and other pets from ingestion of cyanobacterial material in the water or on the shoreline. Similar advice should be given to farmers to protect livestock.
- 7.15** A suggested text for a warning notice is given in **Annex H**.

Fish and Shellfish

- 7.16** LAPs and proactive risk assessments should also consider the need for advice to avoid eating freshwater shellfish.
- 7.17** Fish should not be consumed if fish mortalities, or behavioral abnormalities, are observed at waterbodies containing mass populations of cyanobacteria. In the event of cyanobacterial scum being present, or cyanobacterial cell numbers exceeding 20,000 per ml (**Annex G**), toxin analysis of fish intended for consumption should be carried out. Should toxins be detected by analysis, expert advice will be necessary on whether concentrations are sufficient to justify restrictions on the consumption of fish. The absence of taint and odour does not indicate the absence of cyanotoxins since there is no correlation between the production of compounds affecting taste and odour and the production of toxins by cyanobacteria. The liver and gut from fish caught in waters affected by cyanobacteria should not be fed to pets.

Crop Irrigation

- 7.18** LAPs and proactive risk assessments should consider the use of standing waters for irrigation of crops. While there is evidence of the possibility of accumulation of microcystins and other cyanotoxins by aquatic and terrestrial plants, there is no convincing evidence of related health effects from human consumption. A more significant source of concern is where sprayed irrigation water becomes trapped in the centres of, for example, salad plants or where cyanobacterial cells and cyanotoxins are deposited on plant surfaces when sprayed water dries. Spray irrigation using water from sources containing cyanobacterial blooms and toxins also presents potential health hazards for workers or bystanders who might be exposed to cyanotoxins by skin contact or by inhalation of spray drift. Occupational exposure is subject to the provisions for risk assessment arising from the Management of Health and Safety at Work Regulation 1999 (<http://www.opsi.gov.uk/si/si1999/19993242.htm>) but general advice from the WHO is that exposure of workers, bystanders and animals to spray irrigation water containing cyanotoxins should be avoided. Advice should be given on precautions that are appropriate to local circumstances.

Drinking water supplies and recreational water bodies

- 7.19** Where water is used for potable supply, toxin analysis should be planned and carried out as appropriate as an aid to risk management.
- 7.20** Guidance levels for recreational waters are defined in terms of concentrations of the algae themselves rather than the toxins. However, cyanotoxin analysis for recreational waters should be considered, depending on individual circumstances, in conjunction with advice from relevant sources (**Annex C**). Where a bloom is highly localized or confined to one area, the risks of exposure to significant quantities of cyanotoxin are likely to be low except where there is immersion in or ingestion of water in close proximity to the bloom itself.
- 7.21** Pre-emptive action should also be considered if, from knowledge of the water and recent weather, the probability of bloom scum or mat formation is judged to be high.

Action to reduce the development of cyanobacterial blooms

- 7.22** In waterbodies where persistently high cyanobacterial concentrations occur or regular blooms develop (Categories 1 and 2 in Table 5.1), and where the attendant risk is categorised as "High" (Table 6.1) the source(s) of the problem should be established, and where possible, appropriate action taken. These measures should be enacted in consultation with SEPA and Scottish Water where a public water supply is affected. In the unlikely event that a private water supply is affected, these measures should be enacted in consultation with SEPA and the relevant local authority.

Control of Nutrients

- 7.23** Algal blooms, including cyanobacterial blooms, can result from a combination of natural factors, including availability of nutrients and light, water temperature and wind conditions and can be increased due to human impacts e.g. excessive nutrient input to waterbodies or reduced water flow. Availability of nutrients is a principal concern, as they are essential for plant and algal growth and cyanobacterial blooms have generally become more widespread and intense due to raised nutrient levels in the environment. Typical nutrient sources from human activity in Scotland include discharges from sewage works, industry, and agriculture.

- 7.24** Information on reducing nutrient enrichment of surface waters from agricultural sources can be found in "*Prevention of Environmental Pollution from Agricultural Activity Code of Good Practice (2005)*" which is available from the Scottish Government (<http://www.scotland.gov.uk/Publications/2005/03/20613/51366>). Methods for preventing nutrient losses from urban areas are included in the *Sustainable Urban Drainage Systems* (http://www.sepa.org.uk/water/water_publications/suds.aspx).

Further information and guidance can also be found in the 2003 WHO Guidance document for recreational waters. It is likely that SEPA will take account of such matters under the EC Water Framework Directive. (<http://www.sepa.org.uk/wfd/>). SEPA is developing ecological classification systems based on the condition of biological communities, including cyanobacteria, to help assess the ecological quality of surface waters in response to environmental pressures. Furthermore, SEPA regulates activities including abstraction, impoundment and engineering activities, as well as pollution, under the Water Environment (Controlled Activities) Regulations 2011 (<http://www.legislation.gov.uk/ssi/2011/209/contents/made>).

Control of Blooms

- 7.25** Reducing nutrient inputs from the catchment is part of the long-term strategy to reduce the development of algal blooms, but additional measures may be effective in reducing these events in the short-term. These measures include the use of barley straw, biomanipulation, increased flushing, forced circulation, and chemical control.

Barley straw – This method involves the use of (small) bales or nets of barley straw submerged at the inlet to the waterbody and at other suitable locations. However, it is variably effective and then usually only in small water bodies. Further details are available at:

http://www.ceh.ac.uk/sci_programmes/documents/BarleyStrawtocontrolalgae.pdf

Biomanipulation - This aim here is to make the aquatic ecosystem less conducive to the establishment and persistence of algal blooms. Approaches include interventions aimed at increasing the populations of zooplankton (which feed on algae) and of aquatic macrophytes (rooted or floating water plants) which compete with algae for light and nutrients. The first of these might involve manipulation of the fish community to reduce the rate of zooplankton predation by fish. Macrophytes, e.g. reeds, can be used in constructed wetlands which can act as filter-beds to reduce nutrient concentrations before water enters a lake. The second approach can involve active planting of native water plants, such as water lilies, in the loch.

Increased flushing – If the regulation of water entering or leaving the water body is controlled, it may be possible to optimise flushing to reduce nutrient concentrations and algal blooms. Blue green algae generally do not develop large populations where the loch is flushed through in less than 30 days.

Forced circulation - Water circulation can be forced by a wind- or electrically-driven turbine within the water body, or by sparging with compressed air. This ensures that the water body is evenly mixed to avoid stratification, and this helps to reduce internal release of phosphorus from the bottom sediments of the waterbody under anaerobic conditions. It also forces the algal cells to spend an increasing proportion of the day away from sunlight, reducing their population growth.

