Public Health England

Protecting and improving the nation's health

UK Recovery Handbook for Biological Incidents 2015

Version 1

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. It does this through world-class science, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. PHE is an operationally autonomous executive agency of the Department of Health.

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UK Recovery Handbook for Biological Incidents 2015

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Executive Summary

The UK Recovery Handbook for Biological Incidents has been written to support the functions of Public Health England (PHE), which are "to protect the community (or any part of the community) against infectious diseases and other dangers to health"*. PHE provides support to, and works in partnership with, others who have health protection responsibilities, through its role in reducing the dangers to health from infections and chemical and radiation hazards. PHE also advises all government departments and devolved administrations in the UK through the Department of Health.

This handbook provides a framework for identifying an effective recovery strategy following a biological incident, as well as a compendium of practical, evidence-based recovery options to assist with the remediation of environmental biological contamination. The handbook is designed to support decision makers in developing a recovery strategy for food production systems, inhabited areas and water environments following a biological incident or outbreak of infection causing extensive environmental contamination.

The response to a major biological incident in the UK would involve numerous government departments and agencies, public services and other bodies. Each of these will have their own emergency plans, which cover the detail of their specific areas of responsibility. Expert advice on particular biological agent(s) will be needed from the outset. The response is likely to be complex, and decision making on recovery and remediation will need to take into account a variety of factors. This handbook provides guidance on how to manage the many facets of recovery from a biological incident or outbreak of infection and is designed to augment existing detailed emergency plans held by individual organisations. Sources of biological contamination considered in the handbook include natural contamination, and accidental or deliberate release.

The handbook is aimed at national and local authorities, central government departments and agencies, environmental and health protection experts, emergency services, industry and others who may be affected by, or involved in, the remediation of the environment following a biological incident.

The handbook can be used as a preparatory tool, under non-crisis conditions, to engage stakeholders and to develop local and regional plans. It can also be applied as part of the decision-aiding process to develop a recovery strategy following an incident. In addition, the handbook is useful for training purposes and during emergency exercises. It draws on the model of the UK Recovery Handbook for Chemical Incidents (version 1, 2012) and the UK Recovery Handbook for Radiation Incidents (version 4, 2015).

It is envisaged that the UK Recovery Handbook for Biological Incidents will facilitate access to expert opinion and scientific advice for decision makers by presenting this information in an easy-to-use decision-aiding framework format, and will also enable to decisions made during the recovery process to be documented. The handbook will be openly available and it is expected it will be used widely for training and preparedness activities.

* Health Protection Agency Act, 2004: on 1 April 2013 the Health Protection Agency was abolished and its functions transferred to Public Health England.

Acknowledgements

Government partners steering group

Department for Environment, Food and Rural Affairs

Department of Health, Social Services and Public Safety (Northern Ireland)

Food Standards Agency

Home Office

Scottish Government

Contributing agencies

Animal and Plant Health Agency

Centre for the Protection of National Infrastructure

Chartered Institute of Environmental Health

Defence Science and Technology Laboratory

Department for Transport

Department of Health

Drinking Water Inspectorate

Food, Environment and Research Agency

Government Decontamination Service

Health and Safety Laboratory

Northern Ireland Public Health Agency

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Acronyms

Stakeholders

Defra	Department for Environment, Food and Rural Affairs
DHSSPS	Department of Health, Social Services and Public Safety (Northern Ireland)
FSA	Food Standards Agency
HO	Home Office
PHA	HSC Public Health Agency
PHE	Public Health England

Governmental

ACDP	Advisory Committee on Dangerous Pathogens
APHA	Animal and Plant Health Agency (formerly the Animal Health and Veterinary Laboratories Agency)
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
COBR	Cabinet Office Briefing Room
CPNL	Centre for the Protection of National Infrastructure
DCLG	Department for Communities and Local Government
DE	Department for Education
DH	Department of Health
DT	Department for Transport
DWI	Drinking Water Inspectorate
EA	Environment Agency
FERA	Food, Environment and Research Agency
GDS	Government Decontamination Service
HSE	Health and Safety Executive
LA	Local authority
NHS	National Health Service
NIEA	Northern Ireland Environment Agency
PHSI	Plant Health and Seeds Inspectorate
SEPA	Scottish Environment Protection Agency

Legislation

ABP	Animal by-product
ALARP	As low as reasonably practicable
COSHH	Control of Substances Hazardous to Health Regulations 2002
EU	European Union
FEPA	Food and Environment Protection Act 1985

HSWA	Health and Safety at Work etc Act 1974
IATA	International Air Transport Association
WFD	EU Waste Framework Directive 2008

Other

CDC	US Centers for Disease Control and Prevention
DND	Do not drink
DNU	Do not use
FAC	Free available chlorine
GAP	Good agricultural practice
GP	General practitioner
HAZMAT	Hazardous materials
HEPA	High efficiency particulate air
HVAC	Heating, ventilation and air conditioning
NVZ	Nitrate vulnerable zones
PLAN	Proportional, legal, accountable and necessary
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PPE	Personal protective equipment
QAC	Quaternary ammonium compounds
RA	Risk assessment
RCG	Recovery coordination group
RPE	Respiratory protective equipment
STEC	Shiga toxin producing *Escherichia coli*
SOP	Standard operating procedure
SSSI	Site of special scientific interest
UK	United Kingdom
US	United States
US EPA	US Environmental Protection Agency
VHF	Viral haemorrhagic fever
VTEC	Vero cytotoxin-producing *Escherichia coli*
WEL	Workplace exposure limit
WHO	World Health Organization

Contents

1 General Introduction

The UK Recovery Handbook for Biological Incidents has been developed using the tools and methodologies of the UK Recovery Handbook for Radiation Incidents[1] and the UK Recovery Handbook for Chemical Incidents[2], and forms part of Public Health England (PHE) guidance to help and support users to develop effective recovery strategies both in planning for and following a biological incident or outbreak of infection. The handbook also contains a compendium of practical, evidence-based recovery options for the remediation of contaminated environments.

The handbook is designed to support decision makers in developing a recovery strategy following a biological incident or outbreak of infection in three areas: food production systems, inhabited areas and water environments, and is a compilation of information to help users identify issues associated with the implementation of various remediation techniques. The handbook is designed to support users in the evaluation of available recovery options and facilitate the selection of the most appropriate and effective actions or recovery options when planning for or implementing a remediation strategy.

The handbook should be used as part of a participatory process, involving members of the recovery coordination group (RCG) and other stakeholders to develop a recovery strategy. The RCG, which will usually be led by a top-tier local authority, will form part of the multiagency response arrangements for a major biological incident or outbreak of infection. A key role of the RCG is to identify options for clean-up and waste disposal, including making recommendations on those considered to be the best or most appropriate.

1.1 Structure

Chapter 1: General Introduction

Chapter 2: Factors Influencing Recovery

Chapter 3: Planning for Recovery in Advance of an Incident

Chapter 4: Food Production Systems

Chapter 5: Food Production Systems Recovery Options

Chapter 6: Inhabited Areas

Chapter 7: Inhabited Areas Recovery Options

Chapter 8: Water Environments

Chapter 9: Water Environments Recovery Options

Chapter 10: Worked Examples

These chapters can be linked together as shown in Figure 1.1.

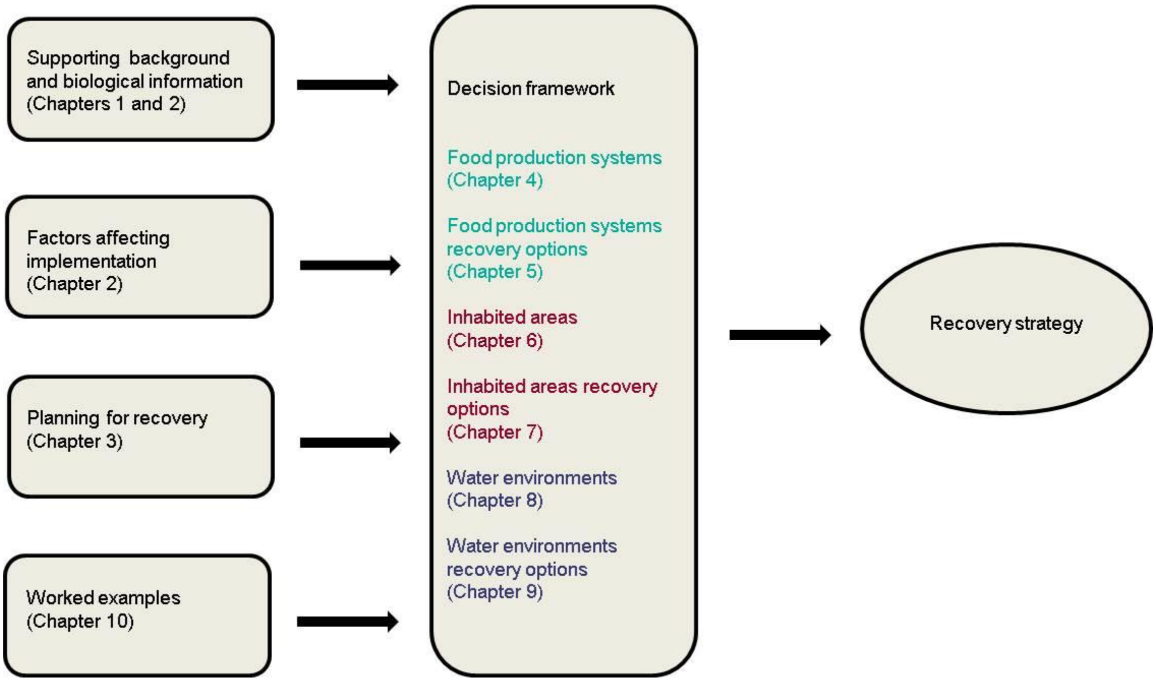

Figure 1.1: Structure of the UK Recovery Handbook for Biological Incidents and how the sections can link together to form a recovery strategy

1.2 Objectives

The handbook has been developed as a reference guide, to meet several interrelated objectives:

- to provide up-to-date information on recovery options for reducing the consequences of contamination of food production systems, inhabited areas and water environments
- to outline the many factors that influence the implementation of recovery options
- to provide guidance on recovery planning preceding an incident
- to illustrate how to select and combine recovery options and hence build a recovery strategy specific to the biological incident or outbreak of infection being managed

The handbook also has a series of secondary aims:

- to generate awareness of biological recovery planning among emergency planners and those who might deal with the aftermath of a biological incident or outbreak of infection
- to promote constructive dialogue between all stakeholders concerned with biological recovery and remediation
- to identify, under non-crisis conditions, specific problems that could arise, including setting up working groups to find practical solutions
- to elaborate plans and/or frameworks for the recovery of contaminated environments at local, regional and national levels

1.3 Audience

The handbook is specifically targeted at:

- central government departments, agencies and inspectorates
- emergency planners
- experts in health protection and environmental protection
- enforcement bodies (local authorities and public health agencies)
- health authorities
- emergency response personnel (police, ambulance and fire and rescue services)
- water companies and distributors
- representatives from the agricultural and food production sectors
- other stakeholders, including members of the public who may be affected or concerned, depending on the situation

1.4 Applications

The handbook should be considered as a reference document, containing a compendium of practical, evidence-based guidance and information for the recovery and remediation of environments that have been contaminated with biological agents. It has been developed to provide the user with a broad overview of distilled knowledge gathered from an extensive literature review. The handbook has been written with the assistance of experts from both stakeholder and PHE steering groups, and input from the attendees at the workshops for each environment. Some of the most likely uses for the handbook are:

- in the recovery phase by national and local government bodies as part of the decision-making process, eg recovery coordination group (RCG)
- in the preparation and planning phase for the response to biological incidents or outbreaks of infection by national and local government bodies
- for training purposes and contingency planning
- for guidance and instruction during emergency exercises

1.5 Context

Experience from previous biological incidents in the UK and throughout the world (eg the US ‘Amerithrax’ incident in 2001[3]) has shown that there is a need for a comprehensive guidance document to support remediation and restoration of normality following an incident.

There are a number of remediation options currently available for dealing with biological contamination. These processes can vary in length of duration, cost and applicability and may cause disruption to the public and services. A comprehensive decision-aiding framework for recovery and remediation would be a beneficial tool allowing for the comparison of available recovery options and the selection of the most appropriate option for the incident in question. This will help to reduce the length of duration, cost of remediation and amount of disruption, while helping to improve communications between all parties involved and restore normality as quickly as is possible.

For example, in 2006 and 2008 there were two fatal cases of anthrax linked to the production, movement and playing of contaminated instrumental drums. Environmental investigations identified four properties that were contaminated with the causative agent of anthrax, *Bacillus anthracis*. Three different recovery options were chosen for the four properties and, although all three options were effective in removing the contamination, the range of outcomes in terms of cost, length of process and social impact varied greatly. The first recovery option used, for a public space, had a relatively high cost and extended duration, but the third recovery option used for a private dwelling could be implemented over a shorter time period and was relatively inexpensive[4,5]. While different in a number of ways, all three options were effective in the removal of *B. anthracis* contamination.

1.6 Legislation

This document has been produced by Public Health England (PHE). The handbook, and the information it contains, is intended for guidance only. Other issues may arise in the course of dealing with particular circumstances of individual incidents, and the handbook should not be treated as a substitute for obtaining appropriate expert guidance in these areas, including legal advice. Comments made on technology, techniques and legislation are based on information available at the time of publishing. They cannot be used as endorsement by PHE of technology and techniques or as a replacement for appropriate legal advice. Applicability of technologies, associated techniques and adherence to relevant UK legislation should be sought at the time of use by the responsible authority, from legal advisers and expert organisations listed throughout.

Detailed aspects of statutory legislation are not included within the handbook; the user must seek expert advice and guidance when implementing a recovery strategy. It must be noted that activities involving specialist responders would be subject to due diligence under the Health and Safety at Work Act etc 1974 (HSWA). Further advice can be found on the Health and Safety Executive website: http://www.hse.gov.uk.

1.7 Scope

This handbook has been developed to cover a range of biological incidents that may occur in an environment, as natural contamination, accidental release or as a result of deliberate release.

Clearly, biological incidents and outbreaks of infection can vary greatly in their scale and impact on their surroundings and those affected – examples could include an individual vomiting in a public place to a bioterrorist incident resulting in contamination spread over a large area. The handbook therefore aims to deliver a knowledge base which can be used by those involved to apply to the scenario presented. The recovery options, together with the other information included in the handbook, provide an evidence base for remediation, with the decision trees guiding the individual through the recovery option selection process.

While the handbook has been designed as a decision-aiding framework, expert opinion, input and involvement should be sought at the earliest point in an incident to supplement the guidance within the handbook, particularly in providing detailed advice on the selection of recovery options, and their efficacy and applicability to the situation, on a case-by-case basis.

1.8 Topics not covered

Although providing a breadth of information on biological incidents, the handbook is not an exhaustive stand-alone reference document. The topics not covered in depth in this handbook are detailed below.

1.8.1 Response phase

The handbook will not cover any aspects of the immediate incident response phase as this will often be dealt with through a multiagency coordinated approach across the emergency services. If a biological contaminant is suspected then the first responders should select the appropriate personal protective equipment (PPE) for the suspected biological organism and environment. In some events recovery options may be put in place without any sampling information especially when contamination is visible or known to be restricted to a defined area, ie room, field or watercourse.

1.8.2 Risk assessments

Risk assessments are key for facilitating the response to an incident, and must be done on a site- and incident-specific basis, to determine the risk, if any, to workers and public health. Risk assessment methodologies and approaches to risk assessment are not included in the handbook. However, there is background information on risk assessment in Section 1.13, which provides some guidance on the aspects of risk assessment that should be considered and appropriate website links. Risk assessments are likely to be performed at the start and end of the recovery phase to assess whether the area is safe to be returned to normal use, once remediation has been undertaken.

1.8.3 Sampling, analysis and interpretation

Sampling methodologies to determine the nature and extent of contamination are outside the scope of the handbook. Initial sampling should be undertaken in the incident response phase with further post-incident sampling to ensure the success of the remediation. Expert advice in the sampling, analysis and interpretation of results should be sought. However, some important considerations are addressed in Section 1.14.

1.8.4 Detailed costing

Recovery options recommended in the handbook contain an estimate of the cost of their application, which is presented broadly as high, medium or low cost. Detailed costings are not provided as the nature of application will depend on the size and scale of contamination.

1.8.5 Communication

An effective communication strategy will be dependent on the area, the personnel preparing and delivering it, and the target audience. With these variables unknown to the handbook team the user has the responsibility of developing a communication strategy, although Chapter 2 will outline some important considerations.

1.8.6 Plant pathogens

This handbook will not detail how to recover from incidents that involve plant pathogens. The protection of plant health is the responsibility of the government, growers, traders and members of the general public. The Plant Health and Seeds Inspectorate (PHSI) is a group within the Animal and Plant Health Agency (APHA) which is responsible for the implementation of the plant health regulations within England and Wales on behalf of the Department for Environment, Food and Rural Affairs (Defra) and the Welsh Government. In Scotland the Scottish Government is responsible for applying the plant health regulations and in Northern Ireland similar arrangements are made. The policies within the UK are the responsibility of Defra, which incorporates APHA and PHSI.

More details can be found at https://www.gov.uk/government/organisations/animal-and-plant-health-agency.

1.8.7 Animal pathogens

It is not within the remit of this document to provide recovery options for biological incidents occurring with infected animals. There are certain diseases that, under Section 88 of the Animal Health Act 1981, if an animal is found to be infected, the police or veterinary health authorities must be alerted.

Further details and a full list of notifiable diseases issued by APHA and Defra can be found at https://www.gov.uk/government/collections/notifiable-diseases-in-animals and https://www.gov.uk/government/organisations/animal-and-plant-health-agency.

Contaminating agents that can affect both humans and animals or humans and plants should be treated depending on the environment in which they are found in and by the organisation to which the contamination should be reported.

Appendix E provides contact details for the relevant organisations.

1.9 Specific recovery techniques and technologies

The handbook has been developed to provide the user with an overview of different remediation techniques (recovery options) that are relevant to the clean-up of the environment following a biological incident or outbreak of infection. Recovery options have been broadly grouped into the following categories:

- *protection options*, which can be used to protect people from exposure to biological contamination, usually by skin contact, inhalation or ingestion

- *remediation/restoration options*, which involve active decontamination or clean-up of contaminated surfaces and objects, including personal items (eg jewellery/electrical items)
- *self-help options*, these are simple measures that may be carried out by people living in the affected area or environment (eg using household cleaning agents)
- *waste disposal options*, these are recovery options that outline how to manage contaminated waste

In some cases, it may be that only one recovery option is required (eg reactive liquids). However, most cases may require several recovery options, which may be available from a variety of commercial suppliers (eg 'reactive gases and vapours' is a recovery option which includes formaldehyde, hydrogen peroxide and chlorine dioxide).

Recovery options recommended in the handbook have been reviewed and evaluated regarding their effectiveness against different contaminants, across different environments (food production systems, inhabited areas and water environments) and sub-surfaces (eg concrete, carpet, vinyl flooring and soft furnishings). As an executive body of the Department of Health, PHE is unable to endorse any individual remediation technique or specific technology. It is the responsibility of the handbook user to seek expert advice and guidance on the practicability and effectiveness of different remediation techniques, and this should be done on a site- and incident-specific basis.

1.9.1 Disinfection

Several of the recovery options discussed in the handbook involve the use of a disinfecting agent to reduce the levels of contamination. It is therefore important to have an awareness of some factors affecting disinfection.

Disinfection – this is the process by which levels of pathogenic organisms are reduced to a pre-determined level. This can be achieved by applying chemicals (disinfectants) to substrates that harbour these organisms, ie surfaces or liquids, or by using physical processes such as heat.

Sterilisation – this is the process by which all living organisms are completely inactivated.

Examples of factors affecting disinfection:

- active agent – whether the disinfectant is active against the contaminating agent, type and concentration of microbial contamination
- contact time – the required contact time for the disinfectant
- shelf life – some disinfectants will show a marked decrease in activity over time and therefore may need to be made up freshly prior to use
- environment – the presence of organic materials, prior cleaning, temperature and humidity may all affect the activity of the disinfectant

Prior to use, the efficacy of the disinfectant against the contaminating agent(s) must be confirmed. Furthermore, any disinfectants used during the response phase of an incident must be noted to ensure that adverse chemical interactions do not occur with those used later in the remediation process.

Examples of chemical disinfectant which may be used during the remediation of a biological incident:

- alcohol
- chlorine and chlorine-producing compounds
- formaldehyde
- hydrogen peroxide
- phenolics
- quaternary ammonium compounds

The European Union sets out strict legislation regarding the use of biocidal products under Regulation (EU) 528/2012. Further details regarding the controls in place can be found through the following link: http://ec.europa.eu/health/biocides/policy/index_en.htm.

Defra provides a list of disinfectants which have been reviewed for their efficacy against specific animal pathogens. By law, a Defra-approved disinfectant must be used when there is an outbreak of a notifiable disease. The list can be accessed at http://disinfectants.defra.gov.uk/Default.aspx?Module=ApprovalsList_SI.

Users should always confirm the effectiveness of a disinfectant prior to use.

1.10 Recovery and health protection

1.10.1 Definition of recovery

For the purposes of the handbook, the term recovery is defined as "the process of rebuilding, restoring and rehabilitating the community following an emergency"[6]. An important aim of this handbook is to support a prompt return to 'normality' and it is therefore important that the remediation strategy, where possible, contributes to the swift restoration of 'normal living'.

1.10.2 Recovery phase

The recovery phase is the period following the initial response and acute phase (Figure 1.2). Its function is to remove any public health threat from the site in question and restore the environment back to normality.

This handbook will offer support to the recovery phase of an incident after the initial acute response has ended or is nearing transition to remediation, with particular attention to the reduction of biological contamination and subsequent public exposure to biological contamination.

The initial response phase of an incident will be primarily dealt with by emergency crews and medical teams. Emergency measures may be put into place directly after an incident to protect the public from any immediate exposure, but any initial phase response should take into consideration the possible impact that these actions may have on future recovery options and remediation strategies.

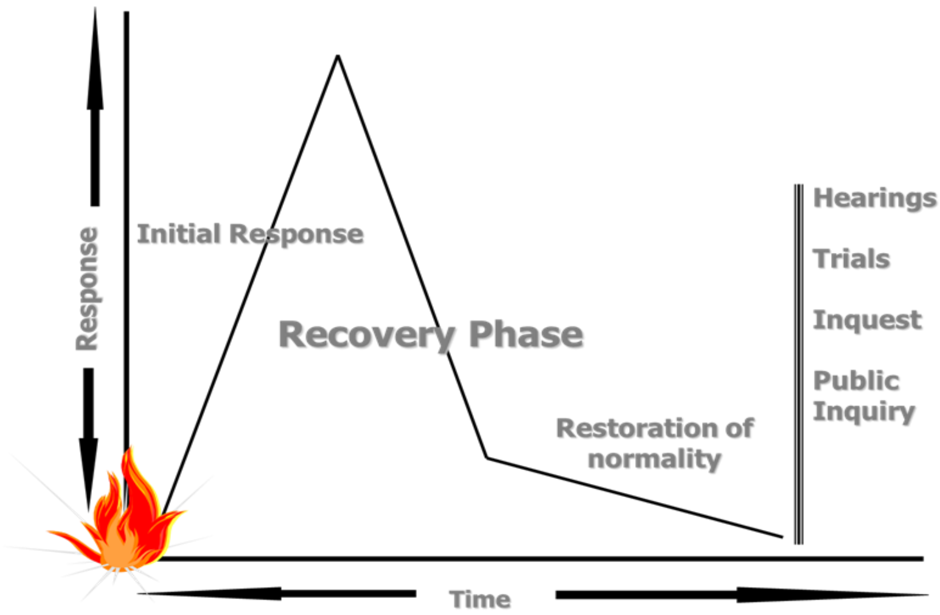

Figure 1.2: Incident response – the response level (number of agencies/people involved) to an incident increases rapidly during the initial response but declines over time during the recovery phase. After the recovery phase, the environment is returned to normal and public access may be restored. After the incident is closed, it is usually followed by a series of inquests which serve to evaluate why the incident happened and the subsequent recovery of the incident

1.11 Principles of microbiology

1.11.1 Introduction to microbiology

Microorganisms are ubiquitous in all of the Earth's environments and play important roles in the maintenance of many ecosystems. There are over 4,500 known species of bacteria described to date with approximately 5 x 10^{30} bacterial cells on Earth[7]. There are more bacterial cells carried within and on the human body than human cells[8]. There are more than 6,000 known viruses and potentially 5.1 million fungal species present on the Earth[9,10]. While the majority of these are not hazardous, a small subsection can cause disease in humans, animals and plants, these microorganisms are termed pathogens. Furthermore, on rare occasions these same microorganisms can cause outbreaks that may lead to widespread ill-health, eg norovirus outbreaks among hospital patients resulting in vomiting and diarrhoea, leading to closure of wards[11], and environmental contamination, eg Shiga toxin producing *Escherichia coli* O157 leading to infections in children causing renal failure due to previous contact with animals/manure[12].