Chemical control methods - Precipitating agents have been used to encourage binding of phosphorus to sediments (reduce internal release); their application is not, however, recommended without expert guidance. Certain algaecides and herbicides have indicative approval for use on or near waters in the UK. However, the proposed use of any control chemicals on or near waters in Scotland must be notified to SEPA for approval where appropriate.

Further information on catchment management, biomanipulation and other control methods can be obtained from the Centre for Ecology & Hydrology (**Annex C**).

Waste Disposal

7.26 In exceptional circumstances, cyanobacterial scums and mats may have to be removed and disposed of. Disposal of waste that has certain hazardous properties ('Hazardous waste' as defined by Article 1(4) of the Hazardous Waste Directive (91/689/EEC)

(<http://eur->

[lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML](http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML))

will have to comply with the requirements of the Hazardous/Special Waste Regulations. Further details and information is available from SEPA

(http://www.sepa.org.uk/waste/waste_regulation/special_waste.aspx)

Public Health Follow-up

- 7.27** Table 7.1 also raises the possibility of "Public health follow-up investigation". This would be a matter for the local Director of Public Health but Section 9 of this Guidance gives some general indications. Where any follow-up investigations are conducted it would be helpful to have the findings reported to HPS via the SEISS surveillance system to which NHS Boards have electronic access.
- 7.28** The long-term adverse effects of cyanotoxins are not fully understood. In cases of exposure only to skin, long-term follow-up is probably not indicated. If toxic bloom or scum or cyanobacterial mat material have been ingested, medical or veterinary monitoring might be needed for adverse health effects and further advice should be sought (**Annex C**).

8. COMMUNICATION STRATEGY

8.1 Provision of public information on the local risks from cyanobacterial blooms - both directly (using, for example, leaflets) and through the news media is seen as important and is a requirement where affected waters are used for bathing and other water-contact activities.

8.2 Responsibility for the provision of information is likely to lie primarily with the owners of waters, employers and others similarly placed. However, local authorities, Scottish Water, SEPA and NHS Boards should consider when, by whom, and with what content, information which comes to their attention on cyanobacterial blooms should be given to:

- waterbody owners
- other official bodies
- those engaged in healthcare - in particular, those providing haemodialysis services, General Practitioners and Veterinary Surgeons
- those with identifiable interests - for example, those receiving haemodialysis, farmers, members of canoe and angling clubs and recreational authorities
- the news media
- the public

8.3 Active provision of information to the news media is considered in **Annex I**.

8.4 While local authorities, Scottish Water, SEPA and NHS Boards will have differing lead responsibilities (for example, NHS Boards in the assessment of and response to enquiries from the public on hazards to human health), stakeholders should seek agreement on the content of press releases, and on the information used by staff when responding to enquiries from the public.

9. CYANOBACTERIAL INCIDENT INVESTIGATION

9.1 While the protection of people and of animals must remain the first objective of a response to a cyanobacterial bloom, investigation and recording of adverse effects, should be carried out wherever possible.

9.2 In cases involving animals, particularly where deaths of livestock, wildlife and pets are thought to be associated with the ingestion of cyanobacteria, it is important that an investigation is carried out. The owner should be referred to his or her veterinary surgeon who will decide whether to submit carcasses and samples to the local Veterinary Centre of the Scottish Agricultural College Veterinary Science Division (SACVSD) for post-mortem examination and further testing. The SAC Veterinary Centre will report findings to the submitting veterinary surgeon and, in the case of positive results, to the relevant Environmental Health Department.

9.3 It would be helpful to SACVSD if Environmental Health Departments could inform the Inverness Centre (Annex C) of incidents involving animals, whether or not carcasses and samples of algae, including cyanobacteria, are available.

9.4 Where people or animals are thought to have been affected by cyanobacteria, samples of cyanobacterial material and, if appropriate, clinical samples (e.g. stomach or rumen contents, liver) should be taken. Advice on sampling is available (**Annex C**).

9.5 HPS should be informed of any algal incidents involving suspected or confirmed illness associated with exposure to cyanobacterial blooms or their toxins. Such incidents should also be reported via the Scottish Environmental Incident Surveillance System (SEISS) to ensure comprehensive surveillance of the health impact of such episodes.

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ANNEX A

MEMBERSHIP OF THE WORKING GROUP

Member	Affiliation
Dr C N Ramsay (Chairman)	Health Protection Scotland
Dr A M Johnston (Secretary)	SGHSCD
Prof D N Bateman	NPIS Edinburgh (formerly the Scottish Poisons Information Bureau)
Dr L Carvalho	Centre for Ecology & Hydrology
Dr J Krokowski	Scottish Environment Protection Agency
Dr Kasia Kazimierczak	Food Standards Agency in Scotland
Dr F Romanes	Consultant in Public Health Medicine, NHS Tayside
Mr Francis Brewis	SG Environmental Quality Division
Professor G A Codd	University of Stirling

ANNEX B

CYANOTOXINS

Neurotoxins are produced by several species of cyanobacteria, including species of *Anabaena*, *Aphanizomenon* and *Oscillatoria*. Several *Anabaena* neurotoxins exist, the most common of which (the alkaloid anatoxin-a) causes depolarisation block at neuromuscular junctions. Another *Anabaena* neurotoxin (anatoxin-a(s)) is a naturally-occurring organophosphate product which inhibits acetylcholinesterase. *Aphanizomenon* toxins have been identified as alkaloids (saxitoxins) of the same group as those responsible for paralytic shellfish poisoning. Signs of poisoning in animals that have ingested cyanobacterial neurotoxins have included paralysis, cyanosis, respiratory arrest, muscular tremor, hypersalivation, staggering and convulsions. Further neurotoxins (non-protein amino acids) are currently under investigation in cyanobacteria.

Hepatotoxins produced by several cyanobacteria, including species of *Anabaena*, *Microcystis*, *Oscillatoria*, *Nostoc*, *Nodularia*, *Gloeotrichia*, *Coelosphaerium* and *Gomphosphaeria*, have been identified as cyclic peptides. The hepatotoxins (microcystins) include over 90 variants; typically, several are present in a single hepatotoxic bloom. Signs of poisoning in animals have included weakness, vomiting, cold extremities, piloerection, diarrhoea, heavy breathing and death due to circulatory failure and respiratory arrest within 2 to 24 hours. Microcystins have also been associated with atypical pneumonia and are potent tumour promoters in laboratory animals. Nodularin, another hepatotoxic tumour-promoter, is also a carcinogen. All cyanobacteria also produce lipopolysaccharides (LPSs) as normal components for their outer layers. The chemical composition of LPS varies between strains of individual cyanobacterial species. LPS may have contributed to skin irritation observed in swimmers in contact with cyanobacterial blooms in the UK and to gastrointestinal disorders associated with blooms in several countries.

For sources of advice on toxicity see **Annex C**.

ANNEX C

SOURCES OF SPECIALIST ADVICE

SOURCE OF ADVICE	ADVICE ON OR ASSISTANCE IN
<p>The Centre for Ecology and Hydrology Bush Estate Penicuik Midlothian EH26 OQB Tel: 0131 445 4343 Fax: 0131 445 3943 Email: laca@ceh.ac.uk</p>	<p>Ecology and control of cyanobacteria</p>
<p>Scottish Environment Protection Agency (SEPA)</p> <p>East Region: Clearwater House Heriot-Watt Research Park Avenue North Riccarton Edinburgh EH14 4AP Tel: 0131 449 7296</p> <p>North Region: Greyhope House Greyhope Road Aberdeen AB11 9RD Tel: 01224 248338</p> <p>South West Region: 5 Redwood Crescent East Kilbride G74 5PP Tel: 01355 574200</p> <p>Email: jan.krokowski@sepa.org.uk</p>	<p>Advice and assistance in analysis of samples from recreational waters. Identification and quantification of algal including cyanobacterial cells. Determination of sources of pollution, their regulation and control.</p>
<p>University of Stirling Biological and Environmental Sciences School of Natural Sciences Stirling FK9 4LA Tel: 01382 360053 Email: g.a.codd@stir.ac.uk</p>	<p>Identification and quantification of algal including cyanobacterial cells; cyanotoxin analysis and toxicity assessment; cyanobacterial bloom control.</p>
<p>The National Poisons Information Service (Edinburgh) Royal Infirmary of Edinburgh Edinburgh. EH10 4SA Tel: 0131 242 1383 (Office hours) Tel: 0870 6006266 (NPIS 24 hour telephone information line)</p>	<p>Treatment of acute effects. Advice on possible long term effects.</p>

<p>Email: spib@luht.scot.nhs.uk Toxbase on line at http://www.TOXBASE.org</p>	
<p>Health Protection Scotland Meridian Court 5 Cadogan Street Glasgow G2 6QE Tel: 0141 300 1100 (office hours and out of hours messaging system) Email: NSS.HPSenquiries@nhs.net</p>	<p>Action to protect people and animals.</p>
<p>The Scottish Agricultural College Veterinary Science Division Veterinary Centre Drummondhill Stratherrick Road Inverness. IV2 4JZ Tel: 01463 243030 Fax: 01463 711103 Email: VCIverness@sac.co.uk</p>	<p>Investigation of health effects on animals.</p>
<p>Water Research Centre Frankland Road Blagrove Swindon Wilts SN5 8YF Tel: 01793 865000 Fax: 01793 865001 Email: solutions@wrcplc.co.uk</p>	<p>Assessment of drinking water quality.</p>
<p><i>The Health and Safety Executive</i> Info-Line Tel: 08701 545500 Email: hseinformationservices@natbrit.com</p>	<p>Advice on employers' duties.</p>

ANNEX D

SUGGESTED FRAMEWORK FOR A LOCAL ACTION PLAN (LAP)

Blue-green algae (cyanobacteria) monitoring and action plan for xxxx NHS Board area

Sections

- 1 Area and time period covered**
- 2 Waterbodies prone to algal blooms, scum, or mat formation**
 - List of susceptible waterbodies
 - Risk assessments
- 3 Planned monitoring of selected waters**
 - Criteria for selection of sampling sites
 - Sites selected for pro-active monitoring
 - Sampling methods
 - Sampling arrangements
 - Sampling schedule
 - Analysis
 - Blue-green algae threshold levels for action
 - Reporting arrangements
- 4 Control measures to be taken**
 - Pro-active action
 - Re-active action
 - Blue-green algae in public drinking water supplies
 - Blue-green algae in private drinking water supplies
- 5 Arrangements for providing information**
 - Informing the public
 - Informing owners of water bodies
 - Dealing with the media
 - Giving the all-clear

Tables

- Table 1:** Blue-green algae monitoring schedule for the time period covered

ANNEX E

RECOGNITION AND IDENTIFICATION OF CYANOBACTERIAL BLOOMS, SCUMS AND MATS AND METHODS FOR SAMPLING

Recognition

Scottish waters can support numerous different species of algae which can "bloom", either as individual species or in combination, when suitable ecological conditions occur. Some ("planktonic") species exist as single cells or colonies or chains of cells suspended in the water, whereas other ("benthic") species may grow on the sediment along the shallow margins of waterbodies and occasionally form thick, slimy attached or detached mats.

When blooms of planktonic cyanobacteria occur, it is often possible to see colonies of algal cells in the water column with the naked eye. These may resemble fine grass cuttings or take the form of small irregular clumps or pinhead-sized spheres. These colonies can concentrate on a downwind shore and sometimes accumulate to such an extent as to form a "scum" which is a thick (often many centimetres) layer of cyanobacteria. They may also be seen in rivers or streams downstream of lochs.

When the cyanobacterial cells start to die and break up, the toxins which they may contain are released into the surrounding water. Cell pigments are also released resulting in a scum resembling turquoise emulsion paint spilt along the shore. It is important to note that not all cyanobacteria are blue-green. They can range from black through dark brown to khaki, green to blue, and dark red. Decaying cyanobacteria can appear sky-blue, grey, and white.

There are only a few other types of algae (e.g. harmless *Euglena*, *Botryococcus*) that will occasionally form scums which can be confused with cyanobacterial scums. Growths of some aquatic macrophytes, particularly duckweed (*Lemna*), and filamentous algae are also commonly mistaken for cyanobacterial scum by inexperienced observers.

Benthic cyanobacteria can be found in both standing and running waters. The algal mats (biofilms) that these occasionally form can become a problem if the water level drops and exposes the mat, or in some cases, they may detach from the bed, rise to the surface and may then be washed up on the shore. These detached mats are often very different in appearance to planktonic forms. They are usually very dark in colour (black, dark brown or dark green). They are much more cohesive in nature than planktonic scums and can be mistaken for sewage or cow dung. For example, a planktonic scum will flow into a bottle as a liquid whereas benthic scum will be lumpy and often have to be scooped into a bottle or jar.