1.11.2 Types of organisms

There are many different types of microorganisms that can cause disease in humans. These include bacteria, fungi, viruses, prions, protozoa and helminths. A brief overview is given in Table 1.1.

Table 1.1: Types of microorganisms

Organism	Description
Viruses	Viruses are a group of infectious agents that can only replicate by infecting a live cell and using its replicative machinery to reproduce[13]. Viruses are unable to replicate outside living cells and therefore do not generally persist for long in the environment outside a host[13]
Bacteria	Bacteria are single-celled microorganisms that naturally occur in all environments on Earth. Only a few species are pathogenic and cause life-threatening disease in humans. Bacteria can be broadly classed into two categories: Gram positive and Gram negative[14]. This classification relates to the structures of their cell walls which can govern their persistence, resistance to decontamination and antibiotic susceptibility[14] Gram positive – Gram positive bacteria include *Staphylococcus aureus*, *Bacillus anthracis* and *Listeria monocytogenes*. These bacteria generally have a thicker cell wall and some, such as *Bacillus* species, are capable of forming endospores[13,14] Gram negative – Gram negative bacteria have a thinner cell wall than Gram positive bacteria and include *Escherichia coli*, *Salmonella typhimurium* and *Legionella pneumophila*[13,14] Endospores – a bacterial endospore is formed when a bacterium is exposed to unfavourable conditions and is used as a method of preservation for the bacteria[14]. Endospores can be formed by bacteria in the genus *Bacillus* and *Clostridium*. An endospore can lie dormant without nutrients for extended periods of time until conditions become more favourable, upon which it can then become a metabolically active bacterial cell[15,16]
Fungi	Fungi are a group of eukaryotic organisms which include multicellular moulds and unicellular yeasts in addition to mushrooms and toadstools. Many reproduce by forming spores which can travel long distances on air currents. Most fungi are harmless but some are pathogenic and may cause disease[13]. They occur naturally in the environment and are often found where there are damp, moist conditions. In high concentrations in indoor environments prolonged exposure to various fungi can result in, or worsen, allergic respiratory syndromes such as asthma[17]
Protozoa	Protozoa are unicellular organisms which are mostly microscopic in size and some are parasites that can infect humans[14]. Some protozoa can release oocysts or cysts into the environment that are able to withstand harsh conditions until they are able to infect a new host[18]. These include *Giardia intestinalis*, *Cryptosporidium* and *Toxoplasma*
Helminths	Helminths are commonly referred to as parasitic worms. They are often large enough to be seen with the naked eye, although vary significantly in size from one species to another. Individuals are generally infected by ingestion, either of contaminated food (with the eggs or larvae of helminths) or through the faecal-oral route
Prions	Prions are proteins found in mammals and other organisms and can cause diseases, when, for reasons not fully understood, the structure of the prion protein changes. This abnormal protein becomes ‘infectious’, inducing in-contact normal prions to ‘misfold’. They are responsible for diseases such as Bovine Spongiform Encephalopathy (BSE) and Creutzfeldt-Jakob Disease (CJD)

1.11.3 Persistence of organisms

Microorganisms are ubiquitous and found in all environments, from hot springs to the depths of the oceans. Some live in soil and water, while others are present on the skin and in the gastrointestinal tract of animals. Depending on the environment, microorganisms can persist for long periods of time or can naturally perish. Environments such as dry surfaces can expose microorganisms to desiccation, while environments such as soil, faeces and bodily fluids can provide microorganisms with nutrients needed for their survival. For example, *Campylobacter* species survive for less than a week on dry surfaces but can survive for over 60 days in manure[19–21]. A biofilm is a community of microorganisms that group together and adhere to surfaces and each other. Microorganisms in a biofilm can share nutrients, confer antibiotic resistance and, as a group, have a higher resistance to decontamination and disinfection.

1.11.4 Levels of resistance of microorganisms

Disinfectants are often used to kill microorganisms and there are a variety of disinfectants that use different mechanisms to inactivate microorganisms. Therefore, not every disinfectant is effective at killing all types of microorganisms. There are varying levels of susceptibility to disinfectants which depend on the microorganisms being targeted and the mode of action of the disinfectant. For example, alcohol sanitisers are effective at disinfecting a range of vegetative bacteria but are ineffective against bacterial endospores or some viruses[22]. When planning a recovery strategy involving contamination with a microorganism it is essential to know the susceptibility of the microorganism to the decontamination method as this will influence the number of recovery options available for use.

1.11.5 Biological organisms associated with incidents

A representative list of organisms and scenarios that are most likely to be encountered or are of high impact in biological incidents has been produced to help to inform the recovery options chosen in a remediation strategy. Table 1.2 lists these organisms, the environment where they are likely to be a problem and the criteria for why they are included in the list.

Preliminary agent data for the prioritised agents discussed in this handbook can be obtained on request to biological.recovery@phe.gov.uk.

1.11.6 Fungal contamination

Fungal spores are naturally found in both outdoor and indoor settings. Fungi play an important role in the outdoor ecosystem where they break down dead organic matter such as fallen leaves and dead trees. In the indoor setting, spores are a common component of household and workplace dusts. People can expect to be constantly exposed to fungal spores except when in a sterile environment (such as a surgical suite or a clean room).

There is no simple, practical way to completely eradicate fungal spores from the indoor environment because they are easily transported on air currents from the outside environment and, once inside, from one surface to another. The main key to controlling fungal and mould contamination is to control the moisture levels and lower the available water in the environment as fungal spores require available water to germinate and grow. It is important to deal with the source of the moisture, if it is continually causing a surface to be damp, to help prevent the build-up of fungal growth. Enhanced ventilation is often sufficient to prevent recurrent fungal growth.

Most people will not encounter any health problems on exposure to the natural levels of fungi in the environment, but prolonged exposure to high numbers of spores might be harmful to certain individuals. Some people, especially atopic individuals and those with asthma, may be more sensitive to the allergens, volatile organic compounds and mycotoxins that are produced by fungi. Most people will have no reaction to these compounds, but they can cause symptoms such as a stuffy nose, eye irritation or wheezing in some, while in others more severe reactions such as fever and shortness of breath are seen. However, these severe reactions usually only affect people who have prolonged exposure to high levels of fungi. Most houses in the UK have areas (showers or bathrooms) where localised fungal growth occurs from time to time. These problem areas can usually be addressed following the guidelines of

Table 1.2: Biological organisms/scenario list

Agent/scenario	Environment	Inclusion criteria
Aspergillus spp. and other fungi	**Food production systems** **Inhabited areas**	Causes aspergillosis infecting humans and birds, can cause sensitisation. Toxins can cause a variety of adverse health effects (eg liver cancer and kidney damage) in humans if ingested in food
Bacillus anthracis	**Food production systems** **Inhabited areas**	Rare but high impact due to persistence/resistance of endospore
Bacillus cereus	**Food production systems**	Causes diarrhoea or vomiting from food poisoning
Brucella abortus	**Food production systems**	Rare but high impact
Campylobacter	**Food production systems**	Common causative agent of food-poisoning outbreaks
Clostridium botulinum	**Food production systems**	Rare but high impact, toxins released cause serious harm and can be life-threatening
Clostridium difficile	**Inhabited areas**	Large numbers of infections annually
Clostridium perfringens	**Food production systems**	Causes many cases of food poisoning. Large number thought to be under-reported.
Coxiella burnetii	**Food production systems** **Inhabited areas**	High impact due to resistance of organism
Cryptosporidiosis	**Food production systems** **Water environments**	Common cause of waterborne disease outbreaks
Cyanobacteria	**Water environments**	Toxins released can cause harm
Dampness in buildings	**Inhabited areas**	Common generic problem
Escherichia coli O157 and other STEC serogroups	**Food production systems** **Inhabited areas**	Seen in food outbreaks, and also in farms/petting zoos
Flood damage	**Food production systems** **Inhabited areas** **Water environments**	Sewage/faecal contamination of indoor and outdoor environments
Giardia intestinalis	**Food production systems** **Water environments**	Common cause of waterborne disease outbreaks
Influenza	**Food production systems** **Inhabited areas**	Highly transmissible, common agent
Legionella pneumophila	**Inhabited areas** **Water environments**	Regular outbreaks often with fatal results
Listeria monocytogenes	**Food production systems**	High impact due to high mortality rate among vulnerable groups
Methicillin resistant *Staphylococcus aureus* (MRSA)	**Inhabited areas**	High priority in healthcare settings
Mycobacterium tuberculosis	**Inhabited areas**	Increasing prevalence in the UK through resistance and immigration
Norovirus	**Food production systems** **Inhabited areas** **Water environments**	Most common cause of gastrointestinal (GI) infections
Salmonella spp.	**Food production systems** **Water environments**	Latest data (2010) close to 10,000 cases per year in the UK
Toxoplasma gondii	**Food production systems** **Inhabited areas** **Water environments**	Outbreaks rare, but most common zoonotic parasite
Viral haemorrhagic fevers, eg Lassa and Ebola	**Inhabited areas**	Occasional outbreaks. High impact
Vomiting in a public area	**Inhabited areas**	Common generic problem

the Centers for Disease Control and Prevention/US Environmental Protection Agency (CDC/US EPA) (http://www.cdc.gov/mold/cleanup.htm). With extensive fungal growth in a property where health might be affected, individuals should consult their GP. If a contractor is employed to help remediate an extensive mould problem, it is important that they have experience in the field of fungal remediation and, as with using any contractor, their references should be checked; guidelines that are given by the US EPA (http://www2.epa.gov/mold) and the World Health Organization (WHO)[17] should be followed.

It should be noted that while there is good medical evidence linking exposure to high levels of fungi with exacerbation of asthma and eye/nose irritation in sensitised individuals, there are also claims of adverse health effects for which there is no published medical or scientific evidence. As stated before, fungi are ubiquitous and expert opinion should be sought to assess risk before remediation options are assessed.

It should be noted that this response may be altered when fungi are present due to food spoilage within food production systems. In this case fungi may be found at a greater concentration and with opportunity to enter the host through the ingestion route, where the effects would present differently. Furthermore, some species of fungi are able to produce mycotoxins, which are discussed below.

1.11.7 Biological toxins

In addition to posing a hazard through infection, some microorganisms including bacteria and fungi can also produce biological toxins. These are non-infectious and unable to replicate, but may cause significant adverse health effects if they are ingested, inhaled, absorbed or injected. Biological toxins may be found naturally in the environment or in contaminated areas, but may also be found in food products or used within a bioterrorist scenario. It is therefore important to be aware of the sources of biological toxins and also the symptoms caused by exposure.

Examples of toxins include:

- mycotoxins, produced by certain fungi, including
  - aflatoxins
  - ochratoxin
  - patulin
  - trichothecenes (T-2 mycotoxin)
  - zearalenone

  further information regarding mycotoxins can be found on the Food Standards Agency (FSA) website: https://www.food.gov.uk/business-industry/farmingfood/mycotoxins
- staphylococcal enterotoxins, which may be found in contaminated dairy products and unrefrigerated meats
- paralytic shellfish poison, eg saxitoxin and tetrodotoxin can become concentrated in shellfish when they feed on specific algae
- botulinum, produced by the bacteria *Clostridium botulinum*, may cause severe food poisoning; it is associated with improperly canned, preserved or cooked food products

1.11.8 Allergy

In addition to infectious risks, biological contaminants may also cause allergic responses. The hazards associated with fungal contamination have been discussed in Section 1.11.6, yet other classes of microorganisms can also cause allergic reactions which will range from mild to severe. Furthermore, sensitisation to chemicals used in remediation of a biological incident needs to be considered as a form of allergic response and appropriate steps need to be put in place to protect recovery workers and others who may be involved.

1.12 Factors affecting biological exposure

There are a number of factors that will affect the level of exposure that an individual or population might have from biological environmental contamination. These factors need to be taken into consideration when developing a remediation strategy and are detailed in Table 1.3.

Table 1.3: Factors influencing exposure

Factor	Description
Infectious dose	Minimum number of organisms or level of toxin required to cause disease or illness. Infectious dose can vary depending on the biological agent and the characteristics of the human population. An immune-compromised, elderly or very young individual may be susceptible to a lower infectious dose than a healthy individual
Routes of transmission	Dermal – direct contact with skin and/or open wounds Mucosal membranes – including eyes, nose and mouth Ingestion – inadvertent or intended ingestion of contaminated food and/or drinking water Inhalation – direct inhalation of contaminated material/dust, resuspended contaminated material/dust or contaminated air/vapour and water droplets Sharps – contamination introduced into the bloodstream by contaminated needles and/or medical devices
Vectors	Insects and other animals can act as vectors and reservoirs for infectious biological agents
Environmental conditions	Temperature – low environmental temperatures (1–10°C) may lead to slow or no growth of microorganisms, whereas at higher temperatures (20–40°C) growth is generally faster. Above these levels higher temperatures can start to have detrimental effects[23,24] Humidity – low humidity can cause desiccation, while high humidity can have protective effects Organic matter can include faeces, vomit, soil and vegetation, which can provide a source of nutrients and prevent areas from being effectively decontaminated[25] Biofilms can attach to surfaces and form communities which enhance survival and increase resistance to antimicrobial and disinfection agents. They can be made up of multiple species and harbour different pathogenic organisms[26,27]
Meteorological conditions	Wind and rain can aid dispersion of biological agents, especially those that can easily be aerosolised, ie bacterial endospores and fungal spores[28,29]
Dispersion	Contamination spread can occur through human and animal movements. Organisms can be transported on surfaces they touch by people walking through a contaminated area or by a vehicle being driven through the area

1.13 Risk assessment

Risk assessment is the objective evaluation of potential hazards related to a specific situation, process or procedure, their severity and the likelihood of their occurrence. A risk assessment should also detail precautionary measures designed to reduce the likelihood of an 'accident' occurring in relation to the situation being evaluated. Risk assessment is a continuous dynamic procedure that constantly identifies, assesses, addresses and reviews the risks of a particular situation.

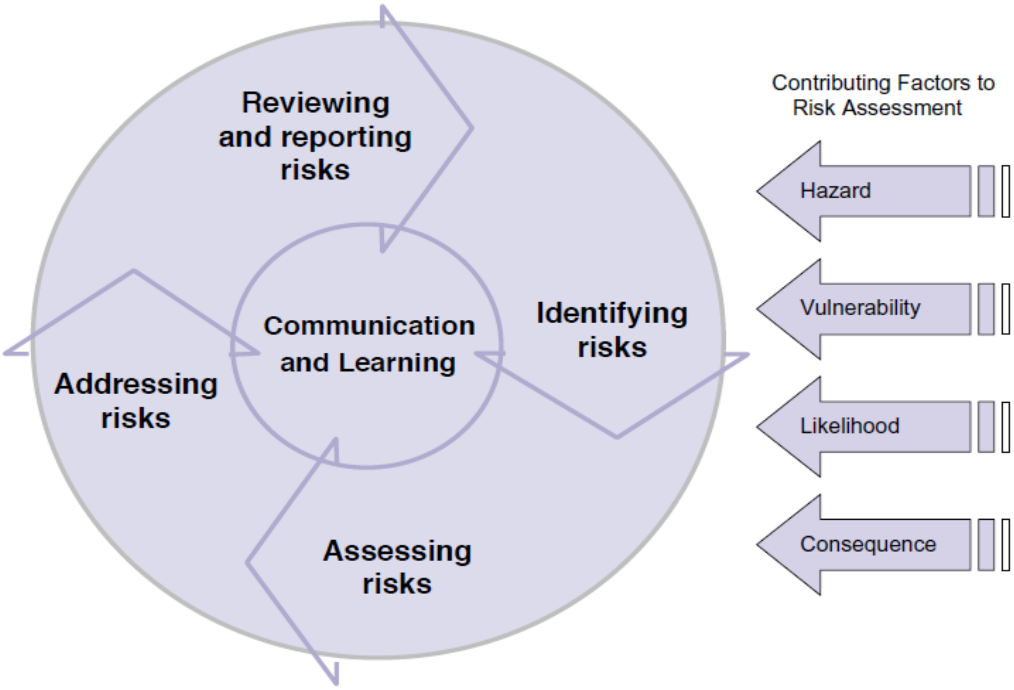

Figure 1.3: Flow diagram showing the dynamic process of the risk assessment cycle and its contributing factors[30]

There are a number of additional principles that need to be considered when completing a biological risk assessment compared to a non-biological focussed risk assessment. It will be important to acquire suitable expert advice with regards to the contaminating agent(s), in terms of the infection risk of the agent, its characteristics, how it needs to be handled, etc. The contact details for the relevant expert agencies for each area that will be able to assist in the creation of a risk assessment can be found in Appendix E. Risk assessments will generally be agreed by the recovery coordination group (RCG) chair.

A risk manager would need to evaluate where risks can be reduced, eg by using correct personal protective equipment (PPE), so that these procedures can be put in place. It is important to ensure that a risk assessment has been completed prior to the recovery work being initiated, and if applicable the risk assessment must be agreed by the RCG chair. If contractors are used during the recovery phase, a check should be completed to ensure they have an adequate risk assessment in place.

Further details on how to complete risk assessments and manage risk from biological agents can be found on the following websites: http://www.hse.gov.uk/risk/ and http://www.fao.org/docrep/005/y1579e/y1579e05.htm.

1.14 Sampling and monitoring following an incident

In contrast to radiation and chemical incidents, biological contamination is not readily measured in-situ by portable detectors and will normally need to be identified in a specialist microbiology laboratory. Biological sampling and subsequent analysis can be a time-consuming process, resulting in a delay in implementing any remediation options. However, protective strategies can be put in place until such time that remediation can commence.

Any sampling of a contaminated environment should be completed by suitably trained and qualified individuals. Expert advice should be sought. The sampling team should use the necessary PPE to prevent biological exposure and samples should be transported safely and in the appropriate manner according to WHO guidance on regulations for the transport of infectious substances[31].

Environmental sampling of the contaminated area is not always necessary, especially when there is obvious visual contamination, eg vomit. It is, however, important to be aware that the affected area may be greater than that seen; data from sampling can therefore be used to determine which sites need to be remediated when there is no evident contamination and can also inform the selection of recovery options. In addition, the sampling process can be used as a reassurance measure, where necessary, to restore public confidence after remediation.

Sampling strategies need to be applicable to the incident and properly defined prior to any sampling is undertaken. A good sampling strategy will contain information on where to sample, how many samples to take, what confidence the results will give and which practical methodology to use. Selecting the most appropriate sampling methodology is critical for obtaining a representative sample. With all sampling strategies there are considerations which need to be taken into account: these are detailed in Table 1.4.

1.15 Mathematical modelling

Mathematical modelling programs are important tools that can be used to aid decision makers in planning and implementing a remediation strategy. They are useful for evaluating and refining proposed strategies to determine which may have the best effect. Modelling programs can be used to augment the sampling data to estimate environmental concentrations, contamination dispersion and exposures risks that can be used to generate risk assessments and for epidemiological studies. Sampling data may also be used to validate and refine the models.

1.15.1 Aspects of the recovery phase that could be modelled

There are some factors in biological recovery that can be modelled, including:

- pathways of transmission of the biological agent
- spread of contamination of the agent
- how to implement the recovery option (eg what concentration of disinfectant is needed)

Table 1.4: Considerations associated with implementing sampling programmes

Consideration	Description
Collection	Any personnel involved in the collection of samples must be provided with appropriate PPE and avoid any cross-contamination of samples. Sampling personnel should ensure a sufficient number of suitable containers are used to store samples and these should be labelled accordingly. Limiting the number of individuals who may enter the contaminated area will minimise exposure and also allow sampling to proceed in an unhindered manner
Transportation	It is important to be aware of transport regulations when transporting potentially hazardous material including samples taken from a biological incident. Comprehensive guidance is available from the WHO[31] and IATA[32]
Time	Samples will need to be collected on site and then taken to an appropriate laboratory. Analysis can be time consuming and take days or weeks, depending on the organism being tested
Analysis	Analysis should be carried out using standard methods by accredited laboratories
Limits of detection	All sampling procedures have a limit of detection. This means that a particular sampling method may not be able to detect an organism once it falls below a specific level or concentration. The limit of detection needs to be taken into account when interpreting sampling results
Background contamination	Microorganisms are ubiquitous in the environment and a range of organisms are likely to be present when sampling. If the contaminant is unknown, background contamination will need to be taken into account
Cost/responsibility	The financial burden of undertaking an environmental monitoring programme can be considerable. It may be difficult to identify the organisation responsible for and/or willing to undertake sampling and analysis. In recurring situations (eg minor food scares that are frequent occurrences), environmental sampling and analysis are usually the responsibilities of local authorities. In unusual situations (ie emergencies), these and other responsibilities are not always clear cut. Expert advice and guidance should be sought to address any uncertainties. Under the ‘polluter pays’ principle, however, costs may ultimately be borne by those responsible for causing an incident where these are accidental

1.15.2 Types of models and input parameters

A number of different modelling systems exist for use, but the systems most applicable to a biological incident might be those that model environmental conditions during the biological incident. These models will enable the users to determine from where the contamination might have originated or if there is the possibility of secondary dispersion. The use of these models will rely on knowledge of the necessary parameters. For instance, to model the dispersion of an organism by the wind from a single source the wind direction and strength will need to be known from the point of release, along with the initial contamination concentration. Other factors that can affect the survival of the organism in the air and, therefore the dispersion range will also need to be taken into consideration, including the type of organism, the temperature and relative humidity, and the amount of sunlight. Similar models can be employed to determine the spread of contamination in the indoor environment after an area has been contaminated. The airflow within the area can be calculated and deposition areas predicted.

1.15.3 Modelling the effectiveness of recovery options

Certain decontamination recovery options can be modelled more easily than others. The use of *D*-values and *Z*-values in microorganism decontamination can be used to determine the length of time that is needed to inactivate the organisms. The *D*-value (decimal reduction time) is the time needed to reduce a microbial population by 90% or 1 log at a given temperature. The *Z*-value is the change in temperature that is required to reduce a microbial population by 90% or 1 log. These values will be applicable to recovery options using heat or a disinfectant to reduce the biological contamination.

The use of modelling in microorganism reduction can be problematic because of the nature of microorganisms. As living entities there will be inherent variability in the manner in which they reproduce and survive in the environment. This can cause problems when trying to model the attenuation or growth of an organism as mathematical modelling programs will need to incorporate this variability into their models to ensure they produce the most accurate results. There also needs to be an understanding of the uncertainty associated with using models, which can be quite large.

1.16 Explanation of scenarios

The handbook will use example scenarios to represent situations where there may not be one causative biological agent but a situation that could cause exposure to various unknown agents which would need to be remediated. These scenarios are described in Table 1.5.