Sampling equipment

Cyanobacteria can be sampled easily and cheaply using simple equipment comprising:

- Sample bottles of suitable size e.g. 1 litre plastic bottle for planktonic forms; vials or jars minimum size 30 ml for benthic forms
- Plastic bucket tied to a rope (optional)
- Field data sheets or notebook

- Self-adhesive labels or waterproof marker
- Preservative (Lugol's iodine) if available can be added to a second sample bottle, which may be necessary only if it is likely that the samples will not be analysed within 24-48 hours. However, Lugol's iodine should not be added to samples if these are required for toxin analysis, since it rapidly destroys the toxins
- Picnic-style insulated hamper box with chiller packs, to keep samples cool if transportation delays are expected

Sampling health and safety

Cyanobacteria may produce toxins hazardous to human health. Care should be taken to avoid ingesting or coming into direct skin contact with cyanobacterial scum and mat material. Wear wellington boots and suitable waterproof gloves and thoroughly wash hands before eating or drinking.

Lugol's iodine is a skin irritant and is harmful if ingested in quantity. Eye protection and suitable rubber gloves must be worn when handling this chemical. The preservative should be added in a well-ventilated environment.

Normal health and safety precautions should be taken for working in or near water (with specific regard to information, instruction and training, avoidance of working alone, ensuring communications in case of emergency, wearing a life jacket and suitable clothing).

Sampling procedure

Samples are normally collected from a point on the downwind shore of a waterbody where the concentration of cyanobacteria is greatest. This may not be obvious to the naked eye, in which case any suitable site on the downwind shore can be selected. Bear in mind that cyanobacteria will often collect in sheltered bays and inlets. If the downwind shore is inaccessible, then the waterbody should be sampled at the nearest accessible point to the downwind shore and this should be noted on the field data sheet or in a notebook.

In large lochs or inshore waters it is usually impractical to examine the whole downwind shore, in which case one or more samples should be taken at selected points.

Planktonic cyanobacteria or benthic scums are sampled at or just below the water surface, preferable by taking a sample with a bucket and transferring the cyanobacteria or scum sample into a pre-labelled bottle, or by directly immersing a pre-labelled bottle and filling it completely. Occasionally it may be difficult to reach open water, for example, because of dense emergent vegetation. In such cases a bucket on a rope may be a useful aid. Benthic cyanobacteria which might be attached to sediment or stones or have become detached may need to be scooped into a wide-mouthed jar. If water levels have fallen, scums and mats may be stranded on the shoreline and scooped or scraped directly into a container.

The following information should be recorded on the sample bottle label:

- Name of waterbody
- Waterbody code (from <http://www.uklakes.net/>), available for the larger waterbodies only
- Sample identifier (site name or number)

- National grid reference of sampling site
- Date and time of sampling.
- Name or initials and contact details (telephone or email) of sampler

Additional information useful to the analyst should be recorded on a field data sheet or in a notebook or communicated via email or telephone. This should include:

- Sampling location. For waterbodies which are sampled regularly, it may be more convenient to include an outline map on the field sheet so that the position of the sampling site can be marked on
- The presence and extent of any cyanobacterial scum or mats. For small easily surveyed waterbodies an estimate of percentage cover of the water surface or shoreline could be made or the position of any scum or mat could be drawn on an outline map
- The presence of any visible cyanobacterial growths in the water column
- The direction and strength of the wind

Sample handling

Samples should be kept in cool, dark conditions, e.g. in an insulated picnic style hamper box, containing chiller packs, and transported to the laboratory as quickly as possible. If this cannot be achieved within 24 hours then aliquots of the samples should be preserved for microscopy by adding Lugol's iodine solution (note previous Health and Safety instructions). Sufficient should be added to turn the sample a dark straw colour.

Samples for toxin analysis should be stored in a cool box after collection and transferred to a refrigerator at about 4°C, but not frozen, if analysis is possible within 48 hours. If not possible within this period, samples for toxin analysis should be deep-frozen.

Sample analyses

Where appropriate capability exists, samples can be analysed locally. Alternatively, (as indicated in Section 5) various organisations including SEPA and Scottish Water can provide an analytical service to identify and quantify algal blooms in samples taken by others.

Standard operating procedures are used to quantify the type of cyanobacteria present, and cyanobacterial abundance is compared against WHO guidance levels. The identification of dominant cyanobacteria will be to genus level as a minimum requirement and to species level wherever possible.

Toxicity assessment and toxin analysis (see **Annex C**) testing may be carried out as a further aid to the management of algal blooms or scum on waterbodies with high recreational amenity value or on waterbodies used to supply potable water.

Further information

Further information and advice can be obtained from Ecology staff at SEPA Regional and Area offices. Contact details are given here in **Annex C**.

ANNEX F

SUGGESTED TEMPLATES FOR RISK ASSESSMENTS

Proactive assessment of the risk to public health of high concentrations of blue-green algae.

Name of water: High Loch

Map reference: X10 Y10

Owner: The Local Authority (Leased to Hightown Angling Association)

Occurrence

Typical pattern of frequency and occurrence of algal blooms:

Typically one algal bloom occurs most (but not all) years usually in late August or September. The intensity varies greatly but the typical duration would be less than two weeks.

Occurrence category: 2

Usage

How is the waterbody used?

Neither the loch nor any of its incoming or outgoing streams is used as a source of public or private drinking water. There is a path around the loch that is used by anglers and walkers (often with dogs). Cattle drink from the loch and its associated streams. The local canoe club uses the loch about three times each year always in summer.

Risk category: Medium to high

Monitoring and control of risks.

Blooms tend to be short-term and are likely to be missed by a planned monitoring programme. No planned inspection or monitoring programme will be undertaken. The local angling association (AA) and the canoe club have both been advised of the risks and provided with leaflets. They have undertaken to advise the local authority of the appearance blooms. A reactive risk assessment will then consider the need for reactive inspection and/or monitoring. Warning signs are kept in the AA hut and will be placed by the AA at pre-defined locations when a bloom appears. Further interventions will be considered in the reactive risk assessment.

Signed John Smith **Date** 01/01/01

Print name JOHN SMITH. SENIOR EHO

**Reactive assessment of the risk to public health
of high concentrations of blue-green algae.**

Name of water: High Loch **Map reference:** X10 Y10

Owner: Hightown Angling Association

Usage.

How is the waterbody used?

Neither the loch nor any of its incoming or outgoing streams is used as a source of public or private drinking water. There is a path around the loch that is used by anglers and walkers (often with dogs). Cattle drink from the loch and its associated streams. The local canoe club uses the loch about three times each year always in summer.

Risk category: Medium to high

Recognition

How and when was the bloom detected and reported?

The local authority was informed of the appearance of a bloom by Mr J Jones of the Hightown Angling Association by telephone on 26/8/02.

Health effects

Have any animal or human health effects been reported? ~~Yes~~/No

If yes please specify.

Actions

What actions have been taken to date?

Warning signs have been placed by the local Angling Association at pre-defined locations. The regional EHO has inspected the loch and has sent water samples to SEPA for analysis. The local farmer has been advised to move cattle from an adjacent field which provides access to water from the loch, until further notice. The canoe club has been informed.

What further actions are planned?

A further inspection will be carried out on 7/9/02.

Signed John Smith **Date** 29/08/02

Print name JOHN SMITH. SENIOR EHO.

ANNEX G

EXTRACT ON EXPOSURE GUIDELINES FROM THE WHO DOCUMENT

Guidelines for Safe Recreational-water Environments 2003 Vol. 1: Coastal and Fresh-waters October 1998

8.7 Guideline values

As discussed above, approaches to recreational water safety should address the occurrence of cyanobacteria as such, because it is as yet unclear whether all important cyanotoxins have been identified, and the health outcomes observed after recreational exposure—particularly irritation of the skin and mucous membranes—are probably related to cyanobacterial substances other than the well known toxins listed in Table 8.1. Additionally, the particular hazard of liver damage by microcystins should be considered. In face of the difficulty of representative quantitative sampling due to the heterogeneous distribution of cyanobacteria in time and space, particularly with respect to scum formation and scum location, approaches should further include addressing the capacity of a water body to sustain large cyanobacterial populations. Health impairments from cyanobacteria in recreational waters must be differentiated between the chiefly irritative symptoms caused by unknown cyanobacterial substances and the potentially more severe hazard of exposure to high concentrations of known cyanotoxins, particularly microcystins. A single guideline value therefore is not appropriate. Rather, a series of guideline values associated with incremental severity and probability of health effects is defined at three levels (Table 8.3).

8.7.1 Relatively low probability of adverse health effects

For protection from health outcomes not due to cyanotoxin toxicity, but rather to the irritative or allergenic effects of other cyanobacterial compounds, a guideline level of 20,000 cyanobacterial cells/ml (corresponding to 10µg chlorophyll-a/litre under conditions of cyanobacterial dominance) can be derived from the prospective epidemiological study by Pilotto et al. (1997). Whereas the health outcomes reported in this study were related to cyanobacterial density and duration of exposure, they affected less than 30% of the individuals exposed. At this cyanobacterial density, 2– 4µg microcystin/litre may be expected if microcystin-producing cyanobacteria are dominant, with 10µg/litre being possible with highly toxic blooms. This level is close to the WHO provisional drinking-water guideline value of 1µg/litre for microcystin- LR (now [WHO, 2011](#)), which is intended to be safe for lifelong consumption. Thus, health outcomes due to microcystin are unlikely, and providing information for visitors to swimming areas with this low-level risk is considered to be sufficient. Additionally, it is recommended that the authorities be informed in order to initiate further surveillance of the site. The results of the epidemiological study (Pilotto et al., 1997) reported some mild irritative effects at 5,000 cells but the level of health effect and the small number of people affected were not considered to be a basis to justify action.

8.7.2 Moderate probability of adverse health effects

At higher concentrations of cyanobacterial cells, the probability of irritative symptoms is elevated. Additionally, cyanotoxins (usually cell-bound) may reach concentrations with potential health impact. To assess risk under these circumstances, the data used for the drinking-water provisional guideline value for microcystin-LR may be applied. Swimmers

involuntarily swallow some water while swimming, and the harm from ingestion of recreational water will be comparable to the harm from ingestion of water from a drinking-water supply with the same toxin content. For recreational water users with whole-body contact (see chapter 1), a swimmer can expect to ingest 100–200 ml of water in one session, sailboard riders and waterskiers probably more.

A level of 100,000 cyanobacterial cells/ml (which is equivalent to approximately 50µg chlorophyll-a/litre if cyanobacteria dominate) represents a guideline value for a moderate health alert in recreational waters. At this level, a concentration of 20µg microcystin/litre is likely if the bloom consists of *Microcystis* and has an average toxin content of 0.2 pg/cell, or 0.4µg microcystin/µg chlorophyll-a. Levels may be approximately double if *Planktothrix agardhii* dominates. With very high cellular microcystin content, 50–100µg microcystin/litre would be possible.

The level of 20µg microcystin/litre is equivalent to 20 times the WHO provisional guideline value concentration for microcystin-LR in drinking-water (WHO, 1998) and would result in consumption of an amount close to the tolerable daily intake (TDI) for a 60-kg adult consuming 100 ml of water while swimming (rather than 2 litres of drinking-water). However, a 15-kg child consuming 250 ml of water during extensive playing could be exposed to 10 times the TDI. The health risk will be increased if the person exposed is particularly susceptible because of, for example, chronic hepatitis B. Therefore, cyanobacterial levels likely to cause microcystin concentrations of 20µg/litre should trigger further action.

TABLE 8.3. GUIDELINES FOR SAFE PRACTICE IN MANAGING RECREATIONAL WATERS^a

Guidance level or situation	How guidance level derived	Health risks	Typical actions ^b
Relatively low probability of adverse health effects			
20,000 cyanobacterial cells/ml or 10µg chlorophyll-a/litre with dominance of cyanobacteria	<ul style="list-style-type: none"> From human bathing epidemiological study 	<ul style="list-style-type: none"> Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness 	<ul style="list-style-type: none"> Post on-site risk advisory signs Inform relevant authorities
Moderate probability of adverse health effects			
100,000 cyanobacterial cells/ml or 50µg chlorophyll-a/litre with dominance of cyanobacteria	<ul style="list-style-type: none"> From provisional drinking-water guideline value for microcystin-LR^c and data concerning other cyanotoxins 	<ul style="list-style-type: none"> Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness 	<ul style="list-style-type: none"> Watch for scums or conditions conducive to scums Discourage swimming and further investigate hazard Post on-site risk advisory signs Inform relevant authorities
High probability of adverse health effects			
Cyanobacterial scum formation in areas where whole-body contact and/or risk of ingestion/aspiration occur	<ul style="list-style-type: none"> Inference from oral animal lethal poisoning Actual human illness occur histories. 	<ul style="list-style-type: none"> Potential for acute poisoning Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes, e.g., skin irritations, gastrointestinal illness 	<ul style="list-style-type: none"> Immediate action to control contact with scums; possible prohibition of swimming and other water contact activities. Public health follow-up investigation. Inform public and relevant authorities

^a Derived from Chorus & Bartram, 1999.