Table 1.5: Description of scenarios used in the handbook

Scenario	Description
Damp buildings	Damp is the presence of unwanted moisture in a building, as a result of either intrusion of moisture from outside or condensation from within. The resulting dampness can provide a hospitable environment for various moulds and other fungi which may pose a health risk if left unattended[33]. It may not be necessary to sample and remediate for specific microorganisms as a variety of different fungal species may be present. In this case, a general recovery strategy that encompasses remediation against most moulds and other fungi would be sufficient and would include methods to prevent persistence or recurrence, including reducing the levels of moisture in the environment
Flood damage	Due to increasing flood risk in the UK, flood damage is a more common occurrence. Flood water can bring various fungi, bacteria, viruses and protozoa with it that may remain when the water has receded[33]. The high moisture conditions may also encourage the growth of various moulds and other fungi similar to those found in damp buildings. Again, a general remediation strategy would have to be employed that would include recovery options to disinfect against bacteria, viruses, moulds and other fungi and protozoa
Vomiting in a public area	Vomiting is caused by a number of medical conditions, some of which may involve an infectious agent. Viruses and bacteria can be found in vomit and the action of vomiting may also aerosolise microorganisms. Furthermore, small particles may travel further than the obvious contamination may suggest. In this case, the recovery phase may coincide with the initial response and it is important to make sure that actions taken immediately do not negatively affect recovery. Any recovery strategy would have to be effective against a range of microorganisms and take into account their possible aerosolisation

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2 Factors Influencing Recovery

Within the handbook, a recovery option is defined as "an action intended to reduce or avert the exposure of people and the environment to contamination". Overall, there are 67 potential recovery options that can be used to remediate contaminated environments in this handbook. They are divided as follows: **food production systems** (29), **inhabited areas** (21) and **water environments** (17). The recovery options described in this handbook are designed to target particular media (soil, water, etc) and potential exposure pathways within each environment (ie water, food and building surfaces). While public health concerns and the reduction of exposure to contamination are mainly taken into consideration within the recovery option, other key issues such as the local economy, societal and ethical concerns, environmental considerations and disposal of wastes are also described.

The three areas covered in the handbook are defined as follows.

Food production systems

For the purpose of this handbook, food production systems include crops, dairy products, agricultural animals (which include both animals used for meat and animals used for non-food purposes), eggs, honey, freshwater and marine fish and shellfish, foraged/domestically grown foods and game, animal feed/silage and waste products (eg slurry) and processed foods. This includes every stage of production from farm to fork and includes home-grown and foraged foods

Inhabited areas

Inhabited areas are places where people spend their time. They can be divided into a number of sub-areas such as residential, industrial and recreational. These sub-areas contain a variety of surfaces such as buildings, roads, woodlands and parks. They may also include vehicles and places of transition and it is important to be aware that these areas may have high levels of utilities

Water environments

Water environments include a variety of water sources such as drinking water supplies (ie public, private and industrial water supplies), water used in food and beverage production and controlled waters (ie surface water, groundwater, recreational waters and coastal waters)

The recovery options considered in this handbook can be divided into three categories: protection, remediation and waste disposal. Many of these options are complementary to each other and can be used together as part of a wider remediation strategy.

2.1 Protection options

What is a protection option?

A protection option is defined as an action that keeps people safe from harm or ill-health and prevents or reduces exposure from biological contamination prior to remediation

The effectiveness of a protection option can be measured by the reduction in exposure to biological contamination from a known source after the option has been implemented

There are a number of potential exposure pathways through which biological contamination may cause ill-health. These include skin contact, ingestion and inhalation. The protection options listed in this handbook are designed to provide effective protection against these exposure pathways.

The effectiveness of a protection option will depend largely on a number of factors including the physiological characteristics of the contaminating agent, the level of contamination, the type of protection being used and the environment where the contamination has occurred.

Protection options may be temporary (short and long term) or permanent. Permanent protection options are more likely to be used in isolated environments that are contaminated with extremely persistent biological agents.

2.1.1 Types of protection

A number of protection options exist, including:

- restricting access of people or relocating people from the area, including storing objects
- preventing entry into/removing from the food chain (eg product withdrawal and/or recall)
- isolating the contamination
- vector control
- medical interventions

The issue of PPE to any individual who has a higher risk of exposure (ie workforce) will aid protection against exposure to biological contamination during the recovery phase.

In some incidents, protection options may be the only options employed as part of a remediation strategy. For example, restricting access or temporarily relocating the affected population away from a contaminated area may be more useful for biological agents that have a short persistency as they may naturally degrade in the environment and therefore may not require any active remediation options. See Table 2.1 for issues to consider with protection options.

Table 2.1: Protection option considerations

Advantages
They are less likely to have a lasting negative effect on the environment. Some options may improve the environment beyond its pre-incident condition, eg water treatment to remove a pathogen may also remove blue-green algae
Some individuals may be able to remain in the area during implementation, ie workforce wearing appropriate PPE
They are usually easier and quicker to implement than removal options
Using holding tanks may be effective at protecting against exposure until contaminated water is removed or treated
Offering medical interventions may improve the overall health of individuals at risk, ie vaccination will offer long-term protection against infection
The biological agent may naturally inactivate in the environment over time requiring no specific clean-up methods
Issues to consider
Contamination is not removed from the affected area. Therefore it may be necessary to deal with a public perception that the area is blighted
If storage (of contaminated objects/media) options are implemented, the assumption has to be made that a subsequent treatment option will be available, which may not always be the case
Restricting access to areas, buildings, objects and water environments or water supplies limits a return to normal living
Medical interventions may have side effects which will need to be considered carefully before implementation
Treating contamination in-situ may cause problems with future maintenance of a piece of equipment or area. Some recovery options might cause issues with corrosion or affect the workings of an item

2.2 Remediation options

What is a remediation option?

A remediation option is defined as an action that will rectify or repair the contaminated environment after biological contamination

The effectiveness of a remediation option can be measured by the reduction in the level of biological contamination from a known source after the option has been implemented

2.2.1 Remediation options

Remediation options encompass the decontamination or clean-up of contaminated areas, media, surfaces and objects. The purpose of any remediation strategy is to reduce contamination to what is deemed a ‘safe’ level or one that is ‘as low as reasonably practicable’ (ALARP). However, if an area remains unsafe, permanent restrictions and bans on access and activities may be required or until such a time that effective remediation can be implemented (this was the case for Gruinard Island which was intentionally contaminated with *Bacillus anthracis* and remained contaminated until effective remediation was finally achieved in the 1980s[1]).

Defining what is considered to be ‘reasonably practicable’ or ‘safe’ will depend largely on the biological agent in question and the importance and intended use of the area that has been contaminated. To prove the effectiveness of any remediation strategy, sampling may need to be undertaken to demonstrate successful decontamination as well as quantifying any remaining contamination and potential exposure (this will be dependent on sampling method detection limits, see Chapter 1). These results will then determine the likely risk of any further exposure and establish whether the environment can return to its normal function. With certain remediation options a resistant indicator (bacterial endospores) may be used to demonstrate process effectiveness; this is important as different locations or surfaces can influence the efficacy of even well-understood decontamination methods.

The effectiveness of a remediation option will largely depend on a number of factors including the physiological characteristics of the contaminating agent, its concentration, the efficacy of the decontamination technique being used, the robustness of the surface and the environment where the contamination has occurred. Expert advice would need to be sought before deciding on the most appropriate or effective remediation technique.

An important issue to consider with remediation options is the generation of contaminated waste which will require disposal. The amount of waste produced will vary according to each individual situation and the remediation option employed.

It is also possible that during remediation, objects and surfaces may be encountered that are considered sensitive and/or valuable where normal decontamination techniques will not be applicable. This may be particularly true for objects found in heritage buildings and museums, personal items (eg mobile phones) or sensitive equipment (eg electronic devices). Disposal is potentially an unacceptable option due to their intrinsic value. Some remediation options are available to allow gentle cleaning and/or storage of these items should it be deemed necessary. However, it should be recognised that these objects may contribute very little to potential exposure and their cleaning would therefore often have the primary purpose of public reassurance.

Considerations for remediation options are listed in Table 2.2.

Table 2.2: Remediation option considerations

Advantages
Remediation options remove or inactivate biological contamination from the affected area
Outcome should be permanent
Effective in reducing exposure
Issues to consider
There may be some waste created due to removal or disposal
They create disruption
Risk of contamination being spread by movement from the incident area
It is likely that the techniques will have to be used on several surfaces to provide significant reduction in exposure, eg different types of ceilings and walls
Unacceptable damage may be done to building surfaces and objects, particularly if old or in poor condition
Ensuring detection limits of monitoring equipment are accurate to ensure clean-up has been effective
There may be limited information on decontamination efficacy for the biological agent involved
Difficulties in selecting appropriate cleaning technique for different surfaces
Negative effect on the environment
Use of some chemicals for decontamination during the remediation phase might require an area to be closed for access for a period of time

2.2.2 Water treatment options

Water treatment options involve the decontamination or clean-up of contaminated water environments. A particular issue with water treatment options is that large quantities of contaminated waste water or material may be generated (ie flushing distribution system). Furthermore bulk volumes of used disinfectants would normally need to be collected and disposed of due to possible adverse effects on sewage treatment processes. Within the environment there may be sites of special scientific interest (SSSI) and sites where unacceptable treatment or removal of large quantities of contaminated water may significantly damage locally protected habitats. Issues to consider with water treatment options are listed in Table 2.3.

Table 2.3: Water treatment option considerations

Advantages
They remove contamination from the affected water system
They reduce or remove exposure to the biological agent
Issues to consider
Some treatment options create waste
Some treatment options may create disruption
Some treatment options could have a negative impact or effect on the environment
Depending on the physiological characteristics of the biological agent, contamination may remain in the affected environment unless extreme, environmentally damaging removal options are undertaken

2.2.3 Self-help recovery options

Within each environment, there are a number of self-help recovery options or simple measures which can be implemented by people living and/or working in the affected areas. These will be options that do not require specialist personnel and/or specialist equipment for implementation. ‘Reactive liquids’ is an example of a self-help option, where members of the public could use household cleaning agents (bleach) to inactivate biological contamination on surfaces within their homes. The main considerations and issues to consider with self-help recovery options are given in Table 2.4. Some technical factors require specific consideration prior to the initiation of self-help recovery options (see Table 2.5).

2.2.4 Implementing recovery options with people in-situ

Ideally, recovery options should be implemented in the absence of the general population in the contaminated area to avoid any risk of exposure to contamination and any chemicals used in remediation. However, it is recognised that this is not always possible, especially when dealing with national critical infrastructure (eg hospitals) which needs to be staffed or when the number of people involved is large. There is also always a risk that relocation may contribute to the spread of contamination.

Table 2.4: Self-help recovery option considerations

Advantages
They involve the people affected, with the aim of improving their own situation (taking positive action). This can help them understand the relative importance of different exposure routes and lead to a better understanding of how exposure can be reduced
Those affected are in control of the situation and the knowledge obtained through direct involvement can prevent unnecessary anxiety
Those affected may know exactly what has to be done to improve their situation and how well it has been done
They have the benefit of introducing an extra labour resource so that clean-up time can be reduced
Members of the public participating in recovery operations are not subject to the same regulations, legislation and occupational exposure limits as recovery workers (eg HSWA) but are subject to the standards applicable to members of the public (eg ambient air quality objectives)
They comply with important ethical values of autonomy, liberty and dignity
Issues to consider
Self-help options are carried out on a voluntary basis
Carefully worded and detailed communication with the people participating would be required. This could take a considerable amount of time to implement
May be difficult to control and standardise clean-up. For example, people may adopt different techniques with varied consistency across the affected households, ie some people may ignore the advice (inconsistent response to advice) and others may make an attempt, but not adhere to it particularly rigorously (ineffective or partial response)
Can be difficult to confirm completeness of clean up
Individuals may be subject to litigation if an injury occurs

Table 2.5: Technical factors to consider for self-help recovery options

Factor	Comment
Safety precautions	These are listed in recovery options (see Chapter 3). As self-help recovery options introduce a higher degree of autonomy, it needs to be stressed that no recovery option should be implemented before adequate safety education, training, detailed instructions and equipment are in place
Specific protection of unskilled people	Methods involving undue risk (eg work at elevated height) have been excluded by default. In addition, people may also not be physically fit for the work
Safety in connection with waste handling	People may receive relatively high exposures near piles or vessels containing concentrated contaminated material generated by self-help measures. Inhabitants would need careful instructions to minimise time spent in such locations over the period before the waste is collected
Information on objective	The objective of a recovery option should be clear. This may partially be done through leaflets, but for some recovery options initial supervision would be recommended, as adverse effects of incorrect implementation may be difficult to rectify
Availability of equipment	Most of the primary equipment required would need to be readily available. Also need to consider the cleaning or potential disposal of equipment following implementation. Some additional equipment may need to be secured and this will need to be made available on the required time scale

If it proves difficult to relocate and/or restrict access and decision makers have to implement recovery options with people in-situ, there are a number of factors that should be considered:

- a good communication strategy will need to be in place to ensure that information can be delivered quickly to those who may be affected, eg remain indoors and keep windows closed
- secure, controlled access may need to be put in place to ensure that only the minimal level of people necessary enter the contaminated area. Decision makers should be aware that many people may not avoid an environment known to be contaminated
- a comprehensive information service should be provided to ensure that relevant advice, reassurance and multiagency information are available to those at risk as many people may be prepared to avoid contaminated areas if they understand the risk, eg remaining in homes
- any recovery operations should be carried out as quickly as possible with minimal risk to the public. This may influence the selection of recovery options, ie natural inactivation would not be an acceptable option
- it may be necessary to administer post exposure prophylactic treatment (if available) to those that need to be in the contaminated area

If recovery workers implementing recovery options wear PPE (respirators, face masks, etc) in areas where individuals may choose to remain then prior information would need to be provided to the watching public as to why similar protection was not provided for them.

2.3 Waste disposal (fate of affected produce and) options

What is a waste disposal option?

A waste disposal option is defined as an action that properly disposes of contaminated material in accordance with local environmental guidelines or laws

Remediation options will potentially produce varying quantities of contaminated waste which will require appropriate waste management and will be linked to waste disposal options (Table 2.6)

Waste is an important factor to consider prior to embarking on any remediation strategy. A few of the recovery options described in this handbook may result in the generation of varying quantities of waste (irretrievably damaged or contaminated objects, fixtures and structures) or waste by-products (eg water run-off from disinfection procedures) due to the nature of the recovery and clean-up process. Any waste generated will require appropriate decontamination (eg incineration or burial) through the appropriate channels and must be managed appropriately. It will be necessary to determine how the waste should be removed, whether it should be treated on site or off site and whether the waste generated is classified as hazardous or not. National guidance is available to help determine if a waste can be described as 'hazardous' and depending on the specific situation and biological agent in question, various options exist for the disposal of wastes. The Environment Agency (EA), Scottish Environment Protection Agency (SEPA) and Northern Ireland Environment Agency (NIEA) can be consulted for advice on appropriate waste management strategies. Furthermore, the Health and Safety Executive (HSE) website also hosts information on transport of waste.

Table 2.6: Recovery options that give rise to waste

Food production systems	Waste produced
Restriction of entry into food chain/withdrawal	Food (eg crops, dairy, meat, honey, eggs, fish and shellfish, processed food)
Product recall	Food (eg crops, dairy, meat, honey, eggs, fish and shellfish, processed food)
Closure of air intake systems at food processing plants	Processed food and raw ingredients
Issue a FEPA order	Crops, dairy, meat, honey and eggs
Pest control	Carcasses
Processing or treatment of food products	Foods where the stringency of the treatment required to destroy the hazard renders the product unusable
Removal of topsoil	Soil
Liquid decontamination of soil	Waste by-products
Culling of livestock	Animal carcasses
Decontamination of animal houses, glass houses, processing plants, and fish and shellfish farms	Waste by-products
Burning in-situ	Fly ash
Disposal of crops, carcasses, animal waste and other foodstuffs	Fly ash and rendered food products
Inhabited areas	**Waste produced**
Medical intervention	Clinical waste
Pest control	Carcasses
Reactive gases and vapours/gaseous decontamination of objects	Waste by-products
Reactive liquids	Solution run-off and waste by-products
HEPA vacuum cleaning	Contaminated debris, dust and HEPA filters
Modify operation/cleaning of ventilation systems	Contaminated filters
Soil and vegetation removal	Soil, vegetation, debris
Removal and disposal of contaminated material	Bricks, building materials, furniture, etc
Incineration	Fly ash
Water environments	**Waste produced**
Identification and remediation of contamination source	Contamination source and any surrounding areas
Introduction/modification of existing water treatment	Contaminated filters
Changes to water abstraction point or location of water source	New equipment and associated waste for the access of the abstraction point
Water treatment at point of use	Contaminated filters
Flush distribution system	Contaminated water
Treatment of sludge	Decontaminated sludge
Drain to waste	Contaminated water
Discharge off site using tankers	Contaminated water

Small-scale incidents are likely to generate small quantities of waste for which normal waste disposal routes that are in close proximity are likely to be sufficient. However, for large-scale incidents, where large quantities of waste are likely to be generated, these disposal routes may be inadequate. Therefore, the handbook also includes less common waste disposal options which can be considered in extreme cases (see Chapters 5, 7 and 9).

Following a large-scale incident, it is within the power of the relevant statutory and regulatory bodies to force waste disposal companies to halt their existing activities at short notice and make their disposal plants available for the treatment of contaminated material providing that the relevant technology is available at these sites. If this occurs, normal waste management regulations can be suspended temporarily to enable contaminated material to be treated subject to certain conditions being met. In these extreme cases, the EA has the power to vary an environmental permit so that the facility could process wastes in an emergency.

Several important criteria need to be considered when selecting the most appropriate waste disposal options, including:

- type and amount of the waste (eg hazardous, biological, chemical)
- legislation concerning disposal routes for waste
- capacity of disposal facilities
- agricultural impact following disposal
- environmental impact following disposal
- potential impact of biological agent during and after disposal
- societal/ethical issues

The issues that need to be considered for waste disposal are summarised in Figure 2.1. For further information and a list of guidance, regulations and legislation on the various aspects of waste management see Appendix A.

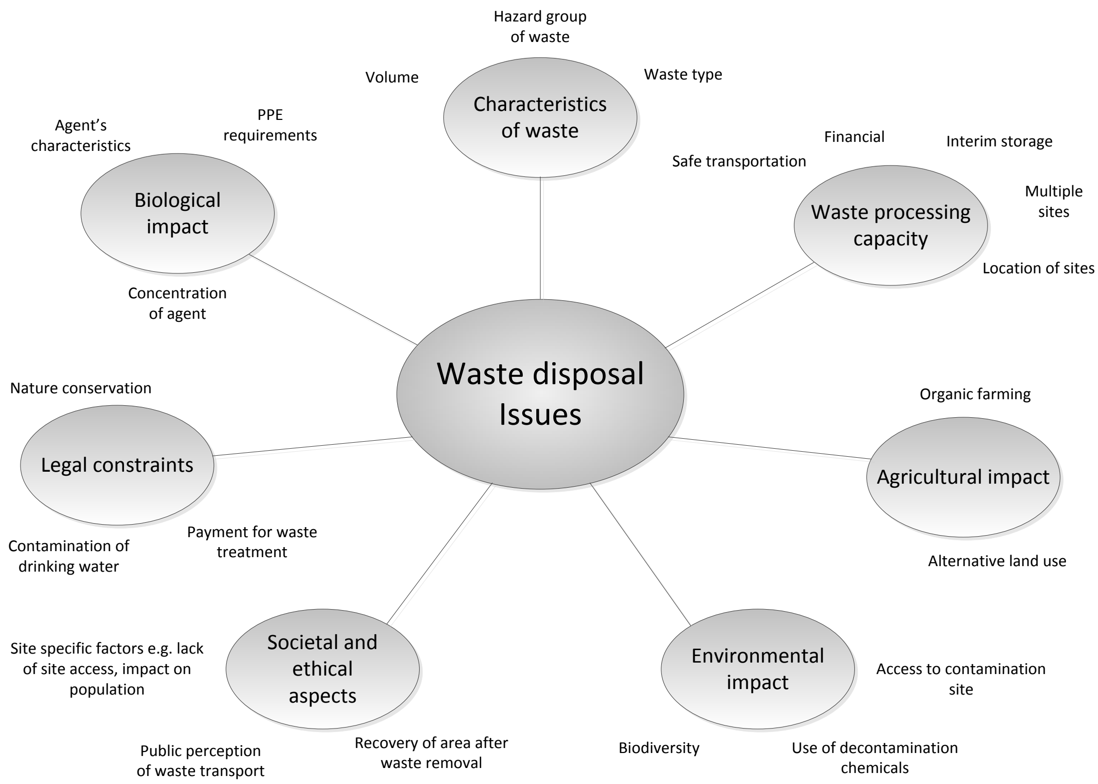

Figure 2.1: Summary of the main factors influencing disposal of waste

2.4 Decision not to implement any recovery options

There may be some circumstances where it is determined by the user or appropriate authorities that the most appropriate course of action is not to implement any recovery option due to the limited environmental persistence of the biological agent. In these cases, a good evidence base for the decision and a good multiagency communication strategy is required to reassure the local population and ensure that there is no risk to public health. This option (natural inactivation) should only be considered if either the information available (ie measurements from environmental monitoring and risk assessments) indicates that the exposures of people living in the area would be insignificant and there is unlikely to be a risk to health or if there is no other suitable and appropriate alternative. It is not within the scope of this handbook to judge what would constitute an insignificant exposure as this would need to be determined on an incident- and site-specific basis with input from appropriate experts (see Appendix E). There are a variety of factors which could influence the decision not to implement any recovery options applicable, such as availability of resources, risk of exposure against the benefits of recovery or the biological agent having a short persistence. The main issues to consider with not implementing any recovery options are outlined in Table 2.7.

Table 2.7: Considerations for not taking remedial action (ie natural inactivation)

Advantages
Implementing recovery options may be perceived by the public as an indication that there is a problem even if potential exposures are so low that the measures are only being undertaken to provide reassurance
Perception of affected area from outside may be better (ie incident is not perceived as real problem; people are living normally). Economic and social blight may be reduced
It sends out a clear message that risks are low and builds public confidence in decision makers. Saying that the risk is low and still undertaking recovery options may give out a mixed message
No waste is produced. Some clean-up options that may be undertaken for public reassurance can create a lot of contaminated waste
Promotes faster return to normal living
Issues to consider
It requires very good communication with the community and media to reassure people that risks are low and that they should accept the decision not to implement recovery options
If recovery options are implemented the public may be more eager to return to their homes, as active remediation may be interpreted as ‘doing something’ rather than a ‘do nothing’ approach
Implementation of recovery options is visible and may provide reassurance to people inside and outside the contaminated area
Natural inactivation may be recommended only after a thorough risk assessment
Not implementing any recovery options may send out a message that the response organisations and other organisations do not care enough about the community
Decision makers need to define the boundaries of the area in which recovery options are not implemented (ie compared to where they are being implemented)
If restrictions have been placed on food consumption, there will need to be careful explanation of why these are required while no action is taken to deal with the contamination in inhabited areas
Persistence of the biological agent will determine if ‘natural inactivation’ is a feasible option
Decision makers will need to consider the cost of clean-up against the risk of infection as well as the available resources to clean up as this will impact on the decision to not implement recovery options

2.5 Identified options

During recovery from a biological incident, the timescale can be split into three stages: the early phase, middle phase and late phase. Recovery options can be considered according to their timescale for implementation. For example, in the early phase (short term), it would be advisable to place protective and precautionary actions into place, such as restrict public access or restrict water use.

Where the information is available, recovery options should also be selected on the level of biological contamination present and land use. Typically there will be areas where contamination levels are high and priority will have to be given to the direct protection of the population to minimise the risk of infection (eg by temporary relocation and restriction of access). In these areas, particularly if resources are limited, protective measures for agricultural production may need to be treated as a lower priority.

Other factors can influence the selection of recovery options including the type of area affected, location and size. The size of the area may affect the speed and timescales with which a recovery strategy can be implemented. For example, a small area which has been contaminated, such as a single-bed isolation room in a hospital, can be more easily cleaned than a large area, such as a multi-bed ward, because more options may be applicable and practicable and it may be easier to shut down and isolate the contaminated room.

However, smaller areas might also be more isolated and options harder to implement. Furthermore, the type of area and its location can play an important part as a contaminated residential area with large numbers of inhabitants will exert a greater pressure from the public to ensure that the area is safe to live in and use. If the location of an incident affects priorities which may be linked to tourism, political sensitivities, economic stability or critical facilities and infrastructure, there will also be increased pressure to minimise or mitigate the contamination promptly.

Implementation of recovery options is generally the responsibility of the RCG and/or local authorities. However, there are a number of self-help options which can be implemented by the affected population and/or landowner and these options are highlighted as self-help options in the recovery option datasheets for each environment. It is also important to note that the option not to carry out any recovery options (ie natural inactivation) can be a valid alternative. Recovery options may be used in combination, and should be evaluated on an incident- and site-specific basis, depending on the characteristics of the incident as different options may be more relevant as an incident progresses.

Within this handbook there are 67 recovery options in total which can be divided into **food production systems** (29), **inhabited areas** (21) and **water environments** (17). This encompasses the main actions that can be carried out in these environments to reduce the impact and risk of exposure to biological contamination, and takes into account most of the criteria that decision makers might wish to consider when evaluating different options. Tables 2.8–2.10 provide lists of these recovery options; it should be noted that some incidents may contaminate more than one environment and therefore it may be necessary to consult all relevant sections of the handbook.

When developing a recovery strategy for remediating a contaminated area, whether it is a food production system, inhabited area or water environment, a number of factors need to be considered. The importance and relevance of these factors will vary according to the specific details of each incident and may only be assessed at the time of the incident; however, some factors can be used as part of planning exercises and further details can be found in individual recovery option sheets.

Factors that should be considered include:

- temporal and spatial factors
- effectiveness of recovery options for the known contaminant
- pathogenicity, transmission routes and infectious dose of the biological agents of concern
- protection of workers
- protection of the general public and vulnerable sub-populations
- waste disposal issues, including transportation
- societal and ethical aspects
- environmental impact
- economic cost
- communication and information issues

Table 2.8: Index of recovery options for food production systems

Protection options
(1) Restrict/controlled access
(2) Precautionary (food safety) advice
(3) Medical intervention
(4) Restriction of entry into food chain/withdrawal from market
(5) Product recall
(6) Closure of air intake systems at food processing plants
(7) Minimise spread from contaminated crops
(8) Issue a FEPA order
(9) Pest control
(10) Relocation of animals
(11) Restriction of animal transport/movement
(12) Restriction on animal breeding
(13) Ban or restriction on hunting, fishing and foraging
Remediation options
(14) Identification/removal of contamination source
(15) Processing or treatment of food products
(16) Selection of alternative land use
(17) Removal of topsoil
(18) Capping of contaminated land
(19) Liquid decontamination of soil
(20) Natural inactivation
(21) Clean feeding/selective grazing regime
(22) Veterinary intervention to animals
(23) Culling of livestock
(24) Decontamination of animal premises
(25) Decontamination of food premises
Waste disposal options
(26) Selection of alternative product use
(27) Burning in-situ (pre-harvested crops)
(28) Disposal of foodstuffs
(29) Disposal of animal wastes
Note: The order in which the datasheets are presented should not be taken as the preferred order of their implementation. All options should be considered

Table 2.9: Index of recovery options for inhabited areas

Protection options
(1) Restrict public access
(2) Controlled workforce access
(3) Impose restrictions on transport
(4) Temporary relocation from residential areas
(5) Medical intervention
(6) Pest control
Remediation options
(7) Removal/treatment of contamination source
(8) Reactive gases and vapours
(9) Gaseous decontamination of objects
(10) Reactive liquids
(11) Energy decontamination techniques
(12) Steam cleaning
(13) HEPA vacuum cleaning
(14) Modify operation/cleaning of ventilation systems
(15) Storage, covering, gentle cleaning of precious objects
(16) Natural inactivation
(17) Soil and vegetation removal
(18) Barriers to seal land contamination
Waste disposal options
(19) Removal and disposal of contaminated material
(20) Burial in-situ
(21) Incineration
Note: The order in which the datasheets are presented should not be taken as the preferred order of their implementation. All options should be considered

Table 2.10: Index of recovery options for water environments

Protection options
(1) Isolate and contain water supply
(2) Restrict water use (DND/DNU notices)
(3) Alternative drinking water supply
(4) Boil notices
(5) Controlled blending of drinking water supplies
(6) Restrict access to inland, recreational or coastal (controlled) water environments
(7) Restrict transport to inland, recreational or coastal (controlled) water environments
Remediation options
(8) Removal/treatment of contamination source
(9) Continuing normal water treatment (with monitoring)
(10) Introduction/modification of existing water treatment
(11) Changes to water abstraction point or location of water source
(12) Water treatment at point of use (tap)
(13) Flush distribution system
(14) Treatment of sludge
(15) Natural inactivation
Waste disposal options
(16) Drain to temporary storage
(17) Discharge off site using tankers (tankering)
Note: The order in which the datasheets are presented should not be taken as the preferred order of their implementation. All options should be considered

Figure 2.2 shows an overview of the factors that need to be considered, although decision makers and other stakeholders may identify additional ones on an incident-specific basis. Each factor is considered in more detail in Section 2.6.

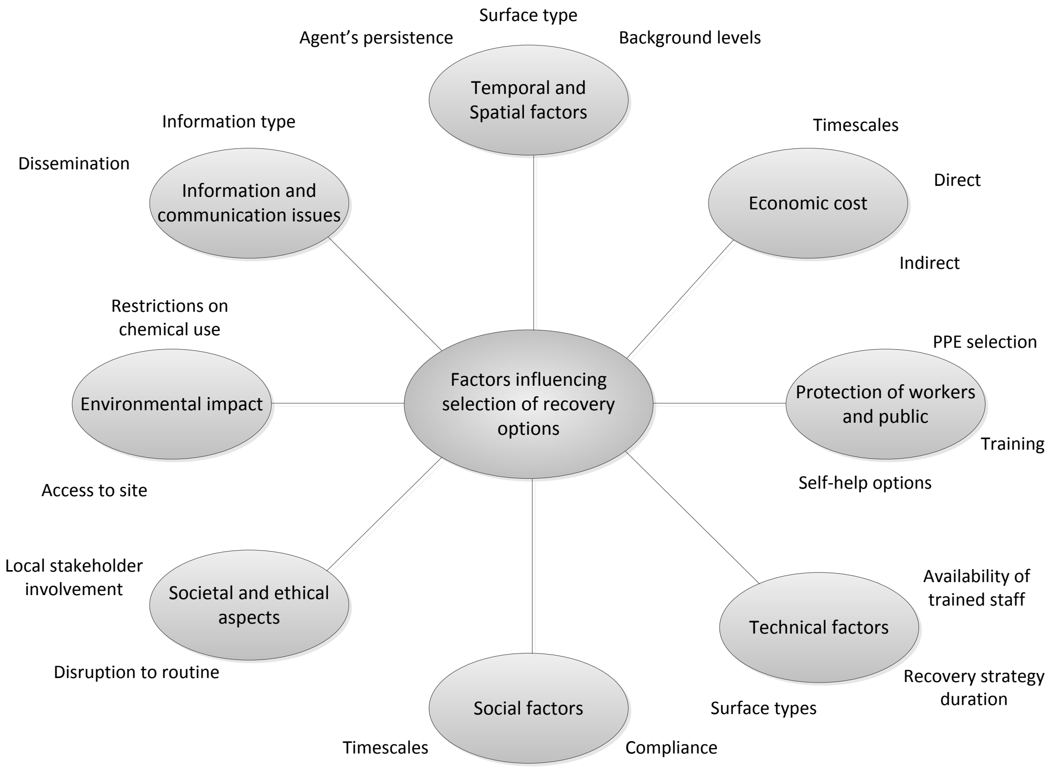

Figure 2.2: Summary of the main factors influencing selection of recovery options

2.6 Factors influencing selection of recovery options

2.6.1 Temporal and spatial factors

The potential for exposure to a biological agent will depend on the time and manner of release as well as the size and demographics of the contaminated area. The consequences of a biological incident will depend on the time of the release; for example, if a deliberate release occurred outdoors in the middle of the night, fewer people are likely to be outside and directly infected. Similarly, rush hour in an urban area/school drop-off times could result in larger numbers of people being infected. The demographic of people who are in contact with the contaminated areas will also represent a difference in infection, where infants, the elderly and immunocompromised people are more likely to be infected by an agent than are healthy adults.

Some biological agents do not exhibit extended persistence in the environment and will naturally inactivate quickly, whereas other, more persistent biological agents can remain for years (eg *B. anthracis* endospores). Agents may also transfer from the location where the original contamination occurred due to wind, water seepage, vehicle or people movement, or through the food chain to the food processing system. Furthermore, the spread of contamination in the area may increase or decrease over time, depending on the biological characteristics and how the agent persists and disperses in the environment.

The background levels of an agent in the environment will also be important. If the background levels of the agent are known then during remediation the agent can be reduced to this level. This will, however, need to be decided prior to the remediation processes being undertaken by the appropriate bodies. Certain areas will have guidelines in place to identify the level to which the organism needs to be reduced in order to be acceptable, eg hospital water systems and *Legionella pneumophila* colony counts[2].

2.6.2 Technical factors

Technical factors that can influence the effectiveness of recovery options can be relatively straightforward to identify with appropriate planning in advance of an incident (see Chapter 3), and do not depend on judgement or societal issues, and include:

- availability of staff, equipment, methodology, transport, resources and access to the incident
- duration of the recovery strategy to facilitate return to normal (ie treatment and application)
- characteristics of the biological agent(s) involved in the incident
- surface type (eg robust or sensitive), land use (eg agriculture, livestock and domestic use such as allotments) and water use (eg drinking water or recreational waters)

More detailed technical factors are highlighted for each of the recovery options sheets for food production systems, inhabited areas and water environments in their respective chapters.

2.6.3 Social factors

The effectiveness and ability to apply the recovery options are also influenced by a wide array of social factors. For example, the recovery option ‘restriction of public access’ will be affected by the ability of the authorities to control the movement of people in and out of the contaminated areas and their compliance with instructions and advice (ie hand washing); people cannot be forced to comply, may not understand the instructions or be able or willing to follow them.

Social factors arise from people’s behaviours, attitudes and perceptions. In contrast to technical factors, the impact of social factors on the effectiveness of recovery options is difficult to quantify and may depend on the acceptability of the option, based on the judgement of the public. Social factors include:

- timescale for decision making and implementation of recovery options
- acceptability and compliance with procedures (implementers)
- expertise and training in new technology
- acceptability to general public, consumers and environmentalists
- willingness of local populations to accept wastes
- willingness of privately owned facilities to accept wastes (this may also be influenced by commercial capacity and licence issues)

2.6.4 Societal and ethical factors

The consequences of a biological incident raise not only technical and health-related problems, but also societal and ethical issues. Biological contamination on a large scale has an impact on living conditions at an individual and community level, and may also have a severe impact on the economy.

It is necessary to remember that even though a recovery option can be extremely beneficial there can be associated implications that can decrease the quality of life for those affected. Implementation of some recovery options can be disruptive to normal social and economic life and may cause panic, stress or upheaval to those affected, possibly resulting in damage to health and well-being. Those people particularly susceptible are elderly people, parents with young families and pregnant women. Failure to take positive action and carry out protective measures may also cause anxiety, often exacerbated by a lack of objective information.

Conversely, the implementation of a recovery option can provide reassurance to members of the public or a workforce in the contaminated environment. The activity of remediating an area can also provide a positive impact by increasing the visual aesthetics of that area and this process might involve local companies, thus benefiting the area financially.

Societal and ethical factors are also relevant to the management of the contaminated areas, and the implication of any actions on the population should be considered, taking into account individual and community concerns and recognising the need to involve local stakeholders in the identification of problems and their solutions.

It is important to engage the members of the RCG to gain their knowledge and assess the social implications of the recovery strategy. The involvement of stakeholders may take into account attributes other than those directly related to protection from biological contamination. This allows those concerned with the situation to be involved and be given the opportunity to participate in the decision-making process under non-crisis conditions. Stakeholder involvement is an important component of the decision-making process, and in some cases it is essential for arriving at the most appropriate recovery strategy for building trust in decision-making authorities.

Societal and ethical aspects must also form part of the decision-making process. Decision makers should define the strategy not only according to technical criteria, but also to cultural and ethical points of view. In practice, the choice of recovery option will almost always involve a balance or trade-off between public health, economic and social consequences, as well as trade-offs between the interests of different stakeholders and the communities of the stakeholders. Such complexity means that it is difficult, if not impossible, to predict the way in which these factors may impact on the recovery strategy. It might be necessary to hold discussions with the people affected by the contamination on all of the potential issues as part of an effective recovery strategy.

In this respect a variety of tools and procedures can be used to help initiate a discussion of societal and ethical aspects. Such processes need to be open, transparent and inclusive and directed towards both citizens and technical experts.

2.6.5 Ethical considerations

There are a number of ethical considerations that will need to be taken into account when developing a recovery strategy; some of the major points are detailed below.

Self-help options (see also Section 2.2.3) that are carried out by the affected population, such as liquid decontamination, can increase personal understanding or control over the situation. Furthermore, through this self-involvement, the population reinforce their autonomy and feeling of self-worth. Conversely, imposed recovery options such as temporary/permanent relocation from residential areas can infringe upon liberty or restrict normal behaviour, while causing resentment in that population.

Animal welfare is concerned with the amount of suffering the recovery option may inflict on animals such as pets, zoo animals, and farm or wild animals. Members of the public will often go to great lengths to ensure their pets are adequately cared for and safe, which can cause issues if there is a need for quick action that might separate a pet from its owner. If animals reside in a contaminated area, humane methods of control will need to be established.

There can be a negative risk to the environment from implementing a recovery strategy; recovery options that change or interfere with ecosystems may have uncertain or unpredictable consequences on the environment. Environmental risk raises a variety of ethical issues including consequences for future generations, sustainability, cross-boundary pollution, and balancing harms to the environment/animals against benefits to humans. The acceptability of the recovery option will be highly dependent on the ecological status of the area and the degree to which the recovery option diverges from usual practice. In most cases, environmental legislation must be considered.

2.7 Recovery workers

2.7.1 Protection of workers

During the initial incident members of the public are most likely to be affected by the biological contamination of the area. As the recovery of the area starts then the risk is transferred to the workers facilitating the recovery. Therefore it is necessary to ensure the workers involved in the recovery are informed of the necessary precautions to sufficiently protect them from the biological hazard and any other environmental hazards in that area.

A number of protective measures may be chosen to reduce the risks to workers, according to the requirements of the specific situation and circumstances. Personal protective equipment (PPE) should only be used where this risk cannot be reduced to be as low as reasonably practicable (ALARP) by other means.

Effective PPE will depend on the contaminating agent and how it is presented; for instance, if an agent causes a gastrointestinal disease, such as Shiga toxin producing *E. coli* O157, then the PPE worn should be designed to reduce transmission by the oral route. However, an agent such as *Aspergillus spp.,* which can cause respiratory tract infections, will need additional PPE to reduce risk of inhalation. In these instances the Health and Safety at Work etc Act 1974, the COSHH Regulations and relevant risk assessments will apply.

Excessive, unnecessary and clearly visible protection of workers (ie full HAZMAT suits) may contribute to the anxiety of local inhabitants of the area; therefore their use should be justified. However, due to uncertainty in the potential exposure a high level of PPE may be recommended. Safety precautions are discussed in general terms within individual recovery option sheets (see Chapters 5, 7 and 9), but it should be the responsibility of the recovery workers' organisation to ensure that the correct PPE is worn and effective training has been given to the workers on its use and removal.

Some PPE can be strenuous and physically demanding to wear. For some items time limits may be set to ensure the user does not become adversely affected from using the PPE. This can be dependent on the environment the user will be in; for instance, a hot day may cause a decrease in the time the user can wear the PPE before they become overheated, with thermal stress being a major consideration.

2.7.2 Workers implementing recovery work

The recovery workers will be entering a contaminated area where they will be at risk of becoming infected with a biological agent. It will be necessary to perform a risk assessment to identify the major hazards associated with the remediation work prior to it being undertaken. As part of this risk assessment advice should be given to the workers on the potential hazards from the biological agent. Preliminary agent data for the prioritised agents discussed in this handbook can be obtained on request to biological.recovery@phe.gov.uk. The interpretations included in the data sheets can be used to complete the risk assessment and used for occupational health assessments. Occupational health assessments can then be used to determine if there is a need for prophylaxis treatment or vaccinations before any work is undertaken, whether follow-up monitoring after the work has been completed is necessary and what medical treatment options should be taken if a worker is infected by the agent.

Recovery workers should be appropriately trained and provided with appropriate PPE according to the hazard that is being dealt with. This should be accompanied by appropriate decontamination of equipment and pre-planned entry and exit protocols to the site. The different levels of PPE will vary from the use of disposable latex/nitrile gloves to a worker using a positive pressure biocontainment suit.

Data (exposure and accident/injury documentation) should be collected and managed to facilitate consistent information sharing among the agencies taking part. This will also help in the provision of appropriate recovery worker medical surveillance and monitoring, and highlight whether further long-term epidemiological studies are required. Workers should be supported with psychological aid during what may be exhausting work. All these tasks and insights into the specifics of recovery workers will help ameliorate future incident response training.

2.7.3 Occupational exposure limits

Although there are no workplace exposure limits (WELs) set for microorganisms, some of the chemicals used in remediation processes are subject to WELs and this will need to be considered when undertaking remediation[3]. Workplace exposure limits are published by the HSE in the UK (document EH40/2005) and are available at the following link: http://www.hse.gov.uk/pubns/books/eh40.htm.

WELs are not available for a large proportion of chemicals. In these cases expert advice should be sought and a risk assessment undertaken. Secondary exposure of workers following implementation of recovery options also needs to be considered.

When dealing with hazardous substances, including microorganisms, a risk assessment must be undertaken to consider how workers may be exposed and what can be done to limit any exposure. The COSHH Regulations require that exposure must be adequately controlled to a level that will not harm individuals health. This is applied not only to recovery workers but also to those who may come into contact with the biological agent, such as members of the public.

The Advisory Committee on Dangerous Pathogens (ACDP) provide a guidance document[4] which can be used to aid the risk assessment process and which provides information on the chain of infection, sources of infection, transmission routes and host factors, all of which need to be considered prior to the commencement of a remediation strategy. The document is available at the following link: http://www.hse.gov.uk/pubns/infection.pdf.

Further documentation to be consulted includes the COSHH 2002 Regulations[5] and The Personal Protective Equipment at Work Regulations 1992[6]. Both of these legislative documents can be used to provide information on the type of PPE which may be used by recovery workers during the remediation process, which, as mentioned earlier, will be determined by risk assessment. Recovery workers should be trained in any necessary PPE required prior to starting work, including fit testing for respiratory protective equipment. It is also possible that following a large-scale biological incident volunteers may act as recovery workers and hence require increased and intensive training in the use of PPE.

2.8 Environmental impact

A recovery option may have a positive, negative or both positive and negative impact on the environment. Therefore it is necessary to consider the impact the option might have on the environment during the decision-making process, ensuring that action is justified.

The positive impacts on the environment can be witnessed when the contaminating source is removed from the area, which will make the land and watercourses cleaner.

The decision to employ a recovery option might cause a negative impact on the environment. An example of this would be if a significant number of people were moved during a relocation process, the increase in human traffic might cause an increase in noise and air pollution and therefore have a negative environmental impact. Other impacts could happen to the natural ecosystem if a decontamination method is used which will adversely affect the naturally occurring organisms within that area.

For example, the recovery option of barriers to seal any contamination can cause negative impacts if a large area is covered or the covering makes the area more flood prone and could damage the environment in that way.

2.9 Economic cost

Implementation of any recovery option will incur some economic cost, both directly and indirectly. Examples of direct and indirect costs are given in Table 2.11. The magnitude of these costs depends on many factors, including:

- period of time over which a recovery option is implemented
- scale of the event – generally costs are proportional to the area of land affected
- land use
- availability of equipment and consumables

Table 2.11: Summary of some of the economic costs associated with implementing recovery options

Direct costs
Labour: salaries for the workforce involved (may need to be supplemented for the type of work being undertaken), overhead costs to organise the work, requirement for additional staff that need to be employed especially if there is a need for training of those staff
Cost of any monitoring that needs to be undertaken (equipment, etc) and medical follow-up
Consumables: specific products are necessary for particular recovery options, including handling of waste (see recovery options in Chapters 5, 7 and 9)
Specific equipment: some recovery options (see recovery options in Chapters 5, 7 and 9) require dedicated equipment that may have to be hired or purchased (investment cost and training) and subsequently maintained and possibly decontaminated after use
Communication: information for the general public (guidance on behaviour, information for transparency and reassurance, etc) this might be in the form of social media, but also press releases and even advertising on commercial media networks
Transportation: workforce, residents, etc
Direct costs for handling waste products
Labour: workers will need to be employed to move and process the waste
Storage: the waste may need to be stored initially before it can be transported to a processing facility
Special consumables for interim storage and processing of by-products after the intervention
Dedicated equipment: special containers conforming to transport regulations[7], etc
Design of a short-, medium- or long-term storage facility
Decontamination of the equipment used for waste collection, packaging and clean-up
Transportation: distance to appropriately licenced disposal/processing facilities may be significant
Research and small-scale testing of waste recovery options
Indirect costs
Changes to outdoor areas can have an impact on soil structure and fertility and may raise the risk of soil erosion. This might then incur costs to put in place environmental protection options
Loss of production because of the closure of business and industries, with subsequent effects on individuals' salaries and business' reputation
Temporary or permanent restriction of access and a reduction or loss of tourism may have an impact on businesses (particularly small businesses). The impact may also be experienced across the whole region if tourists avoid areas near to the contaminated area for fear of contamination
Restrictions on subsequent land use once recovery options have been implemented may mean that people cannot live or work in certain areas or return to a normal lifestyle. This may result in relocation costs or business closures
Cost of replacing personal possessions/furniture following an indoor incident
Costs of relocation (feeding/housing)
Infrastructure costs of closure of airports/railway station
Indirect loss down the supply chain when production is stopped, as particular supplies and services will no longer be required
Implementation of recovery options to restore or conserve both the agricultural potential of an area and also the broader environment may cause changes in soil structure (eg capping of contaminated land or liquid decontamination of soil)
Loss of market share. Even if the food products originating from the affected area comply with regulations, customers and, consequently, the retail industry may have lost confidence and refuse to buy the products even when the situation has returned to normality from a biological point of view. Products from other regions will be imported to the market of the affected area, and this lost market share may prove difficult to recover
Regional impact. Consumers may refuse to buy products from a much larger area than that directly affected (eg county, province, national or even international levels)
Restrictions on subsequent land use. Land may be used for non-food production requiring investment of resources in alternative seed stocks, expertise, new markets (eg processing industry) and marketing
Impact on social and economic fabric, such as tourism but also on the whole economy of the region (if, for example the recovery option chosen is 'alternative land use'). However, if the outcome was that farmland was converted to a golf course, this may have a positive impact on the area and may even increase recreation use and attract tourism

2.10 Information and communication issues

It is very important to ensure there is an effective communication and information strategy that can be put in place in response to a biological contamination event. This will be important regardless of the scale of contamination, but certain recovery options will require more communication input than others. Protective recovery options such as temporary relocation from residential areas or medical interventions will require a large amount of thought and planning, whereas protective options, ie reactive liquids, may need only a brief communication plan. The communication strategy will form part of the effective recovery option implementation. If communication is not planned in advance of an incident, it may prove difficult to ensure the process is accurate, appropriate and consistent, causing further issues.

2.10.1 Mechanisms for communication and dissemination

A major consideration of communication and information dissemination is to maintain the public's trust in the authorities and responsible organisations that are involved in the recovery strategy. Trust is difficult to build in the beginning, fragile to maintain, can be easily lost and is even harder to re-establish. Information will be limited at the start of a biological incident so the communication must reflect this and any advice produced will be precautionary. In the majority of cases people will need information and advice on what they can do as self-help options because they will want to start the recovery process as early as possible.