^b Actual action taken should be determined in light of extent of use and public health assessment of hazard.

^c The provisional drinking-water guideline value for microcystin-LR is 1µg/litre (WHO, 1998).

Non-scum-forming species of cyanobacteria such as *Planktothrix agardhii* have been observed to reach cell densities corresponding to 250µg chlorophyll-a/litre or even more in shallow water bodies. Transparency in such situations will be less than 0.5 m measured with a Secchi disc. *Planktothrix agardhii* has been shown to contain very high cell levels of microcystin (1–2µg microcystin/µg chlorophyll-a), and therefore toxin concentrations of 200–400µg/litre can occur without scum formation.

An additional reason for increased alert at 100,000 cells/ml is the potential for some frequently occurring cyanobacterial species (particularly *Microcystis* spp. and *Anabaena* spp.) to form scums. These scums may increase local cell density and thus toxin concentration by a factor of 1,000 or more in a few hours, thus rapidly changing the risk from moderate to high for bathers and others involved in body-contact water sports. Cyanobacterial scum formation presents a unique problem for routine monitoring at the usual time intervals (e.g., 1 or 2 weeks) because such monitoring intervals are unlikely to pick up hazardous maximum levels. Because of the potential for rapid scum formation at a cyanobacterial density of 100,000 cells/ml or 50µg chlorophyll-a/litre (from scum-forming cyanobacterial taxa), intensification of surveillance and protective measures are appropriate at these levels. Daily inspection for scum formation (if scum-forming taxa are present) and measures to prevent exposures in areas prone to scum formation are the two principal actions important in these situations.

Intervention is recommended to trigger effective public information campaigns to educate people on avoidance of scum contact. Furthermore, in some cases (e.g., areas with frequent scum formation), restriction of water contact activities may be judged to be appropriate. An intensified monitoring programme should be implemented, particularly looking for scum accumulations. Health authorities should be notified immediately.

8.7.3 High probability of adverse health effects

Abundant evidence exists for potentially severe health outcomes associated with scums caused by toxic cyanobacteria. No human fatalities have been unequivocally associated with cyanotoxin ingestion during recreational water activities, although numerous animals have been killed by consuming water with cyanobacterial scum material. This discrepancy can be explained by the fact that animals will drink greater volumes of scum-containing water in relation to their body weight, whereas accidental ingestion of scums by humans during swimming will typically result in a lower dose.

Cyanobacterial scums can represent thousand-fold to million-fold concentrations of cyanobacterial cell populations. Calculations suggest that a child playing in *Microcystis* scums for a protracted period and ingesting a significant volume could receive a lethal dose, although no reports indicate that this has occurred. Based on evidence that a lethal oral dose of microcystin-LR in mice is 5,000–11,600µg/kg body weight and sensitivity between individuals may vary approximately 10-fold, the ingestion of 5–50 mg of microcystin could be expected to cause acute liver injury in a 10-kg child. Concentrations of up to 24 µg microcystin/litre from scum material have been published (Chorus & Fastner, 2001). Substantially higher enrichment of scums—up to gelatinous consistency—is occasionally observed, of which accidental ingestion of smaller volumes could cause serious harm. Anecdotal evidence indicates that children, and even adults, may be attracted to play in scums. The presence of scums caused by cyanobacteria is thus a readily detected indicator of a risk of potentially severe adverse health effects for those who come into contact with the scums. Immediate action to control scum contact is recommended for such situations.

8.7.4 Conclusions

The approach outlined in this section does not cover all conceivable situations. Swimmers may be in contact with benthic cyanobacteria after a storm breaks off clumps of filaments or cyanobacterial mats naturally detach from the sediment and are accumulated on shorelines (Edwards et al., 1992). Measures of cyanobacterial cell density will not detect these hazards. Instead, this cyanotoxin hazard calls for critical and well informed observation of swimming areas, coupled with a flexible response.

It is difficult to define “safe” concentrations of cyanobacteria in recreational water for allergenic effects or skin reactions, as individual sensitivities vary greatly. Aggravation of dermal reactions due to accumulation of cyanobacterial material and enhanced disruption of cells under bathing suits and wet suits may be a problem even at densities below the guideline levels described above.

ANNEX H

SUGGESTED TEXT FOR WARNING NOTICES

TEMPORARY/PERMANENT*
WARNING NOTICE

BLUE-GREEN ALGAL BLOOMS

HIGH CONCENTRATIONS OF BLUE-GREEN ALGAE HAVE BEEN FOUND IN THIS WATER.

SWALLOWING THE WATER OR ALGAL SCUM OR SHORELINE MATS CAN CAUSE STOMACH UPSETS OR MORE SERIOUS HEALTH EFFECTS.

CONTACT WITH THE WATER OR WITH ALGAL SCUM CAN CAUSE SKIN PROBLEMS.

IT IS A SENSIBLE PRECAUTION FOR YOU, YOUR CHILDREN AND YOUR ANIMALS TO AVOID CONTACT WITH THE SCUM, ALGAL MATS AND THE WATER CLOSE BY.

NOTICE POSTED ON: <DATE>

EFFECTIVE UNTIL **: <DATE>

**NOTICE POSTED BY: <NAME OF ORGANISATION>
<ADDRESS>**

**FOR FURTHER INFORMATION
TELEPHONE**

** AS APPROPRIATE*

*** FOR TEMPORARY NOTICES ONLY*

ANNEX I

MEDIA BRIEFING NOTES

I1 Algal Bloom Initial Release on Discovery

<Day,Month,Year>

<Time>

For Immediate Release

BLUE-GREEN ALGAE

Recent samples taken at <name of waterbody> have indicated the presence of blue-green algae. As a precautionary measure, notices have been posted next to the waterbody, warning that contact with the algal scum or mat material should be avoided. [If a bathing water: – *Information, including on-site notices, have been provided to the public that bathing is inadvisable at this time.*]

Adjoining landowners and fishing interests have been advised of the situation as have the Environmental Health Department of <Council>, <the SEPA office> and <NHS Board>.

At this stage there is no adverse effect on water supplies.