2.10.2 Developing a communication framework

The communication strategy framework should be defined and developed during non-crisis conditions. While it is not possible to have a framework in place to cover every incident, it would be prudent to have a set of dynamic strategies that can be adapted to different situations. A number of key considerations are:

- a single body must be used for the communication releases. This should be defined and agreed early to ensure there is no ambiguity or contradiction that will be relayed to the affected community
- the information released needs to be tailored to ensure it is at the right level for the target audience, ie those inside and outside the affected area, those involved in implementing actions and those affected by the actions
- the form of communication should be adapted for those for whom it is intended. For some groups it might be necessary to include more specific details within the information, whereas a more generic message can be acceptable for other groups. The communication strategy should also decide whether communications are better given face to face (community forums) or through structured press releases
- during the recovery phase the communicating authority should be able to consult with a range of people to ensure that the correct messages are released depending on the needs of that community. Consultations should be made with experts and lay people to ensure communications meet the needs of the affected communities
- evidence should be recorded appropriately as it may be required at a later date; for example, if a prosecution was to occur

Consideration to some of the communication and information issues should be given:

- biological incidents are often only discovered after the initial exposures have taken place, often when those exposed visit their local medical facility. Therefore it can be difficult to accurately ascertain the scale and impact of the contamination until sampling or epidemiological data has been analysed more fully
- while the agent data sheets within the handbook contain data on the medical interventions that can be used for the contaminating agents, the use of this information coupled with public health advice should be considered carefully before inclusion in a communication to avoid any undue worries for the community
- as the incident develops communications might occur from other unofficial sources such as from the community on social media. It will need to be established whether these should be responded to or additional official communications released to allay disquiet
- security of information is of high importance, avoiding ‘leaks’ of inappropriate information

Clear, pre-planned protocols for communication with the media and community are essential. Media messages play a vital role in public order following a biological incident and during the recovery phase. The development of a detailed communication strategy is not discussed further in this handbook.

2.11 References

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2 HSE. Legionnaires’ disease. Part 2: The control of legionella bacteria in hot and cold water systems. HSG274 Part 2. 2014. Available (September 2015) at www.hse.gov.uk/pubns/priced/hsg274part2.pdf

3 World Health Organization. WHO Guidelines for Indoor Air Quality: Dampness and Mould. 2009. Available (September 2015) at http://www.who.int/indoorair/publications/7989289041683/en/

4 Advisory Committee on Dangerous Pathogens. Infection at work: Controlling the risks. A guide for employers and the self employed on identifying, assessing and controlling the risks of infection in the workplace. 2003. Available (September 2015) at http://www.hse.gov.uk/pubns/infection.pdf

5 The Control of Substances Hazardous to Health Regulations. 2002. Available (September 2015) at http://www.legislation.gov.uk/uksi/2002/2677/contents/made

6 The Personal Protective Equipment at Work Regulations. 1992. Available (September 2015) at http://www.legislation.gov.uk/uksi/1992/2966/contents/made

7 International Air Transport Association. IATA Dangerous Goods Regulations (DGR). Available (September 2015) at http://www.iata.org/publications/dgr/Pages/index.aspx

3 Planning for Recovery in Advance of an Incident

The response to a biological contamination event will be dependent on the potential impact of the incident. Primarily, incidents will be managed at a local level as the majority will only affect a small area/single property. However, for high impact incidents that affect multiple properties or one that concerns a high hazard biological agent there may be the requirement to form a national recovery group to oversee clearance.

Emergency plans should be produced that can be used whenever incidents occur. These generic plans can be used by the authorities and responders for training purposes to ensure they are adequately prepared to deal with a biological incident. Training is usually aimed at first responders and the emergency services and will cover the initial response to the incident. This can be similar for small- and large-scale incidents, but the training usually does not include the clean-up phase post-incident (the transition from 'blue to amber light'). In this phase of the response it can be difficult to predetermine the recovery options that will need to be implemented due to each incident having different considerations (eg biological agent, area contaminated and level of contamination). Emergency planning might take into account some of the recovery options, such as restriction of public access or temporary relocation by the implementation of measures such as emergency cordons or evacuation, but rarely includes more specific options such as the removal of contamination or decontamination options that are likely to help reduce the time taken to restoring the area back to 'normality'.

This chapter is designed to identify the major factors that need to be addressed and information that is required to develop the emergency planning process that will assist with the recovery strategies for each incident.

Forward planning and thorough preparation can increase the effectiveness of a response to a biological incident. As part of this planning and preparation, Table 3.1 shows the range of guidance documents available for reference in advance of an incident.

3.1 Preplanning for the recovery of food production systems

Biological incidents can spread rapidly in food production systems, often due to the close proximity of crops/animals during farming, or if there is a delay in identification of contamination resulting in the production of large quantities of food prior to the issue being identified.

Costs and time pressures can quickly increase following an incident even prior to remediation, with restrictions placed on the transport and sale of animals and food. Furthermore, financial losses may be considerable and may not be covered by company insurance; an example would be the requirement to dispose of bulk stored food products which have been contaminated. With biological outbreaks involving animals (eg foot and mouth disease) the restrictions placed on movement are likely to spread over a wide area and whether there are single or multiple geographical sources is an important consideration. The same can be witnessed with crops that have been affected by biological incidents. Further details on how to deal with these incidents can be found by contacting Defra or APHA (https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs and https://www.gov.uk/government/organisations/animal-and-plant-health-agency).

Table 3.1: Summary of national planning and preparation guidance

Guidance	Issued by	Date	Web address
Guidance on development of a Site Clearance Capability in England and Wales	Department for Communities and Local Government	2005 (Annexe A updated 2012)	https://www.gov.uk/government/publications/guidance-on-development-of-a-site-clearance-capability-in-england-and-wales Updated Annexe A: https://www.gov.uk/government/publications/guidance-on-development-of-a-site-clearance-capability-in-england-and-wales-annex-a
Strategic National Guidance: The decontamination of buildings, infrastructure and open environment exposed to chemical, biological, radiological or nuclear materials	HM Government/ Government Decontamination Service	2015	http://www.cabinetoffice.gov.uk/resource-library/strategic-national-guidance-decontamination-buildings-infrastructure-and-open-envirhttps://www.gov.uk/government/uploads/system/uploads/attachment_data/file/402645/Strategic_National_Guidance_4th_Edition.pdf
Arrangements for Health Emergency Preparedness, Resilience and Response from April 2013	Department of Health	2012	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/215083/dh_133597.pdf
National Risk Register for Civil Emergencies	Cabinet Office	2013	https://www.gov.uk/government/publications/national-risk-register-for-civil-emergencies-2013-edition
Preparing Scotland: Scottish Guidance on Resilience	Scottish Government	2012	http://www.gov.scot/Publications/2012/03/2940
Emergency responder interoperability lexicon; Lexicon of UK Civil Protection Terminology	Cabinet Office	2013 (version 2.1.1)	https://www.gov.uk/government/publications/emergency-responder-interoperability-lexicon
Emergency responder interoperability: common map symbols	Cabinet Office	2012 (version 1.0)	https://www.gov.uk/government/publications/emergency-responder-interoperability-common-map-symbols
Bellwin scheme of emergency financial assistance to local authorities	Department for Communities and Local Government	2014	https://www.gov.uk/government/consultations/bellwin-scheme-of-emergency-financial-assistance-to-local-authorities
Emergency Financial Assistance Scheme	Welsh Government	2011	http://gov.wales/topics/localgovernment/finandfunding/emergency/?lang=en
Emergency Response and Recovery	Cabinet Office	2010 (updated 2013)	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/253488/Emergency_Response_and_Recovery_5th_edition_October_2013.pdf
Protecting against terrorism	Centre for the Protection of National Infrastructure	2010 (3rd edition)	http://www.cpni.gov.uk/documents/publications/2010/2010002-protecting_against_terrorism_3rd_edition.pdf
Support for Recovery from Exceptional Emergencies	Department for Communities and Local Government	2009	https://www.gov.uk/government/publications/support-for-recovery-from-exceptional-emergencies

Guidance	Issued by	Date	Web address
UK Recovery Handbook for Chemical Incidents	Public Health England	2012 (version 1)	https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
CBRN incidents: clinical management and health protection	Public Health England	2008 (version 4)	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/340709/Chemical_biological_radiological_and_nuclear_incidents_management.pdf
UK Recovery Handbook for Radiation Incidents	Public Health England	2015 (version 4)	https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015
Guidance on Claiming Emergency Capital Highway Maintenance Funding	Department for Transport	2007	http://webarchive.nationalarchives.gov.uk/+/http://www.cabinetoffice.gov.uk/media/230802/dcsf-funding-guidance.pdf
Guidance on the Possible DCSF Funding for Recovery from Future Emergencies	Department for Education		http://webarchive.nationalarchives.gov.uk/+/http://www.cabinetoffice.gov.uk/media/230802/dcsf-funding-guidance.pdf
National Recovery Guidance	Cabinet Office	2013	https://www.gov.uk/national-recovery-guidance
Precautions to minimise effects of Chemical, Biological Radiological or Nuclear Event on Buildings and infrastructure	Department for Communities and Local Government	2004	https://www.gov.uk/government/publications/precautions-to-minimise-effects-of-a-chemical-biological-radiological-or-nuclear-event-on-buildings-and-infrastructure
National Recovery Guidance – Economic Issues	Cabinet Office	2013	https://www.gov.uk/national-recovery-guidance-economic-issues
The release of CBRN substances or material – Guidance for Local Authorities	Cabinet Office	2006	https://www.gov.uk/government/publications/the-release-of-chemical-biological-radiological-or-nuclear-cbrn-substances-or-material-guidance-for-local-authorities
Strategic National Guidance: The decontamination of people exposed to CBRN substances or materials	Cabinet Office	2006	https://www.gov.uk/government/publications/strategic-national-guidance-the-decontamination-of-people-exposed-to-cbrn-substances-or-material
The Civil Contingencies Act	Cabinet Office	2004	http://www.legislation.gov.uk/ukpga/2004/36/contents
Viral haemorrhagic fevers: epidemiology, characteristics, diagnosis and management	Public Health England	2014	https://www.gov.uk/government/collections/viral-haemorrhagic-fevers-epidemiology-characteristics-diagnosis-and-management
Flooding: health and advice guidance	Public Health England	2014	https://www.gov.uk/government/collections/flooding-health-guidance-and-advice
Flooding: food safety advice	Food Standards Agency	2014	https://www.food.gov.uk/science/microbiology/flood
Preparation and planning for emergencies: the National Resilience Capabilities Programme	Cabinet Office	2013 (updated 2014)	https://www.gov.uk/preparation-and-planning-for-emergencies-the-capabilities-programme

The level of planning needed will be determined by the potential impact of the biological incident. One of the major topics that will need to be addressed during planning is how to dispose of the waste that will be produced during remediation of the incident. The waste will not be limited solely to that from the decontamination process used on the area, but planning should take into account the perishable nature of foodstuffs, as this could produce a large quantity of waste for disposed. These waste disposal arrangements, including transport of hazardous materials, will be specific to each site and depend on the local infrastructure and resources.

A summary of the data and information topics that can be gathered prior to an incident is given in Table 3.2. This table shows what information can be applicable to recovery efforts. Having localised archives detailing commercial and private food producers, suppliers of raw materials (animals and crops) and waste disposal facilities is advocated and will speed up the response and remediation of an incident. These databases should have a single point of contact, as again this will speed up the retrieval of information from them, additionally this will allow them to be maintained more readily.

While Table 3.2 provides a wide range of information that would be usefully gathered, it is acknowledged that it may take considerable additional effort to complete this task if it is not done routinely. Therefore prioritisation of the information should be completed to ensure the resources are best used. Table 3.3 shows an additional list of factors to consider when developing outline arrangements for a recovery strategy, primarily focusing on the local level.

Table 3.2: Summary of data and information that could be usefully gathered in advance of an incident for food production systems

Topic	Category	Data and information requirements
Land use	Agricultural production – animals	Identification of milk producers/purchasers within an area Identification of private dairies and major on-farm consumers Identification of small holdings with domestic livestock, eg goats and hens Availability of alternative animal feeds
	Agricultural production – crops	Scale and crops that are being grown in the local area Information on harvest times for different produce
	Domestic production	Information on scale and distribution of domestic production in an area, eg areas with allotments and small holdings Information on feeding regimes of domestic livestock Identification of allotment holders and other types of domestic producer Identification of domestic produce areas on local flood plains
	Gathering of free/ wild foods	Information on scale and importance of free/wild food collection in an area Identification of areas where gathering of free foods is common at different times of the year
	Hunting/fishing	Availability of, or access to, database of people with licences for fishing and firearms in the area (Environment Agency)

Topic	Category	Data and information requirements
Recovery options	Legislative processes/ contractors	Identify any government agency or legislation that needs to be addressed prior to remediation Identify the major contractors for implementation of the food production systems recovery options. Consultation with the GDS will help to identify key contractors (https://www.gov.uk/government/groups/government-decontamination-service)
	Equipment	List of equipment required for implementation of options and indication if this is 'specialist' machinery and likely to be in limited supply
	Infrastructure	Availability of, or access to, database with local/regional information on road networks, sewage and water treatment facilities, licenced landfill and incineration facilities, composting sites, slaughterhouses and rendering facilities List of locations where contaminated material, equipment, etc, may be stored
	Personnel	Identify organisations that can assist in the remediation process, eg PHE and GDS Establish whether skilled personnel are required to operate equipment and the numbers that would be available in a particular area/region Establish safety criteria for working in contaminated areas Prepare template for risk assessment Identify training requirements where there might be a shortage of skilled workers
	Impact on the economy/ environment	Consider the likely scale of the economic impact from implementing each of the recovery options Consider whether some options could have a negative impact on the local environment, eg sites of special scientific interest, national parks, areas of outstanding natural beauty, nature reserves and historic buildings
	Acceptability	This is likely to be influenced by the type of biological incident, its scale, how the response is handled, the cause of the incident, etc. Exercises run to test remediation from an incident can help gauge whether some recovery options are acceptable to the stakeholders and the public Establish whether there is a framework in place locally for stakeholder engagement and agree in advance how it would be used
	Members of the public	Arrangements for communications through local/national TV and radio, and websites Timelines for these announcements Plan for engaging local people in decisions that will affect them
Communication	Provision of information to implementers of recovery options	Provision of information on the objectives of the recovery option to ensure that those implementing the option understand why it is being undertaken and how the objectives can be achieved. Leaflets to provide instruction on how to implement options correctly and effectively for self-help options

Table 3.3: Factors and actions that may need to be considered when developing an outline recovery strategy for food production systems

Topic	Factors and actions to consider
Generic strategy	Ensure information requirements (see Table 3.2) are prioritised, put into action, achieved and maintained – there should be confidence that information is complete, reliable and up to date Establish mechanisms for accessing information, ie a single point of contact or easy access to the databases Develop a set of communication strategies with pre-prepared information for different audiences, eg consumers, farmers and allotment holders. Establish the audience and the message and how it will be conveyed Produce and maintain a risk register for things that could go wrong in the development of the strategy, eg non-compliance or local population will not engage in dialogue. Identify drivers and barriers and establish which ones will make the biggest difference
Roles and responsibilities	Ensure the roles and responsibilities of the agencies that would undertake tasks in the recovery response are well known – identify the leading agencies and legal responsibilities Establish how the roles and responsibilities change along the timeline Consider for each recovery option how the available resources will be coordinated and moved to the affected area
Role of stakeholders	Identify existing stakeholder groups in the area, eg parish councils and community groups. Investigate whether these could/would be prepared to provide feedback on a recovery strategy for the area Consider processes that could be used to establish bespoke stakeholder panels where no relevant groups exist
Recovery options	Identify practicable and acceptable recovery options for use at the local level based on information provided in this handbook in advance (Chapters 4 and 5) Identify aspects for each recovery option that will require consideration in advance of a biological incident emergency and those that will be of particular importance to be taken into account in the event of an emergency Consider trials of the recovery options, to obtain a better understanding of the effectiveness and feasibility
Criteria for a successful strategy	Identify appropriate criteria to be used to determine whether a remediation strategy has been successful and/or how this can be demonstrated

3.2 Preplanning for the recovery of inhabited areas

In inhabited areas, there is a wide range of surfaces that may be contaminated after a biological incident. Although the size of the area affected by the biological contamination will affect the complexity of the recovery, other aspects will also cause issues, such as the contaminating agent and the use of the contaminated buildings. These are likely to be site specific according to the characteristics of the local infrastructure.

As with food production systems there will be pressures caused by time and associated costs following biological contamination of inhabited areas. These can escalate quickly depending on the area that is contaminated. For example, a city centre or business district will be affected more than a single building. The waste produced will also be dependent on the sub-areas contaminated. Commercial properties, such as shops, will potentially have merchandise that may need to be destroyed if they are contaminated. A private residence will produce a mixture of contaminated objects, some of which can be disposed of but others may have sentimental value and need to be returned to the owners in a decontaminated and undamaged state. Therefore the recovery options need to reflect this approach. The use of recovery options will need to be considered depending on the surface types that are present in the contaminated area because some recovery options are more effective against certain surface types. More details are given in Chapters 6 and 7 on these issues.

Table 3.4 contains potentially useful data and information requirements that could be gathered before a biological incident to aid in planning a response and kept within a database. The production of such databases should allow easy access to them and will help to reduce any delays in implementation of the remediation phase after a biological incident has been identified. The data recommended to be compiled is comprehensive and may take some time to collect. But once it has been collated it can be updated relatively simply by those responsible when further information becomes available. If the organisation is small and there are limited resources available then the information can be prioritised within the database. This will allow organisations at the local level to develop their own approach for preparing for a biological incident, according to their responsibilities and involvement.

Table 3.5 gives a list of factors, in addition to the information requirements listed in Table 3.4 that might need to be considered when developing outline arrangements for a recovery strategy, focused at the local level, in advance of an incident. Dialogue between different stakeholders is important to gain a balanced view on various aspects of topics at the national, regional or local level. It enables a common language and a shared understanding of the challenges to be developed.

Table 3.4: Summary of data and information that could be usefully gathered in advance of an incident for inhabited areas

Topic	Category	Data and information requirements
Population	General issues	Size and distribution Groups, eg age, religious groups and patients Movements, eg commuters Where the population spend their time
	Temporary relocation	Numbers of people Availability of and provision of resources for accommodation/housing Availability of transport and infrastructure When the population can return home
Building type		Construction material Internal surface composition Configuration, eg multistorey, terraced, semi-detached and detached Leakiness of building Air exchange/ventilation
Types of land use		Industrial Recreational Public buildings Residential Critical facilities, eg factories and hospitals Infrastructure, eg roads and railways Designated sites, eg special protection areas, nature reserves and areas of outstanding natural beauty

Topic	Category	Data and information requirements
Recovery options	Technical feasibility	Which contractors/skilled personnel can implement the recovery option? Consultation with the GDS will help to identify key contractors (https://www.gov.uk/government/groups/government-decontamination-service) Identification of necessary training
	Available resources to implement recovery strategy	Local and regional availability of equipment and materials required Costs of resources: labour costs, cost of materials and equipment Whether skilled workers are required to operate equipment
	Personnel	Identify organisations that can assist in the remediation process, eg PHE and GDS
	Acceptability of recovery options	This is likely to be influenced by the type of biological agent and the size of the incident Public and other stakeholder views on the acceptability of the types of recovery options available
Waste management	Solid waste	Location and capacity of authorised waste storage, disposal and incineration facilities Quantities of domestic refuse produced weekly, including garden waste Disposal options for contaminated commercial goods that are un-saleable (not necessarily because they are highly contaminated) Transport to the waste facility Legislation on construction of waste facilities
Legislation	Options	Environmental legislation may preclude implementation of some recovery options in the contaminated area, eg introduction of decontamination chemicals. Further details on how to deal with these incidents can be found by contacting Defra, APHA or FERA (https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs, https://www.gov.uk/government/organisations/animal-and-plant-health-agency and http://fera.co.uk/)
	Workers and public	Consult with appropriate bodies to ensure the correct PPE and training is given to workers
Training		Consider developing a training programme for the roles required to be performed, eg decision makers and decontamination workers Provision of information on the objectives of the recovery option to ensure that those implementing the option understand why it is being undertaken and how the objective can be achieved
Contacts		List of contacts in organisations that have a role in the event of a biological emergency List of contacts with local information List of country/regional/local databases that provide useful background data and information on how to access them
Communication	Members of the public	Arrangements for communications through local/national TV and radio, and websites Timelines for these announcements Plan for engaging local people in decisions that will affect them
	Provision of information to implementers of recovery options	Provision of information on the objectives of the recovery option to ensure that those implementing the option understand why it is being undertaken and how the objectives can be achieved. Leaflets to provide instruction on how to implement options correctly and effectively for self-help options

Table 3.5: Factors and actions that may need to be considered when developing an outline recovery strategy for inhabited areas

Topic	Factors and actions to consider
Generic strategy	Ensure information requirements (see Table 3.4) are prioritised, put into action, achieved and maintained – there should be confidence that information is complete, reliable and up to date Establish mechanisms for accessing information, ie a single point of contact or easy access to the databases Consider how the protection recovery options will be employed and continued during other implementation of recovery decontamination options Consider employing a phased approach in which some contaminated areas are dealt with promptly, whereas others are treated later (for larger scale incidents) Consider the role of self-help options Produce and maintain a risk register for things that could go wrong in the development of the strategy (eg non-compliance). Identify positive and negative considerations and establish which ones will make the biggest difference
Roles and responsibilities	Make sure the roles and responsibilities of the agencies that would undertake tasks in the recovery phase are well known by all. Need to clearly identify leading agencies and legal responsibilities Establish how the roles and responsibilities change along the timeline Consider for each recovery option how the available resources will be coordinated and moved to the affected area
Role of stakeholders	Identify existing stakeholder groups in the area, eg parish councils and community groups. Investigate whether these could/would be prepared to provide feedback on a recovery strategy for the area Consider processes that could be used to establish bespoke stakeholder panels where no relevant groups exist
Recovery options	How the contamination is presented (adsorbed/free/inaccessible) on the surfaces Identify practicable and acceptable recovery options for use at the local level based on information provided in this handbook in advance Consider: • any constraints on use of options (from recovery options in Chapters 6 and 7) • impact of weather conditions, eg flooding from precipitation and temperature levels • aspects for each recovery option that will require consideration in advance of a biological incident and those that will be of particular importance to be taken into account in the event of an emergency Consider trials of the recovery options to obtain a better understanding of the effectiveness and feasibility
Protection of workers	Type of PPE to be worn by the remediation workers, which is dependent not just on the biological agent and its presentation, but on any environmental factors present in that area
Criteria for a successful strategy	Identify appropriate criteria to be used to determine whether a remediation strategy has been successful and/or how this can be demonstrated

3.3 Preplanning for the recovery of water environments

A variety of water environments can be contaminated following a biological incident, these are discussed in depth in Chapter 8, but briefly they can be divided into drinking water supplies that are either private or public, recreational water or rivers and lakes. The main points that will drive what level of response is needed to the incident will depend on the contaminating agent and the size of the contaminated area, which can vary on an incident-specific basis.

The type of biological incident and the water environment affected will determine how quickly the response will need to be initiated. Drinking water supplies will need to be dealt with rapidly to avoid the spread of infection to the recipients of the water, especially if the elderly, young or infirm are at risk. Temporary replacement measures (eg bottled water) for drinking water will be costly and difficult to sustain on a large scale so a quick response is needed to remediate the problem. Biological contamination of a recreational water area might be allowed to remain for a period of time before action is taken as it is not an immediate threat to the health of the public if they are restricted from the area. This also might allow the use of recovery options that could take a longer time to complete. These topics are covered in more depth within Chapters 8 and 9 of this handbook.

A breakdown of the topics that cover useful data and information required to be collated prior to a biological incident is shown in Table 3.6. It would be beneficial to collect this information and produce databases that can be easily accessed or have a single point of contact for them so information is readily available when required. A single point of contact or designated database owner will mean that the information within them can be periodically updated and maintained. Table 3.6 indicates a large amount of data from different sources that may take an extended period of time to collect; therefore it is prudent to prioritise the data to be collected to ensure the most important data is gathered first. This will allow organisations at the local level to develop their own approach for preparing for a biological incident, according to their responsibilities and involvement.