Media Briefing Note:

- Blue-green algae (cyanobacteria) exist in fresh waters in Great Britain and throughout the world; they are noticed when their concentrations increase to form “blooms” and when they form scums – looking like blue-green paint – or when they collect on the shore line as scums or mats.
- Some blue-green algae may give rise to adverse medical effects - but not always. Effects on people coming into contact with toxic scums include skin rashes, eye irritations, vomiting and diarrhoea, fever and pains in muscles and joints. Toxic algae have caused deaths of livestock and dogs, waterbirds and fish. The treatment of water supplies removes blue-green algae and additional treatment may be applied to destroy or remove toxins should they arise. The actions currently taken are precautionary.
- The behaviour of algae is erratic.
- The level of its toxicity can fluctuate; it can appear one day, be dispersed by the wind and mixing and re-accumulate at any time.

Ends

Press Contact: Corporate Communications, tel :<<number>>

I2 Algal Bloom if Toxicity has been established

<Day,Month,Year>

<Time>

For Immediate Release

BLUE-GREEN ALGAE

Further tests carried out by <agency> have shown that the blue-green algal bloom at <name of water body> has become active. <<The reservoir is not being used for water supply. Alternative sources are being used>> // <<Additional treatment methods have been employed at <treatment works> to ensure our customers are not affected.>> Daily monitoring of the supply is being carried out.

<Council> Environmental Health Department and <NHS Board> have been advised. Adjoining landowners have also been advised, and fishing and boating has been stopped as a precautionary measure. Members of the public have been advised to stay away from the reservoir.

Media Briefing Note:

- Blue-green algae (cyanobacteria) exist in fresh waters in Great Britain and throughout the world; they are noticed when their concentrations increase to form “blooms” and when they form scums – looking like blue-green paint – or when they collect on the shore line.
- Some blue-green algae may give rise to adverse medical effects - but not always. Effects on people coming into contact with toxic scums include skin rashes, eye irritations, vomiting and diarrhoea, fever and pains in muscles and joints. Toxic algae have caused deaths of livestock and dogs. The treatment of water supplies removes blue-green algae and additional treatment may be applied to destroy or remove toxins should they arise. The actions currently taken are precautionary.
- The behaviour of algae is erratic.
- The level of its toxicity can fluctuate; it can appear one day, be dispersed by the wind and mixing and re-accumulate at any time.

Ends

Press Contact: Corporate Communications, tel :<<number>>

ANNEX J

REGULATORY ENFORCEMENT – ROLES AND RESPONSIBILITIES

1. Responsibilities for enforcement measures in respect of cyanobacteria in inland and inshore waters fall into four general areas. These are, (i) minimising the incidence or severity of algal blooms by control of aquatic eutrophication or treatment of affected waters, (ii) minimising the scope for direct contact with affected waters for people (workers and the general public) and animals, (iii) control of cyanotoxins in drinking water and (iv) control of algal toxins in food.

2. Enforcement provisions are further complicated by the large number of "stakeholders" involved. Table 9.1 therefore gives a general overview of their roles and responsibilities in this connection.

Table J.1: A general overview of the interests and responsibilities of various stakeholders relevant to enforcement of provisions for mitigating the risk of health effects due to cyanobacteria in inland waters.

Stakeholder	Interests and responsibilities
Water owners	<p>Owners have a general duty to be vigilant to any factors relating to their property that might reasonably be considered to present a risk to members of the public or to animals. A need for particular vigilance often applies in the case of children. Owners must also take reasonable actions to inform and protect those who might be at risk. In these connections, decisions of what was "reasonable" would ultimately be a matter for the courts.</p> <p>The owner of the land on which a private drinking water source is located is responsible for controlling any activities on their land that might affect the supply to the extent that cyanobacterial mass growths might be such as to breach the quality standards.</p>
Members of the public	<p>Members of the public are responsible for taking reasonable action to protect themselves, their children, and their animals.</p> <p>Common law provides that persons may not recklessly or wilfully bring harm on themselves and then seek compensation from others. However, the extent to which they had done so would ultimately be a matter for the courts.</p>
Health Protection Scotland (HPS)	<p>HPS is the principal focus in Scotland, within the NHS, for advice on issues relating to health risks associated with infectious diseases and environmental hazards, including water contamination related incidents. HPS carries out surveillance of algal, including cyanobacterial, incidents, which have affected or have the potential to affect human health, using the Scottish Environmental Incident Surveillance System (SEISS), an on-line electronic reporting system for SEPA, Local Authorities, and NHS Boards. Data on incidents are available via a password protected</p>

Stakeholder	Interests and responsibilities
	site to registered users, and annual reports are provided via the HPS weekly report and web-site.
National Poisons Information Service (NPIS)	The principal source in Scotland for information on toxicology and clinical management for hazardous substances. NPIS manages TOXBASE, a database that provides information on toxicology and treatment for poisons (including cyanotoxins) to registered users.
NHS Boards	NHS Boards in Scotland are accountable to the Scottish Government Health Directorates for the overall assessment of health needs of all people within their geographic areas, for arranging for those needs to be met and for providing public health advice to the public. They are also responsible for provision of medical advice to Scottish Water and (via the Health Board Competent Person (HBCP) to the local authorities. The local NHS Board should take the lead in co-ordinating the development of a LAP for its area.
Health and Safety Executive	The HSE is responsible for enforcement of relevant "employers" legislation.
Employers	<p>Employers must comply with the general and specific provisions of the following legislation in respect of their employees and any members of the public that might be affected by their business:</p> <p>The Health and Safety at Work etc Act 1974. (http://www.legislation.gov.uk/ukpga/1974/37) The Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended) . (http://www.legislation.gov.uk/uksi/2002/2677/contents/made) The Management of Health and Safety at Work (MHSWR) Regulations 1999 (http://www.opsi.gov.uk/si/si1999/19993242.htm)</p> <p>Specific provisions of the MHSWR include the need for risk assessments and these should include any risks associated with exposure to cyanobacteria or their toxins. Employers must then provide information, instruction, and training in respect of these risks and their mitigation, in order to ensure safe systems of work.</p>
Scottish Government Enterprise and Environment Directorates (SGEED)	<p>SGEED has overall responsibility for the regulatory framework for the water industry in Scotland and through the office of the Drinking Water Quality Regulator (DWQR) is responsible for ensuring compliance by the Scottish Water with specified drinking water quality standards.</p> <p>SGEED also oversee other legislation relevant to cyanobacteria in Scottish waters including :</p>