Table 3.7 gives a list of factors, in addition to the information requirements listed in Table 3.6 that might need to be considered when developing outline arrangements for a recovery strategy, focused at the local level, in advance of an incident. Dialogue between different stakeholders is important to gain a balanced view on various aspects of topics at the national, regional or local level. It enables a common language and a shared understanding of the challenges to be developed.

Table 3.6: Summary of data and information that could be usefully gathered in advance of a biological incident for water environments

Topic	Category	Data and information requirements
Population	General issues	Distribution and size of those affected Groups, eg school children, religious groups, patients, prisoners and tourists
Type of water environment		Drinking water supply (public or private), recreational, transport, etc Number of each type and volumes How many people use/rely on each environment Designated sites, eg special protection areas, nature reserves and areas of outstanding natural beauty
Recovery options	Technical feasibility	Which contractors/skilled personnel that can carry out the recovery option? Consultation with the GDS will help to identify key contractors (https://www.gov.uk/government/groups/government-decontamination-service) Consultation with the responsible water company Identification of necessary training

Topic	Category	Data and information requirements
	Available resources to implement recovery strategy	Local and regional availability of equipment and materials required Costs of resources: labour costs, cost of materials and equipment Whether skilled workers are required to operate equipment
	Impact of geography and weather on recovery options	Impact of long periods of adverse weather, eg droughts and floods
	Impact on the economy and environment	Consider the likely scale of the economic impact from implementing each of the recovery options Which options may have a negative impact?
	Acceptability of natural inactivation	Draw on experience from other emergencies/natural disasters to identify what factors drive the return to normality, including experience of using different types of equipment
	Acceptability of recovery options	This is likely to be influenced by the type of biological agent and the size of the incident Public and other stakeholder views on the acceptability of the types of recovery options available
Waste management	Liquid waste	Volume of waste likely to be produced Availability of holding containers Normal practices for disposal of waste Transport to the waste facility Legislation on construction of waste facilities
Legislation	Options	Environmental legislation may preclude implementation of some recovery options in the contaminated area, eg introduction of decontamination chemicals. Further details on how to deal with these incidents can be found by contacting Defra or FERA (https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs and http://fera.co.uk/)
	Workers and public	Consult with appropriate bodies to ensure the correct PPE and training is given to workers
Training		Consider developing a training programme for the roles required to be performed, eg decision makers and decontamination workers
Contacts		List of contacts in organisations that have a role in the event of a biological emergency List of water companies List of contacts with local information List of country/regional/local databases that provide useful background data and information on how to access them
Communication	Members of the public	Arrangements for communications through local/national TV and radio, and websites Timelines for these announcements Plan for engaging local people in decisions that will affect them
	Provision of information to implementers of recovery options	Provision of information on the objectives of the recovery option to ensure that those implementing the option understand why it is being undertaken and how the objectives can be achieved. Leaflets to provide instruction on how to implement options correctly and effectively for self-help options

Table 3.7: Factors and actions that may need to be considered when developing an outline recovery strategy for water environments

Topic	Factors and actions to consider
Generic strategy	Ensure information requirements (see Table 3.6) are prioritised, put into action, achieved and maintained – there should be confidence that information is complete, reliable and up to date Establish mechanisms for accessing information, ie a single point of contact or easy access to the databases Consider how the protection recovery options will be employed and continued during implementation of other recovery options Consider employing a phased approach in which some contaminated areas are dealt with promptly, whereas others are treated later (for larger scale incidents) Consider the role of self-help options Produce and maintain a risk register for things that could go wrong in the development of the strategy (eg non-compliance). Identify positive and negative considerations and establish which ones will make the biggest difference Consider the impact of different weather conditions and the geography of the area on the strategy and choice of recovery options
Roles and responsibilities	Make sure the roles and responsibilities of the agencies undertaking tasks in the recovery phase are well known by all. Need to clearly identify leading agencies and legal responsibilities Establish how the roles and responsibilities change along the timeline Consider for each recovery option how the available resources will be coordinated and moved to the affected area
Role of stakeholders	Identify existing stakeholder groups in the area, eg water companies, parish councils, community groups. Investigate whether these could/would be prepared to provide feedback on a recovery strategy for the area Water companies will already have existing protocols to put in place for biological incidents Consider processes that could be used to establish bespoke stakeholder panels where no relevant groups exist
Recovery options	How the contamination is presented in the water environment Identify practicable and acceptable recovery options for use at the local level based on information provided in this handbook in advance Consider: • any constraints on use of options (from recovery options in Chapters 8 and 9) • impact of weather conditions, eg flooding from precipitation and temperature levels • aspects for each recovery option that will require consideration in advance of a biological incident and those that will be of particular importance to be taken into account in the event of an emergency Consider trials of the recovery options to obtain a better understanding of the effectiveness and feasibility
Protection of workers	Type of PPE to be worn by the remediation workers, which is dependent not just on the biological agent and its presentation, but on any environmental factors present in that area
Criteria for a successful strategy	Identify appropriate criteria to be used to determine whether a remediation strategy has been successful and/or how this can be demonstrated

4 Food Production Systems

What is a 'food production system'?

For the purpose of this handbook, food production systems include crops, dairy products, agricultural animals (which include animals used for both meat and non-food purposes), eggs, honey, freshwater and marine fish and shellfish, foraged/domestically grown foods and game, animal feed/silage and waste products (eg slurry), and processed foods. This includes every stage of production from farm to fork and includes home-grown and foraged foods.

There are a few types of products and production systems that are not explicitly included in this handbook, including certain farm certification schemes (eg free-range systems). Information on managing contaminated water used in food production can be found in the chapter on water environments (Chapter 8).

In terms of biological contamination, commercial food production systems are highly regulated to minimise the presence of pathogenic microorganisms within food and therefore prevent food poisoning and outbreaks of infection. Throughout food production systems, there are critical control points which all food businesses must put in place to ensure the quality of their products and the protection of the consumer[1]. All food companies, farmers and growers must abide by the EU Food Hygiene Regulations and the Food Safety Act 1990[2,3]. Outbreaks of infection are mainly caused by the failure of these critical control points. These failures will need to be dealt with quickly to avoid any repeat events. The high degree of regulation of commercially produced food means that contaminated produce is unlikely to reach the consumer and, if it does, protective procedures and effective communication strategies are immediately put in place.

Biological contamination within a food production system does not just affect the consumer but also affects the workers, companies and farmers within the food production system as well as those who operate smallholdings and those who may grow, rear or forage their own food. The purpose of this chapter is to devise a recovery strategy that promotes a return to normality for all those affected within food production systems as well as the consumer.

Following a biological incident, decision makers require a framework which allows them to select appropriate recovery options to produce a remediation strategy for a contaminated food production system to return it to normal use. This handbook is a tool to help users evaluate potential recovery options by providing a decision-making framework and the relevant information needed to support decisions, enabling implementation of timely and effective remediation strategies[4].

For small-scale biological incidents the recovery strategy may comprise of one or two recovery options that could be applied over the first few days or weeks. For example, some biological incidents which affect products that have already reached the retailer or consumer, may only require protection options such as (5) Product recall and the provision of (2) Precautionary food safety advice until the outbreak attenuates. However, for a widescale biological release involving persistent agents, eg the foot and mouth epidemic in the UK, the recovery strategy is likely to be more complex, comprising multiple recovery options which include both protection and remediation options. These options would be implemented over different phases of the incident response and may affect a number of food production systems. Some aspects of recovery can be considered in advance of an incident as part of contingency planning. A series of checklists is provided in Chapter 3 to highlight the type of information that can be gathered under non-crisis conditions to help manage the pre-release and early phases of an incident. Decision makers will need input and guidance from the relevant experts to supplement the information, particularly to provide advice on the suitability of recovery options for the biological agent in question and the practicability of their implementation[4].

4.1 Food production systems within the handbook

4.1.1 Agricultural production systems

Agricultural production systems in the UK range from large-scale production to smallholding operations which can be classified as either intensive or extensive management systems. The majority of commercial agricultural production in the UK is classified as intensive farming. In microbiological terms, contamination can build up quickly and spread easily in large-scale, intensive farms both in livestock and through crops. For example, potato blight (*Phytophthora infestans*) can rapidly sweep through fields of potatoes destroying entire crops; it led to the Irish potato famine in 1845[5]. Furthermore, flooding and similar events can also lead to contamination of crops and other food sources. Good agricultural practice, crop rotation and proper food storage conditions can prevent the build-up of pathogens but this is not always successful.

Smallholdings and extensive management systems are less likely to have large numbers of animals in confined areas or sizeable areas of one crop and therefore microbial contamination may have limited impact.

An overview of the types of food product which are applicable to the handbook can be found in Tables 4.1 and 4.2. ‘Food product’ is a generic term for categories of foods that can be derived from several sources. For example, milk is a generic product that can be derived from cows, sheep and goats[4].

4.1.2 Domestic food production and free foods

Domestic food production includes all food that is produced by individuals in allotments, private or kitchen gardens and foraged foods which are collected from the wild. These food production systems are not regulated by the authorities and the critical control points that are found in commercial agricultural production do not exist. This type of production system is not always used for personal use as some restaurants have their own kitchen gardens and allotment communities often share produce. If an incident occurred within domestic food production or free foods it would be the responsibility of the landowner and/or the local authority to remediate the environment.

Tables 4.3 and 4.4 give an overview of the types of domestic and free foods for which the handbook can be applied to develop a recovery strategy.

Table 4.1: Food products applicable to the handbook from intensive food productions and small holdings

Food product	Sources/examples
Dairy products	Cow, sheep, goat milk and dairy products such as cheese
Meat	Grazing livestock: beef cattle, sheep and lamb, deer, pig and poultry (chicken, turkey, geese and duck)
Eggs	Hens, ducks, geese, etc
Cereals	Wheat, barley, oats, seed rape, rye and maize
Vegetables and horticultural crops	Root crops (carrots and parsnips), tubers (potatoes), onions, legumes (peas and beans), brassicas (Brussels sprouts, cabbage, broccoli and cauliflower), salad (lettuce), herbs, glasshouse and other protected crops
Industrial crops	Oil seeds, pulses, sugar beet, hops and watercress
Fodder plants	Silage, hay and root vegetables
Fruit	Orchard (apples, pears and plums), bush (blackberry and gooseberry), canes (raspberry), herbaceous (strawberry) and grapes
Honey	Commercial beehive
Fish	Fish farm (salmon and trout)

Table 4.2: Food products applicable to the handbook from extensive food productions

Food product	Sources/examples
Meat	Hill lamb and hill beef, free range
Fish	Marine fish, wild salmon, freshwater fish, shellfish, mussels, oysters, cockles, scallops, crab and lobster

Table 4.3: Domestic foods applicable to the handbook

Food product	Sources/examples
Dairy	Domesticated livestock such as cattle, sheep, goat for dairy products, both pasteurised and unpasteurised, such as milk and cheese
Meat	Domesticated livestock and fowl such as cattle, sheep, goat, pig, duck, goose, turkey, quail and chicken
Eggs	Domesticated fowl such as duck, goose, quail, hen and peahen
Vegetables, herbs, edible flowers, fruit and berries	Vegetables (carrots, courgettes and cauliflower), herbs (mint, fennel and basil), edible flowers (elderflower and nasturtium) and berries (strawberry and gooseberry)
Nuts	Garden production of nuts such as hazelnut, chestnut and walnut
Honey	Private beehive
Freshwater fish	Private lake
Home processed foods	Jams, pickles and chutneys

Table 4.4: Free foods applicable to the handbook

Food product	Sources/examples
Meat	Waterfowl, wildfowl and game fowl such as pheasant, partridge, grouse, goose, duck, snipe and woodcock Ground game such as hare, rabbit and deer Pests such as grey squirrel and pigeon
Mushrooms	Foraged mushrooms such as field mushrooms, chanterelle, puffball and oyster
Fruit, berries, herbs, edible flowers and aquatic plants	Fruits such as apple, damson and sloe Foraged wild berries such as elderberry, blackberry and rose hips Wild herbs/vegetables such as horseradish, dandelion root and nettle Edible flowers such as elderflower Foraged wild aquatic plants such as seaweed and watercress
Nuts	Foraged nuts such as hazelnut, chestnut and walnut
Honey	Feral beehive
Freshwater fish	Fish such as trout, carp, eel, grayling, perch, pike and salmon Shellfish such as crayfish
Marine fish and shellfish	Fish such as cod, haddock, plaice, herring and mackerel Shellfish such as clam, scallop, oyster, cockle, mussel, winkle, crab, lobster, prawn and shrimp

4.1.3 Organic farming

Food produced from organic farming has to conform to the same legal requirements as conventional food regarding biological contamination. However, when remediating an organic environment from a biological incident there are some aspects specific to organic food that need to be considered:

- use of conventional veterinary medicines for treating sick animals
- restricted use of cleaning products and disinfectants
- restricted use of pesticides
- prohibition of prophylactic treatment for unaffected animals
- emphasis on soil health and maintaining this through application of manure, compost and crop rotation
- restricted use of additives during processing of organic foods

The recovery option sheets (see Chapter 5) state where relevant if their implementation may affect the organic status of food.

4.1.4 City farms and community gardens

There are a growing number of city farms and community gardens in the UK which are being developed in response to the needs of the local people. Each community garden, city farm and school garden is unique, but they often have a number of features in common. They are often found in built-up areas, where their creation is a response to the local community's lack of access to green space, and often make use of disused or derelict areas. They can vary in size from a few metres squared (the smallest community garden) to a number of hectares (the largest city farm). City farms and community gardens are open to the public and, while larger farms and gardens may employ paid workers, they rely on dedicated volunteers. Most groups are run by a management committee of local people and some are run as partnerships with local authorities, while retaining strong local involvement. More information on city farms and community gardens can be found on the Federation of City Farms and Community Gardens website (www.farmgarden.org.uk)[6]. It is envisaged that following a biological incident these areas should be treated as food production systems if food is being produced there (some community gardens may not produce food) as well as being considered an inhabited area. Therefore the inhabited areas section (Chapter 6) of the handbook should also be consulted.

4.1.5 Food premises

Within the handbook, food premises are split into two types: animal and non-animal. Animal food premises include animal houses such as cow barns and chicken coops as well as fish and shellfish farms. Non-animal food premises include food processing plants and plant houses such as greenhouses. Specifically, food premises in food production systems are those buildings that deal directly with the rearing, growing or processing of food products. While recovery options exist for the decontamination of such premises within this section of the handbook, the inhabited areas section (Chapter 6) should also be consulted when any buildings are affected by contamination. Buildings such as garages, sheds, restaurants and shops should be remediated using the inhabited areas section of the handbook.

4.1.6 Ready-to-eat food

Ready-to-eat foods have normally undergone a commercial process designed to manufacture products for ease of consumption; for example, cocoa and other raw ingredients can be processed into chocolate. As with agricultural production, the commercial processing of food is highly regulated with various critical control points. If these control points fail, the appropriate authorities are quick to act to ensure the protection of the consumer where possible. This chapter covers the remediation of ready-to-eat food production systems but the inhabited areas section (Chapter 6) should also be consulted for the remediation of buildings and warehouses that could be contaminated.

Table 4.5 provides an overview of the types of ready-to-eat foods for which the handbook can be applied to develop a recovery strategy.

4.1.7 Water environments in food production systems

Water environments and food production systems are interlinked as each can have an effect on the other, especially in the spread of contamination. Potable water must be used in all food production environments, and the distinction between potable water and clean water must be understood and adhered to. In dealing with biological contamination in a food production system it is important that a clean water source is used when irrigating crops or for animal husbandry and that, where possible, contaminated water run-off is prevented from entering any water environments to avert the spread of contamination. If a water environment that feeds a food production system (eg a watercress farm) is contaminated, the water environments section of this handbook would need to be consulted alongside the food production systems section so that an effective strategy for the clean-up of the affected water environment can be implemented.

Table 4.5: Types of ready-to-eat foods applicable to the handbook

Food product	Sources/examples
Meat	Cooked ready-to-eat beef and chicken, processed ham, pâté and ready meals
Grains	Bread, pasta, pastry and flour
Fruit and vegetables	Canned sauces, baked beans, crisps, pickles and chutneys
Nuts	Roasted, salted and flavoured nuts
Drinks	Wines, beers, ciders, fruit juices and carbonated drinks
Fish and shellfish	Smoked fish
Other foods	Chocolate, sandwiches and biscuits

4.2 Health protection criteria for food production systems

It is important that any measures taken to protect public health and reduce the risk of infection (eg PPE, infection control measures and evacuation) are appropriate to the level of risk of the biological contaminant in question. They, therefore, must also take into account all the wider consequences of the proposed protective measure; for example, costs and disruption to implement the measure must be balanced against the pathogenicity of the agent and expected benefits of implementation, including public reassurance. This balance must take into account the specific circumstances of the event, which are likely to vary between incidents[4,7]. At present there are no international or national regulations outlining clean-up criteria following an incident involving a biological release in the UK.

It is recognised that, through published advice for radiation and chemical incidents, some clean-up techniques, such as ‘decontamination of animal premises’, are considerably more resource intensive and disruptive than others[4,7]. This principle can also be applied to biological contamination. It is difficult to specify clean-up goals in advance of an incident as background levels of biological contaminants are often not known and should be considered alongside other aspects of planning for a response (see Chapter 3). Following an incident, it is recommended that assessments of the remediation strategy should be completed, examining both the risk and the consequences. These consequences should include cost, timescales, public acceptability and the availability of the necessary resources. Any information relevant to these assessments (eg potential efficacy, resource requirements, identification/deployment of appropriate equipment and contractors, and cost) would enable the completion of such assessments quickly and efficiently in the event of an incident. Potential strategies that involve high levels of cost and disruption should only be undertaken if the risk to public health is also high, thereby maintaining a balance between the expected harms and benefits of the strategy[4,7].

4.3 Generation of waste from food production systems

Depending on the biological agent and the affected food production system, some or all of the contaminated waste products (animal by-products, ready-to-eat food or the by-products of decontamination processes) may require disposal through the appropriate waste disposal routes. If food products cannot be used for the purpose for which they were grown, they may be regarded as waste (if appropriate processing and/or treatment routes are not available). Depending on the specific situation and the type of produce affected, various options exist for the recovery and removal of such wastes:

- no action is taken (the risk to health is insignificant and any action would be disproportionate)
- contamination can be removed from the food product using established techniques and the food is re-introduced into the food chain (as long as this is not expressly prohibited by law)
- the food product is diverted to animal feed (depending on legislation)
- the food product is diverted to non-food use (eg vegetable oil to biofuels or food grade guar gum to the paper or textile industry)
- the food product is disposed of as waste

It is likely that taking no specific action or re-introducing food products following removal of contamination are potentially controversial from a consumer perspective. Effective communication strategies will need to be put into place to ensure that these options are viewed as ‘acceptable’ by the consumer. Additionally, it is important to render food waste so as it cannot be recycled or resold to consumers (food fraud).

Rarely, some types of waste that can be encountered during a biological incident may be classified as ‘hazardous waste’. National guidance is available to help determine if a waste can be described as ‘hazardous’ or not[8]. Depending on the specific situation and the biological agent in question, various options exist for the disposal of wastes.

The Environment Agency (EA), Scottish Environment Protection Agency (SEPA) and Northern Ireland Environment Agency (NIEA) can be consulted for advice on appropriate waste management strategies[9].

For further information and a list of guidance, regulations and legislation on the various aspects of food waste management refer to Appendix A.

4.4 Preventing exposure during remediation of food production systems

The exposure to an individual from biological contamination following an incident can vary widely. There are many factors which govern the estimated exposure of an individual in such a situation, including the physiological properties of the biological agent in question, the extent of the contamination in the affected area, the amount and type of food consumed by the individual and the time spent by workers in the contaminated environment.

Any individual should be protected from exposure to biological contamination, both at home and in the workplace. This should be done by the use of PPE, such as gloves, overshoes, face shields, masks, and reinforcement of the requirement for good personal hygiene. The type of PPE used will depend on the agent, the route of infection and the recovery options to be used. If there are very good reasons as to why individuals may need to be in areas where the likelihood of exposure is high or the consequences of exposure are high, there should be an appropriate health monitoring programme in place including a log of those involved in the remediation[4,7].

4.5 Constructing a recovery strategy for food production systems

Constructing a remediation strategy and selecting appropriate recovery options involves multiple steps. An overview of the decision-making framework for developing a recovery strategy is given in Figure 4.1. It is important to note that this framework should not be considered as a substitute for expert specialist advice, but provides a framework for requesting, recording and evaluating the advice (Steps 1–3). The decision-making framework (Figure 4.1) comprises six steps which involve the elimination of inappropriate recovery options through the use of a decision tree, selection diagrams, tables and checklists.

Step 1 of the framework describes the identification of the biological agent (if possible) and the gathering of information relevant to the incident. Step 2 then leads the user to the decision tree in Figure 4.2 and the selection tables in Figures 4.3–4.12. The decision tree guides the user through the initial decision-making process and the range of considerations that need to be taken into account, as well as allowing the user to select all the available appropriate recovery options for the incident in question. Steps 3–5 then provide a methodology for eliminating options that are unsuitable or ineffective by evaluating their efficacy and characteristics. From the remaining options, a recovery strategy can then be developed (Step 6). A template table is provided (Table 4.7) that can be used to help record the decisions made during the recovery option elimination process. Once the recovery strategy has been developed, it can be executed and monitoring can be performed to confirm whether acceptable levels have been reached and the area can be returned to normality. If acceptable levels have not been reached then the user can return to the decision tree in Step 2.

The final step is to document the incident and evaluate the recovery response with the formation of a report, including the effectiveness of the handbook. This report can then be used to determine any lessons that should be learnt from the response. It would also be helpful to forward the report on to the handbook project team (biological.recovery@phe.gov.uk) as the information can then be incorporated into the databases which support the document.

Further details of the steps are given in the following sections. The food production systems decision framework does not include a strategy for performing a risk assessment or for designing or implementing a monitoring strategy following a biological incident, this falls outside the scope of the handbook.

To view an example of how this process works, please see Chapter 10: Worked Examples.