Stakeholder	Interests and responsibilities
	<p>The Bathing Water (Classification) (Scotland) Regulations 2008 (http://www.legislation.gov.uk/ssi/2008/170/contents/made)</p> <p>The Surface Water (Fishlife) (Classification) (Scotland) Regulations 1997 (http://www.legislation.gov.uk/uksi/1997/2471/contents/made)</p> <p>The Surface Water (Abstraction for Drinking Water) (Classification) (Scotland) Regulations 1996 (Currently being reviewed) (http://www.legislation.gov.uk/uksi/1996/3047/contents/made)</p> <p>The Sludge (Use In Agriculture) Regulations 1989 (as amended). (http://www.legislation.gov.uk/uksi/1989/1263/contents/made)</p> <p>The Water Quality (Scotland) Regulations 2010. (http://www.legislation.gov.uk/ssi/2010/95/contents/made)</p>
<p>Drinking Water Quality Regulator for Scotland (DWQR)</p>	<p>DWQR is responsible for ensuring compliance by Scottish Water with specified drinking water quality standards.</p> <p>DWQR therefore ensures compliance with the Water Supply (Water Quality) (Scotland) Regulations 2001 (as amended). (http://www.legislation.gov.uk/ssi/2001/207/introduction/made)</p>
<p>Local Authorities (LAs), (mainly through Environmental Health Officers)</p>	<p>The general powers and responsibilities for Scottish Local authorities are defined in the Local Government (Scotland) Act 1973 (http://www.legislation.gov.uk/ukpga/1973/65/enacted). The general functions of LAs in relation to water quality are defined in Section 76F(1) of the Water (Scotland) Act 1980.</p> <p>The Private Water Supplies (Scotland) Regulations 2006 (http://www.legislation.gov.uk/ssi/2006/209/contents/made) define standards of wholesomeness in respect of water from private supplies for drinking, washing, or cooking or for food production purposes. <u>The 2006 Regulations distinguish between supplies serving less than 50 persons that have no commercial activity associated with them (Type B supplies) and all other supplies (Type A supplies).</u> LAs are the regulators and have powers and responsibilities for classification and monitoring of waters and for enforcement of the relevant provisions. <u>Pollutants and blue green algae, to be monitored under these regulations are not specified precisely.</u></p> <p>However, Section 76G(1) of the Water (Scotland) Act 1980 (http://www.legislation.gov.uk/ukpga/1980/45/contents) provides that where a local authority considers that a private supply is likely not to be wholesome; <u>"the local authority shall, in the case of a private supply which is a Type A supply or may, in the case of a private supply which is a Type B supply serve a notice in relation to that supply on one or more of the relevant persons".</u></p> <p>LAs also have general powers and responsibilities under the Local Government (Scotland) Act 1973 and the Public Health etc.</p>

Stakeholder	Interests and responsibilities
	<p>(Scotland) Act 2008 http://www.legislation.gov.uk/asp/2008/5/contents) for the protection of the local population from environmental hazards such as cyanotoxins in recreational waters.</p> <p>LAs should co-operate with others in the development and implementation of the LAP</p>
Scottish Water	<p>Scottish Water is responsible for the cleanliness and safety of public water supplies for homes and businesses throughout Scotland. Duties are defined by the provisions of:</p> <p>The Water (Scotland) Act 1980 (as amended) The Water Industry (Scotland) Act 2002 http://www.legislation.gov.uk/asp/2002/3/contents) The Water Environment and Water Services (Scotland) Act 2003 http://www.legislation.gov.uk/asp/2003/3/contents) The Water Services etc. (Scotland) Act 2005 http://www.legislation.gov.uk/asp/2005/3/contents) The Water Supply (Water Quality) (Scotland) Regulations 2001 The Water Quality (Scotland) Regulations 2010</p> <p>Enforcement provisions include surveillance and analysis for the presence of potentially hazardous substances including cyanotoxins in the water that they supply.</p> <p>Scottish Water should co-operate with others in the development and implementation of the LAP</p>
SEPA	<p>SEPA is responsible for ensuring compliance with environmental legislation, in particular:</p> <p>The Control of Pollution Act 1974 http://www.legislation.gov.uk/ukpga/1974/40) The Environmental Protection Act 1990 http://www.legislation.gov.uk/ukpga/1990/43/contents) The Environment Act 1995 http://www.legislation.gov.uk/ukpga/1995/25/contents) The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (SSI 2011/209) http://www.legislation.gov.uk/ssi/2011/209/contents/made) The Bathing Water (Classification) (Scotland) Regulations 2008. (as amended).</p> <p>SEPA will co-operate with others in the development and implementation of the LAP.</p>
The Food	The FSA was established under the Food Standards Act 1999

Stakeholder	Interests and responsibilities
Standards Agency in Scotland (FSAS)	<p data-bbox="454 246 1420 358">(http://www.legislation.gov.uk/ukpga/1999/28/contents) as an independent food safety watchdog to protect the public's health and consumer interests in relation to food.</p> <p data-bbox="454 392 1420 582">The FSA's principal interest in cyanobacteria is therefore any effect that they might have on the human food chain or on food processing. The FSA is not responsible for drinking water as supplied by a public or private water supply, but is responsible for bottled waters.</p> <p data-bbox="454 616 1420 806">To fulfil the Community obligations as Competent Authority the Agency designates, monitors and controls production areas for live bivalve molluscs. The main concern in Scotland is biotoxins in marine shellfish in relation to which the FSA has powers and responsibilities under Regulation (EC) 854/2004.</p> <p data-bbox="454 840 1420 1209">Under Regulation (EC) 854/2004 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004R0854:en:NOT) FSA operates an official control monitoring programme to monitor for biotoxins in live bivalve molluscs from classified shellfish production areas, and for the presence of toxin-producing plankton in these areas. When toxins for Amnesic Shellfish Poisoning (ASP), Paralytic Shellfish Poisoning (PSP) or lipophilic toxins including Diarrheic Shellfish Poisoning (DSP) toxins are found to exceed the maximum permitted levels a Temporary Closure Notice (TCN) is made to close a classified area.</p> <p data-bbox="454 1243 1420 1467">Wild King Scallops (Pectinidae) harvested outside classified areas in Scotland are also monitored for the presence of biotoxins. Where regulatory levels are exceeded for wild Pectinidae placed on the market they must be withdrawn and where appropriate the issuing of a Food Alert, and RASSF (Rapid Alert System Food and Feed) will be undertaken.</p> <p data-bbox="454 1500 1420 1915">In addition, shellfish processors and their products must comply with all the statutory requirements in Regulation (EC) No 853/2004 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0055:0205:EN:PDF) which lays down the hygiene requirements for the production and placing on the market of live bivalve molluscs. The EC regulations are enabled by the Food Hygiene (Scotland) Regulations 2006 (as amended) (http://www.legislation.gov.uk/ssi/2006/3/contents/made). If necessary, similar provisions could be made in respect of shellfish or fin-fish harvested from freshwaters in Scotland</p>



**The Scottish
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