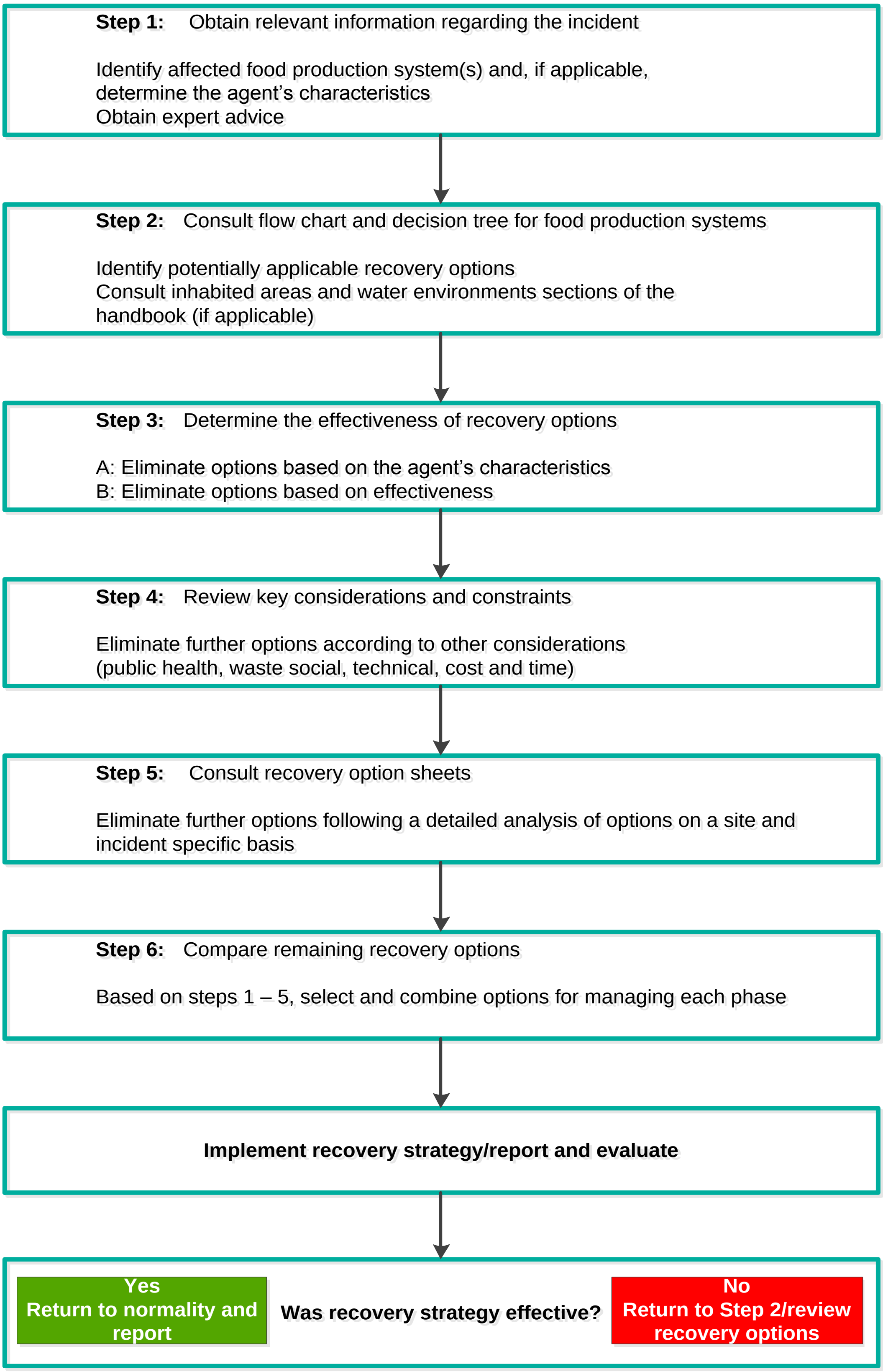

Figure 4.1: Key considerations for recovery

Step 1 Obtain relevant information regarding the incident

When a biological incident occurs, the initial steps are to identify the biological agent(s) involved and seek technical (biological) expertise. It may not always be possible to identify the biological agent (eg vomiting) and there may be cases where there are multiple agents in a contaminated area (eg soil). There may also be delays before the laboratory identification of the agent. However, by consulting the appropriate experts it may be still possible to gather information on the likely contaminants that may be found. An example of this can be found in Chapter 10.

Having identified the biological agent (if possible), information should then be collected on the agent's biological characteristics, eg persistence and mode of transmission. The handbook has identified a subset of biological characteristics and properties that need to be considered – see Table 4.6. These properties will then be used to eliminate options in Step 3 of the decision-making process. Only when this information is available can an appropriate recovery strategy be developed.

Table 4.6: Important physiological characteristics of biological agents

<table>
<tr><th rowspan="2">Agent characteristics</th><th rowspan="2">Description</th><th rowspan="2">Interpretation</th><th colspan="2">Biological agent</th></tr>
<tr><th>Characteristic</th><th>Interpretation</th></tr>
<tr><td>Agent's species</td><td>Agent's taxonomy</td><td>Further details about the agent can be determined from literature searches and consultation with experts
For example, Clostridium difficile<table><tr><td>Genus</td><td>Clostridium</td></tr><tr><td>Species</td><td>difficile</td></tr></table>The persistence of and efficacy of disinfection techniques can be determined by agent species, genus or family</td><td><table><tr><td>Genus</td><td></td></tr><tr><td>Species</td><td></td></tr></table></td><td></td></tr>
<tr><td>Organism form</td><td>Bacteria, bacterial spore, virus, fungi, parasite, oocyte</td><td>The form of the organism will help to determine the persistence of the agent and types of disinfection methods that are most effective for decontamination. It is possible that more than one form may be present, in which case the method of disinfection should consider the more resistant form
For example, alcohol-based solutions are very effective for disinfection of some vegetative bacteria; however, they are ineffective against bacterial spores</td><td></td><td></td></tr>
<tr><td>Persistence</td><td>How long will the agent survive in the environment?</td><td>How long a biological agent can persist in the environment will influence which recovery options should be considered for the remediation strategy (consult the persistence database)
An additional factor that should be considered is 'What is the environment used for?' This may also influence which recovery options are selected
For example, protective options (restrict public access) could be used if an agent has limited persistence (1–2 days) as natural inactivation (natural weathering) would eliminate the agent from the environment. However, this would not be appropriate for persistent agents, more active decontamination or removal options need to be considered</td><td></td><td></td></tr>
<tr><td>Resistance</td><td>Is the agent known to be resistant to disinfection processes or methods?</td><td>If the biological agent exhibits increased resistance to a disinfection method (eg vapour hydrogen peroxide) then alternative recovery options should be considered (consult the disinfection database)
Repeating disinfection with more effective disinfection techniques may result in delays and increase costs for remediation</td><td></td><td></td></tr>
</table>

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Person to person spread/route of transmission	Can the agent be spread from person to person or animal to human? How is the agent infectious? (gastrointestinal/inhalation) Is the agent zoonotic?	Further recovery options might be necessary to stop the spread of the agent from person to person The route of transmission will affect the prioritisation of recovery from the agent *For example, a scenario where an agent causes gastrointestinal upset but is not infectious through the aerosol route may lend more time to develop a recovery strategy than a scenario with highly infectious or contagious agents that would need to be dealt with as a priority*		
Prophylaxis, vaccination and treatment	Is there medical intervention available with activity against the agent?	The risk to the public and workers will be increased if there is no prophylaxis or treatment available		
Hazard group	What is the ACDP hazard group of the agent?	Agents with a hazard group of 3 or 4 are more likely to cause serious infection and pose a significant risk to public health The recovery from incidents involving hazard group 3 or 4 agents could have increased cost implications, may take longer to remediate, require appropriate levels of worker PPE, and may involve specialist techniques		
Production of toxins	Does the agent produce a toxin? What is the stability of the toxin?	Toxins might persist in the environment after the destruction of the parent agent. Therefore consideration should be given to potential release of harmful toxins from the parent agent. Additionally, they may also be volatile and therefore difficult to contain Recovery options will need to be effective against the parent agent and subsequent toxins (eg mycotoxin). Seek expert advice and guidance for information on toxicology of toxic compounds Some toxins are heat resistant and may not be inactivated by processes used to inactivate microbial agents		
Background level of agent	Are the levels of the agent within the environment before the incident known?	This level will determine the extent of the contamination and the levels that need to be achieved during decontamination. The recovery phase must return the agent's level to at least the background amount		
Will the agent multiply in the environment?	Is the agent able to replicate in the environment in which it is found?	If the agent has the ability to replicate in the environment in which it is found then the level and spread of contamination could increase If the agent can replicate in the environment then the decontamination recovery options will need to be employed earlier to limit the growth and spread of the agent. This will be further dependent on the environmental conditions at the time, including the availability of water and nutrients, the relative humidity and the ambient temperature		

Step 2 Consult decision tree/diagrams for food production systems

The decision tree should be consulted (Figure 4.2); this guides the user through a number of questions investigating the affected environment and purpose of the contaminated area. The decision tree also highlights any immediate protection options that should be considered. The protection recovery options shown in the yellow boxes are there to identify options that should have been implemented during the response phase. If they are deemed appropriate to the incident but have yet to the implemented they can be put in place during the recovery phase. Examples on how the decision steps should be used are located in Chapter 10 of this handbook; further help can be sought by contacting PHE.

The decision tree then leads into Figures 4.3–4.12, which identify applicable recovery options that are specific for each type of contaminated food production system. These recovery options are split into three categories: protection options, remediation options and waste disposal options. This step will need be repeated for each different contaminated food production system identified to select the relevant recovery options.

This step is essentially an ‘inclusive’ step, identifying all potentially applicable recovery options prior to the elimination of options which will be carried out in Steps 3–5. Table 4.7 has been produced to allow the user to record the recovery options that have been identified as potentially applicable for use in remediation of the incident. As the user works through Steps 3–5 then this table can be used to identify if the option is still applicable and whether it should be removed from consideration. The reasons for removal should be recorded in the spaces provided; these can be used later in the review of the recovery of the incident and during the production of the report. This will allow anyone auditing the choices made during remediation to ascertain why recovery options were not used and allows for a clear and open decision-making process.

Selection tables (Figures 4.3–4.12) include recovery options for the following food production systems:

- crops (such as rice, wheat, corn, fruits and vegetables, both in the field and post-harvest)
- dairy products (including raw and pasteurised milk, butter, cheese and yoghurt)
- animals: animals bred for food (eg beef cattle), animals that have already been slaughtered and butchered for meat and breeding animals (non-food) such as egg-laying hens
- eggs
- honey
- freshwater and marine fish and shellfish (farmed and wild fish, and shellfish both in the sea/river and post-harvest)
- domestically grown/foraged foods and game (all wild foods that have been gathered such as mushrooms and berries, wild game and foods grown in gardens and/or allotments)
- processed food (all foods that have been processed in some way, eg bread, chocolate sauces, ready meals and ready-to-eat foods)
- animal feed/silage (all products used to raise animals including but not limited to feed, silage, bedding and housing)
- animal waste products (eg manure and slurry)

In some instances, there may be cross-over between sections of the handbook – inhabited areas (Chapter 6) and water environments (Chapter 8) – if other environments have been contaminated. This is highlighted in Figure 4.2 where applicable.

Table 4.7: Recording and analysis of identified recovery options

Recovery option name	**Step 1** Obtain information regarding the incident	**Step 2** Identify preliminary options for affected food production system (refer to Figures 4.2 to 4.12)	**Step 3** Determine applicability of recovery options, eliminate options on:		**Step 4** Review key considerations and constraints (refer to Table 4.9)	**Step 5** Consult recovery option sheets (Chapter 5)	**Option applicable?**	**Reason for elimination?**
			3A Agent characteristics (refer to Table 4.6)	**3B** Effectiveness of option (refer to Table 4.8)				

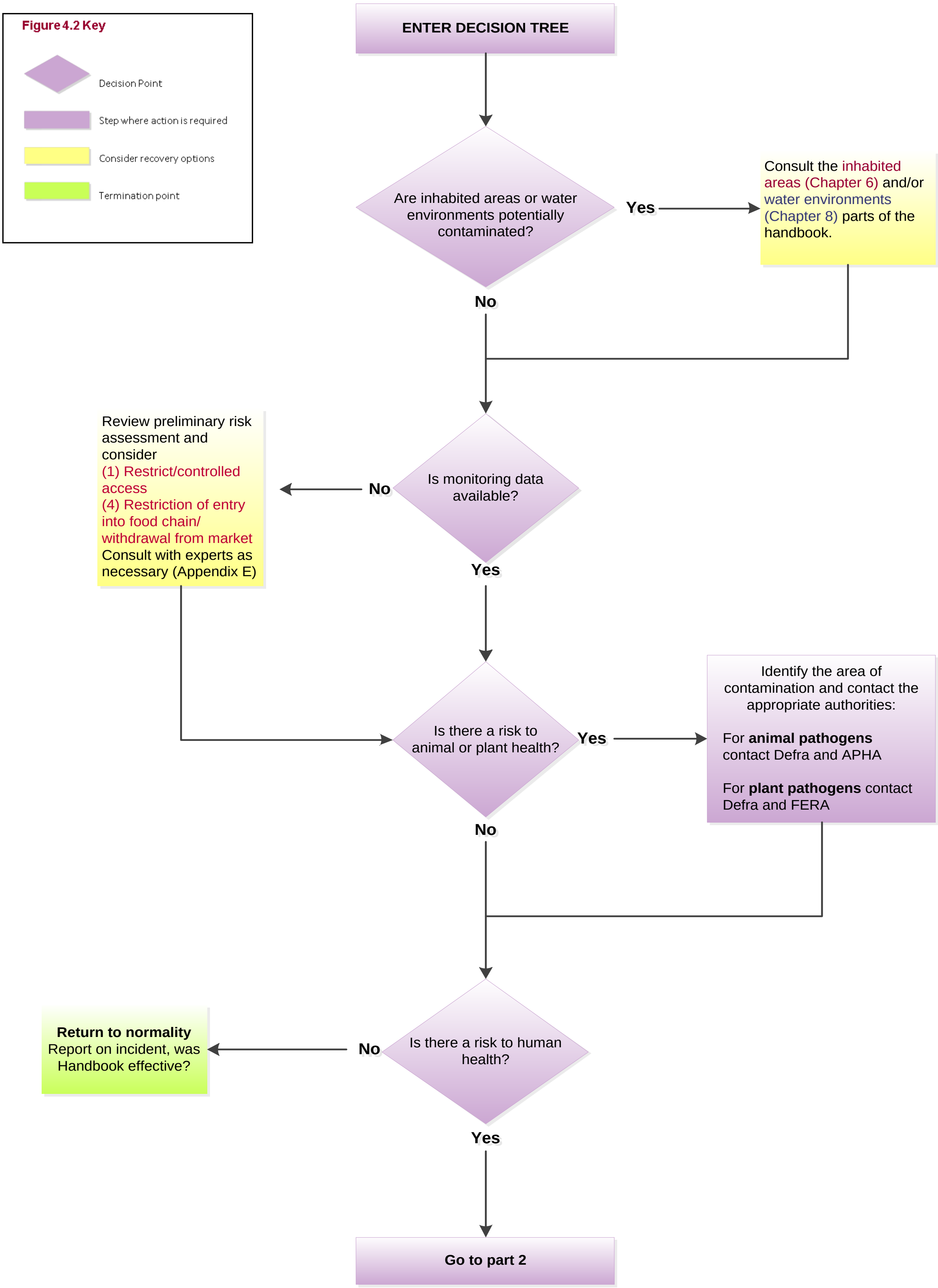

Figure 4.2: Food production systems decision tree (part 1)

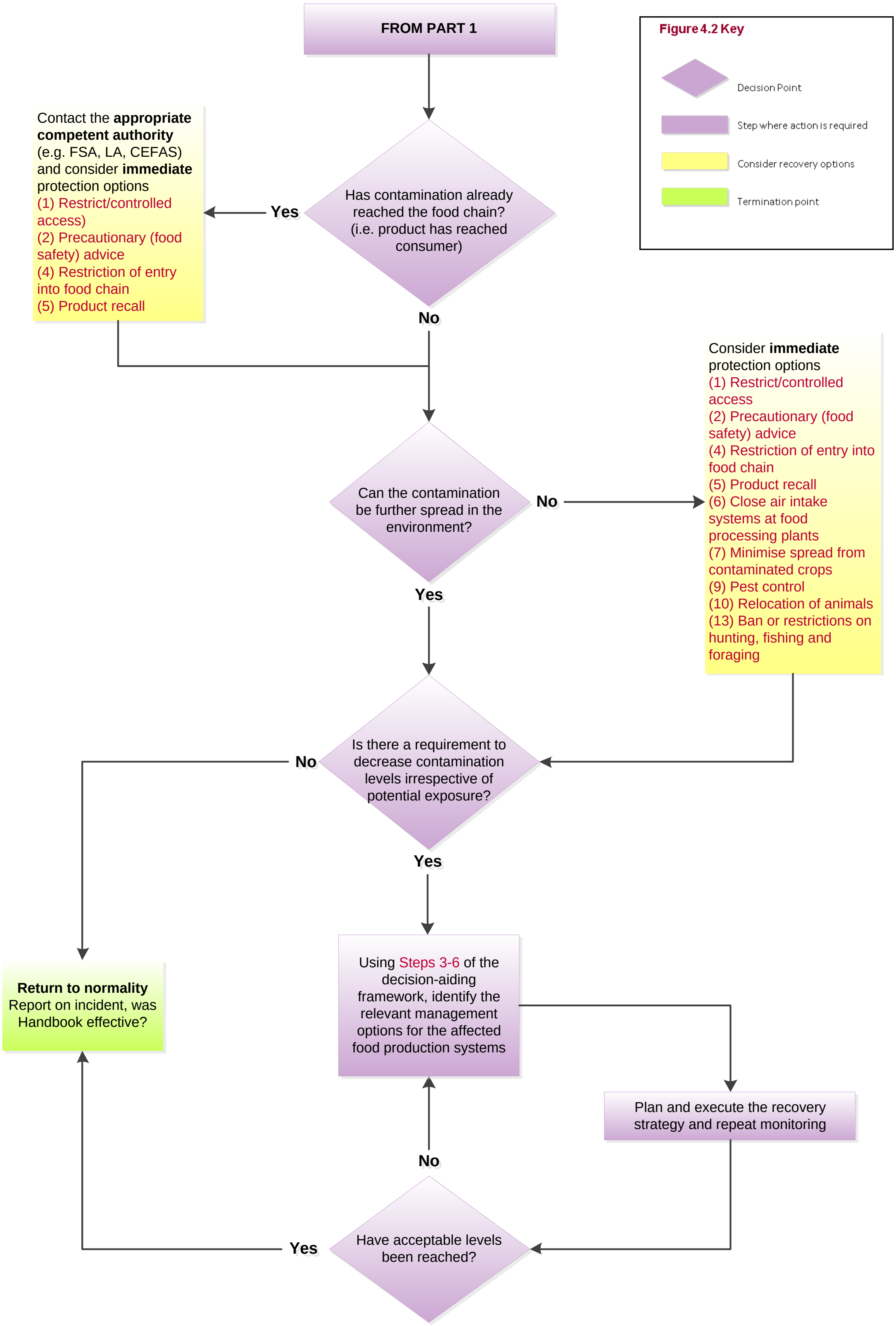

Figure 4.2 *(continued)*: Food production systems decision tree (part 2)

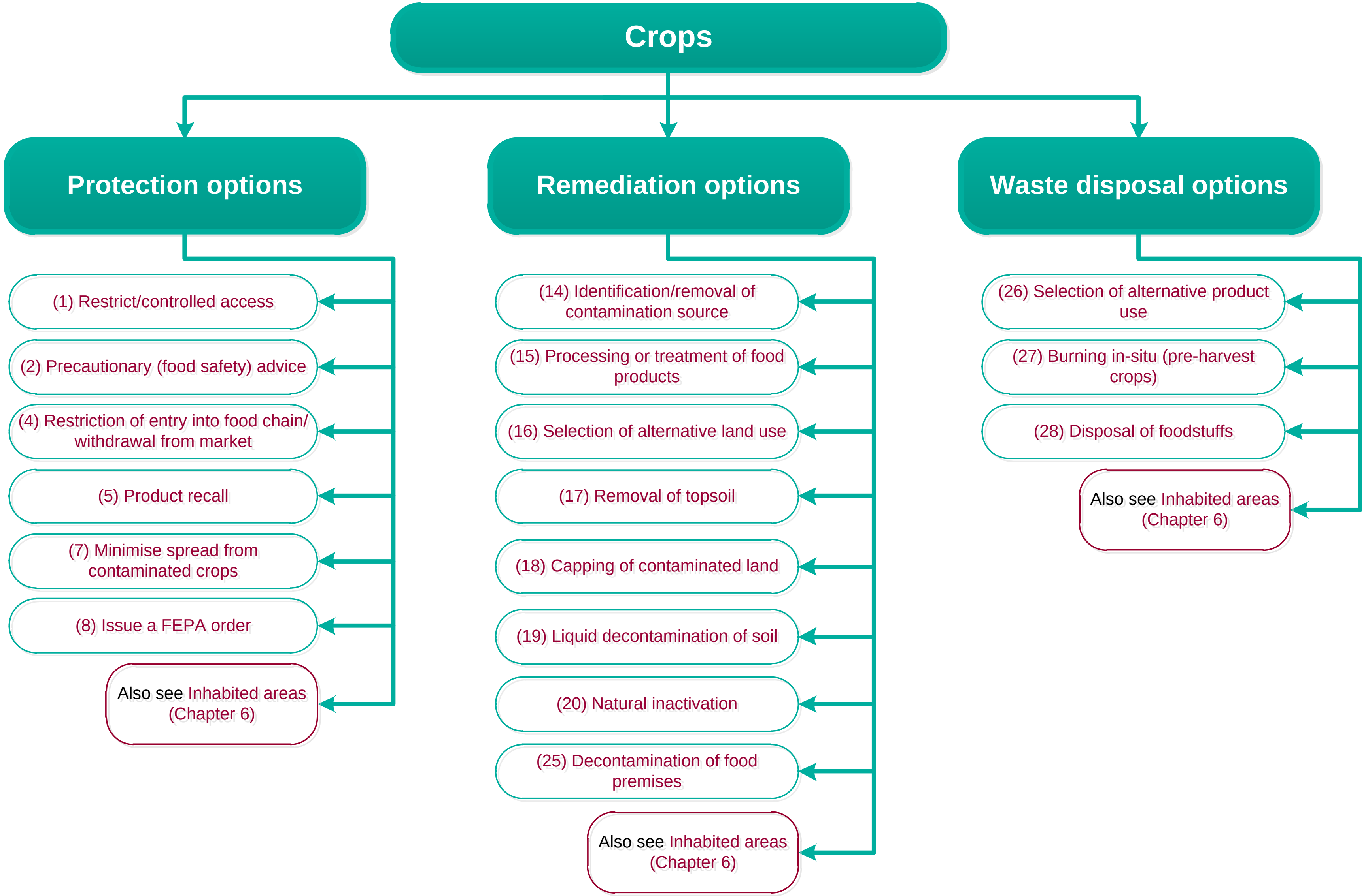

Figure 4.3: Crops

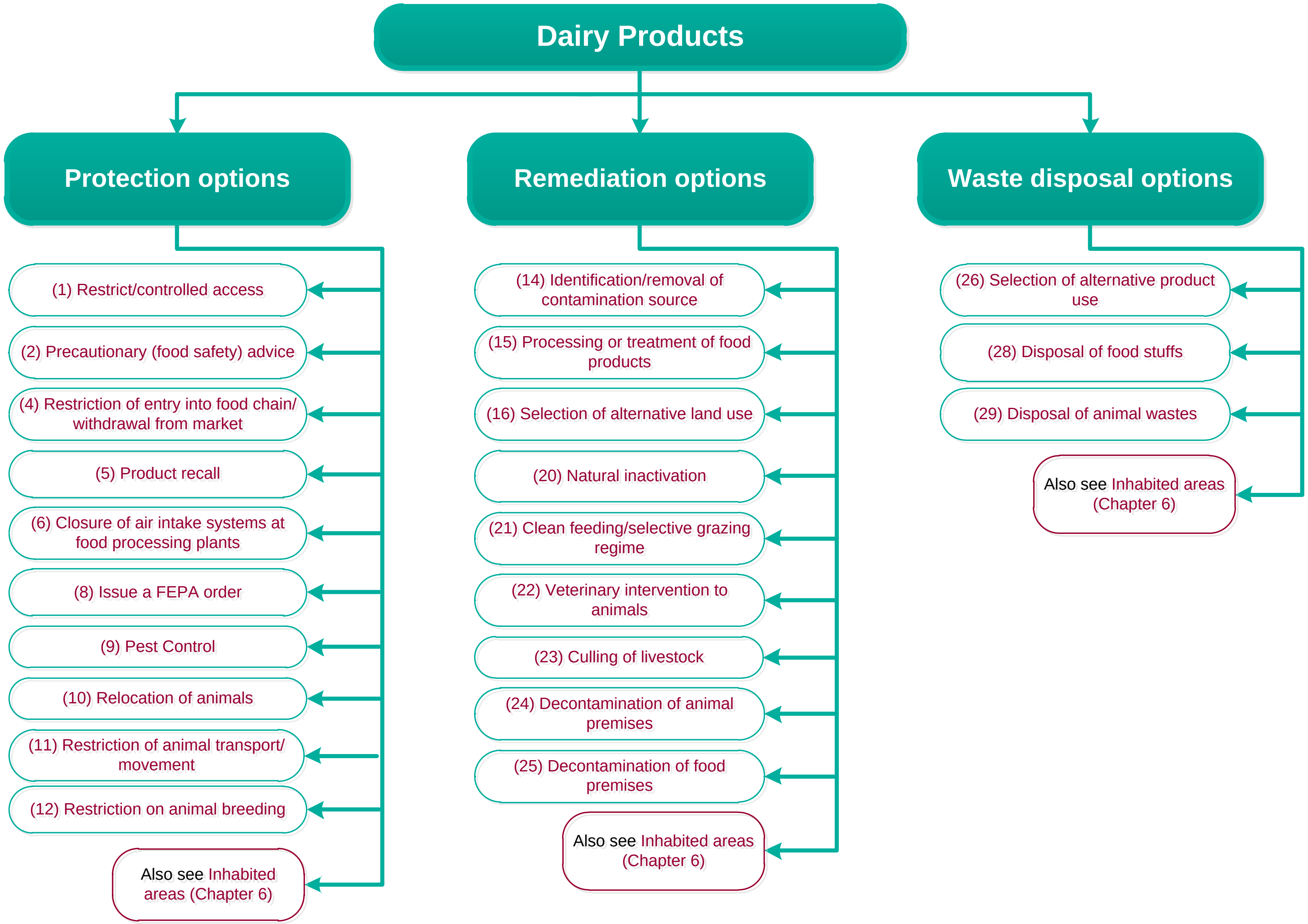

Figure 4.4: Dairy products

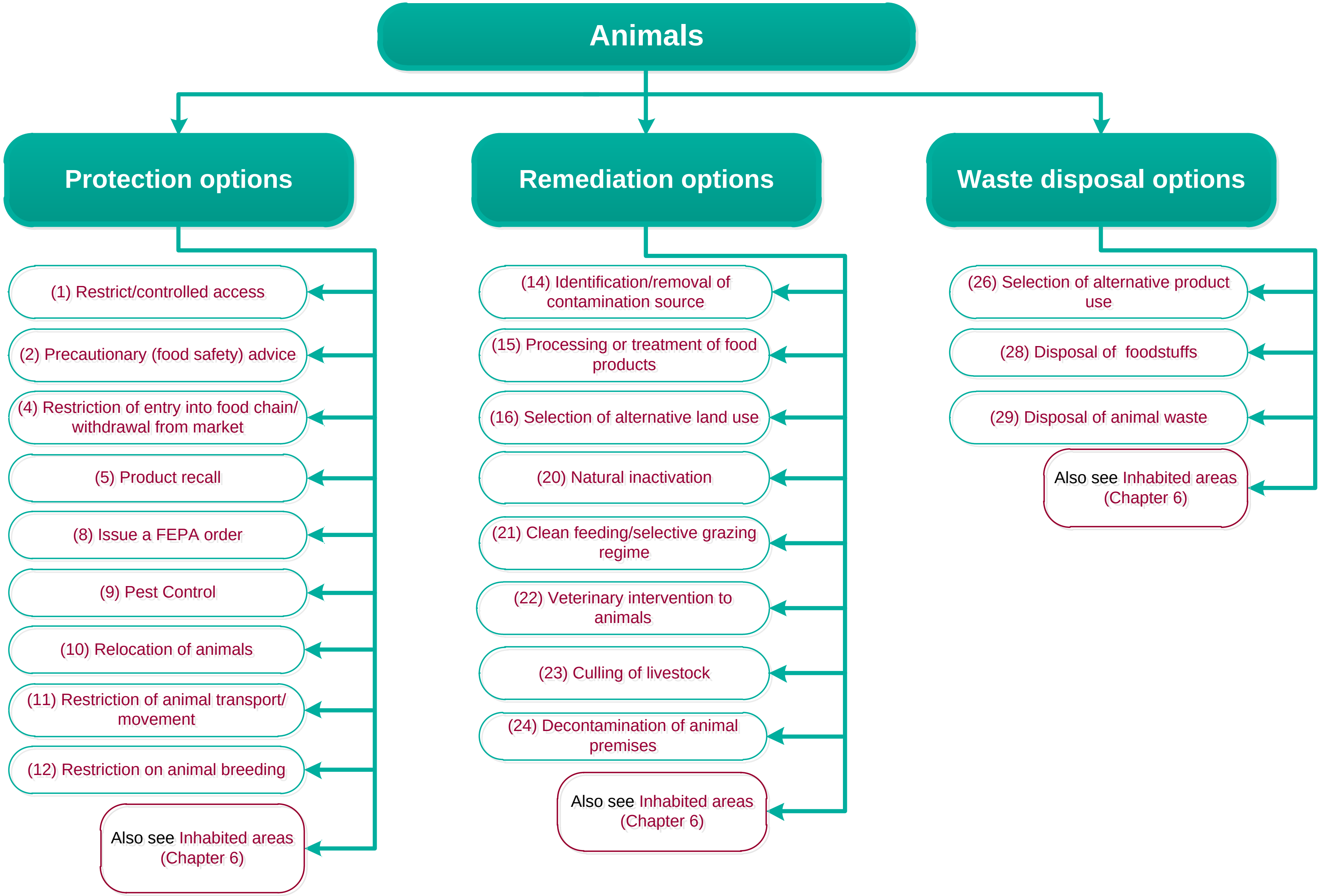

Figure 4.5: Animals

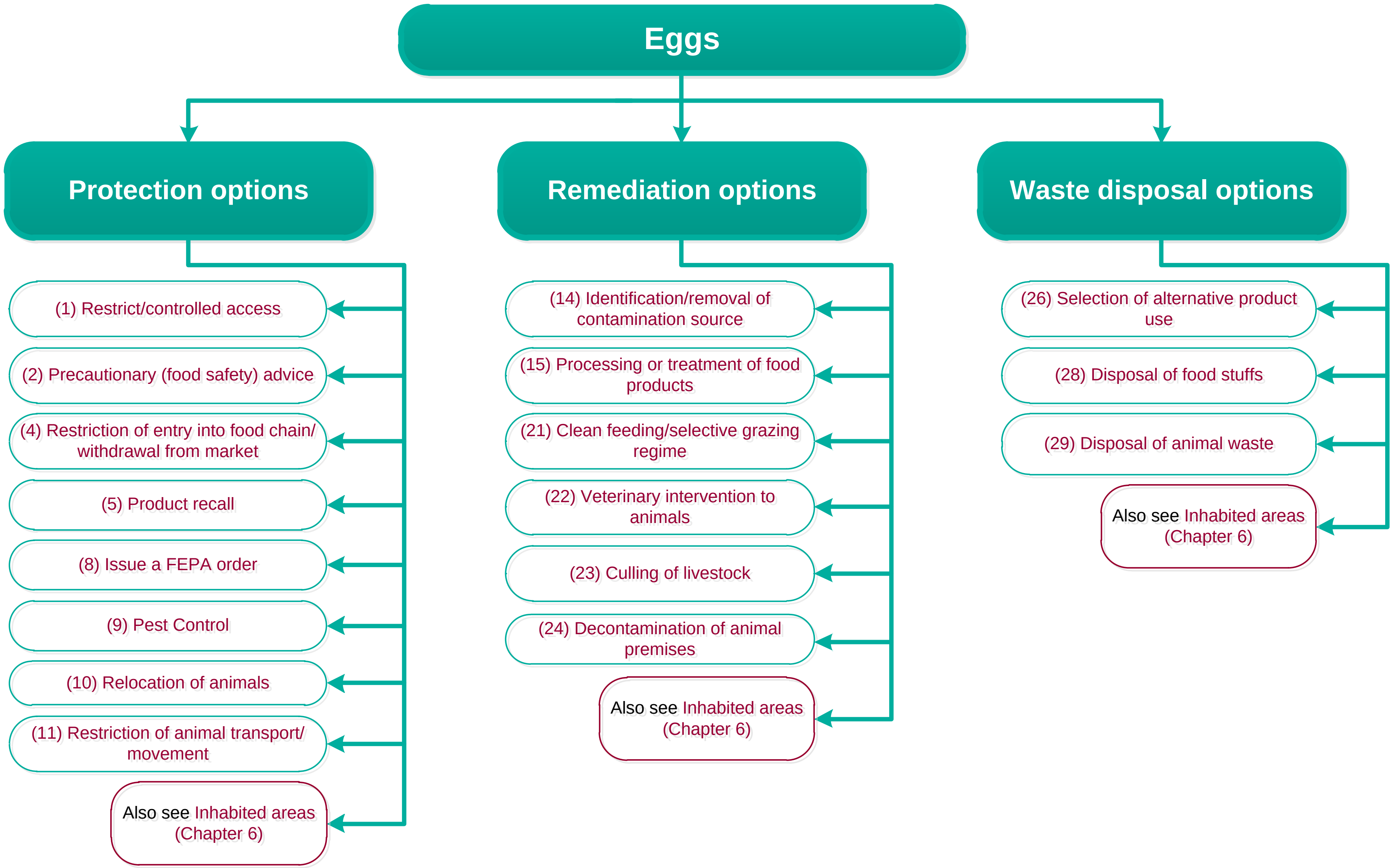

Figure 4.6: Eggs

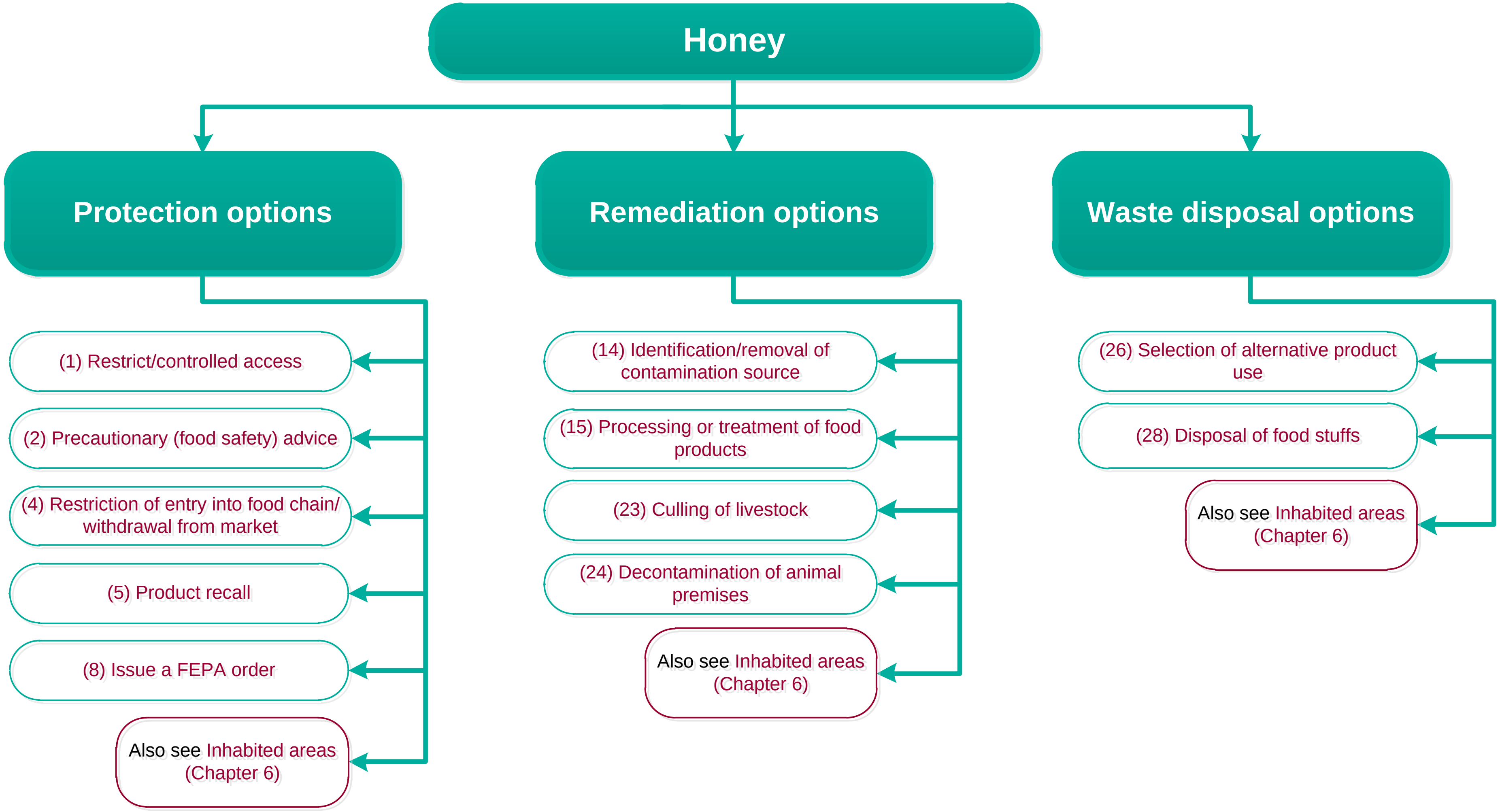

Figure 4.7: Honey

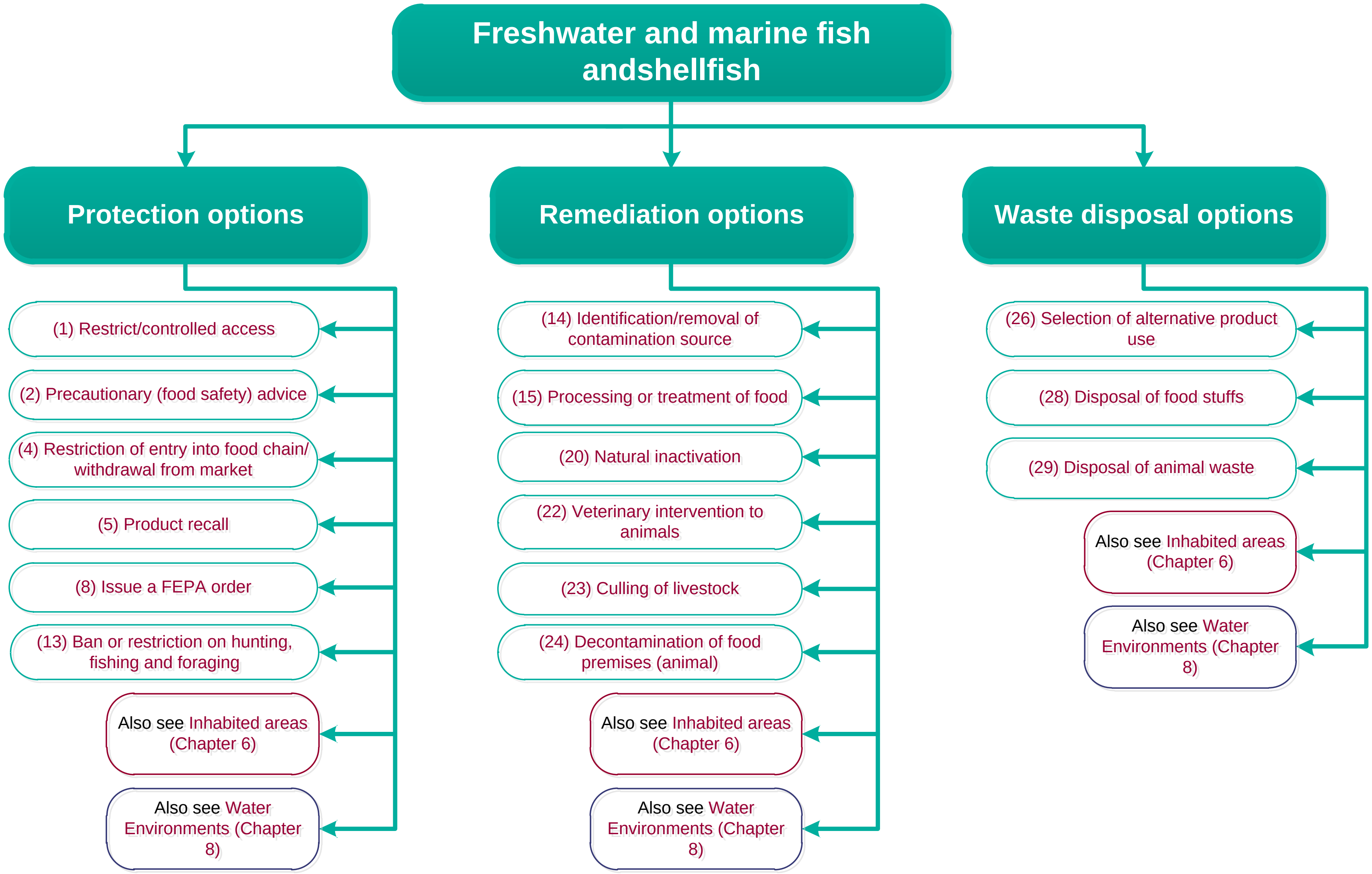

Figure 4.8: Freshwater and marine fish and shellfish

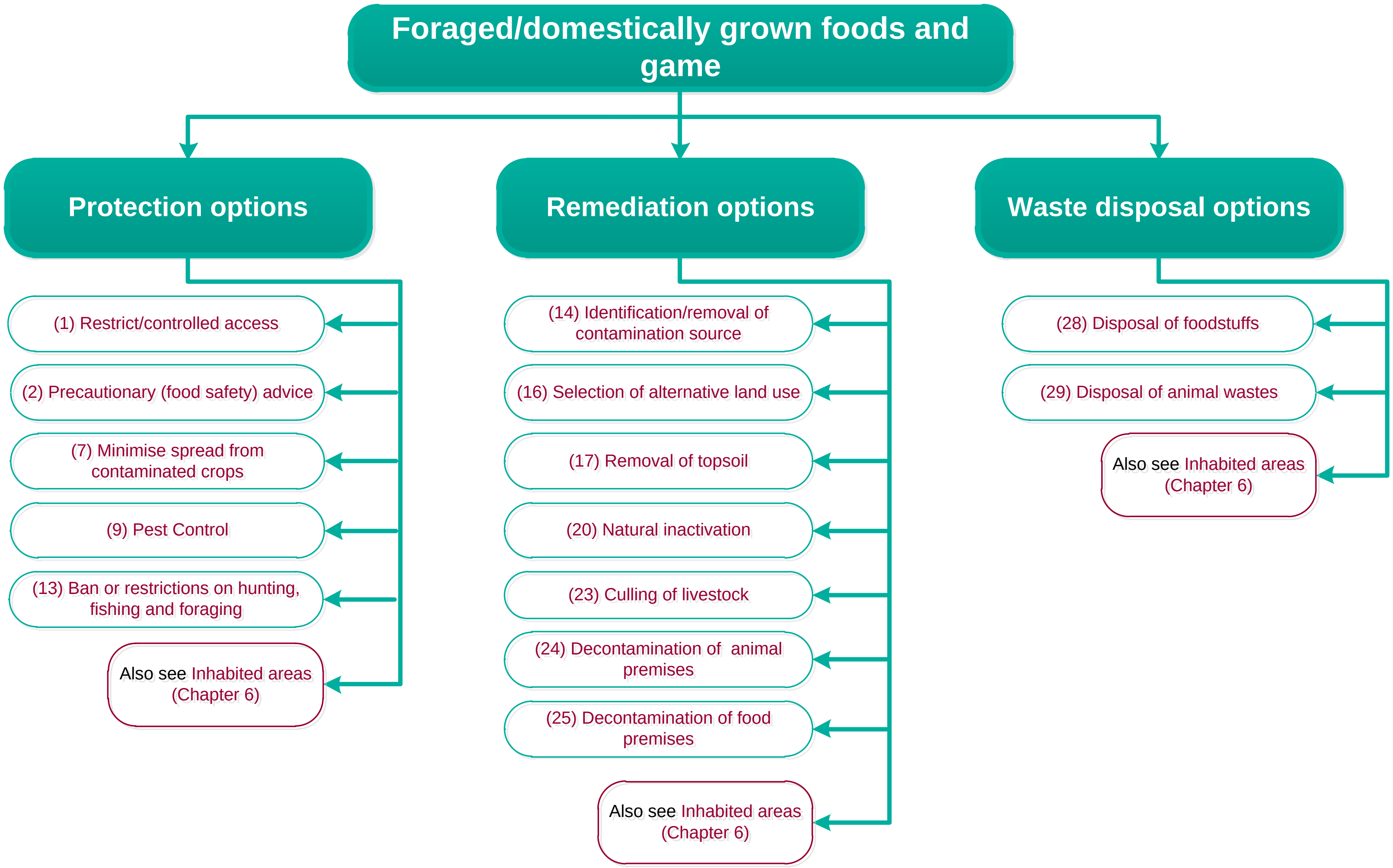

Figure 4.9: Foraged/domestically grown foods and game

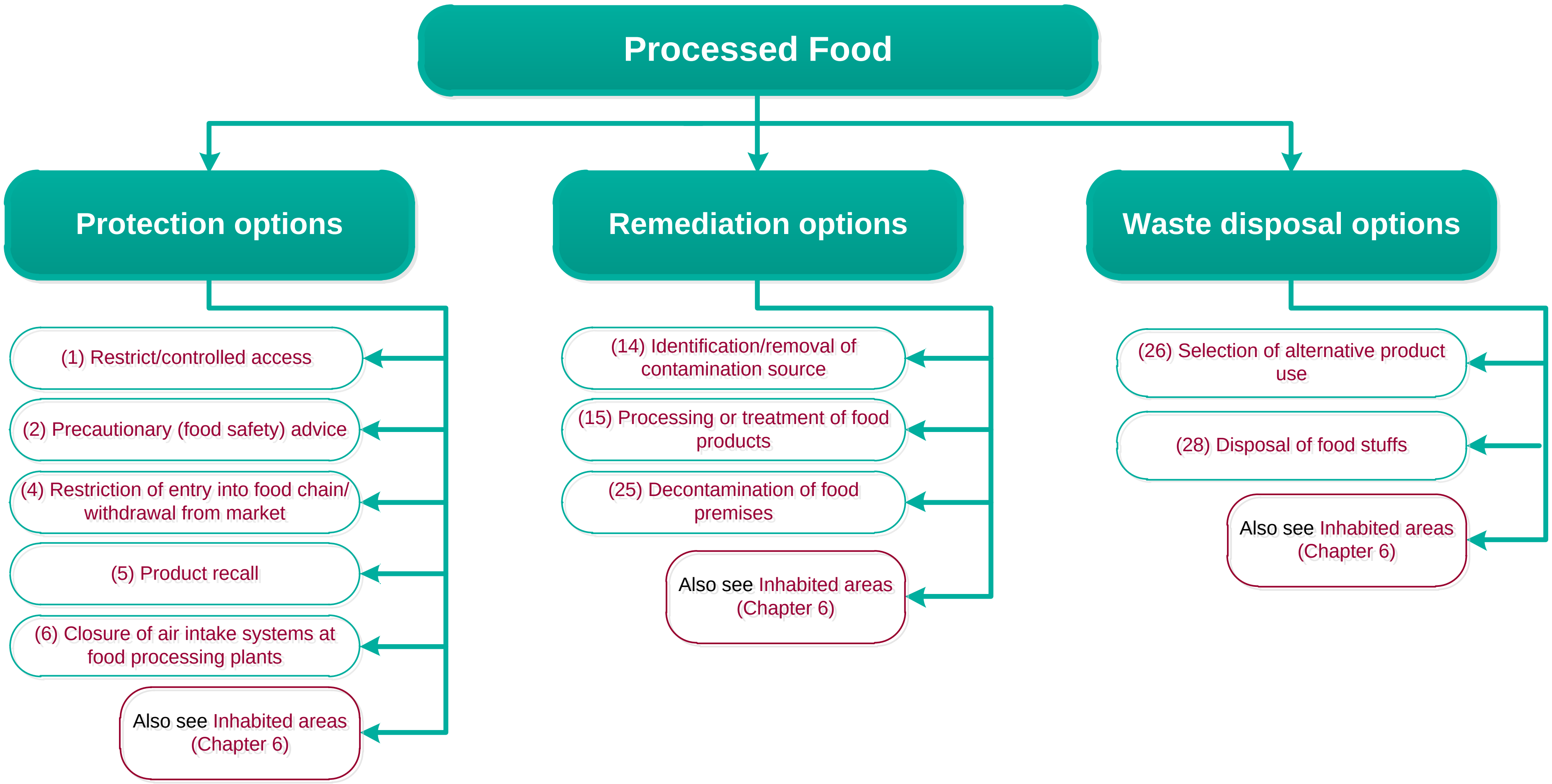

Figure 4.10: Processed food

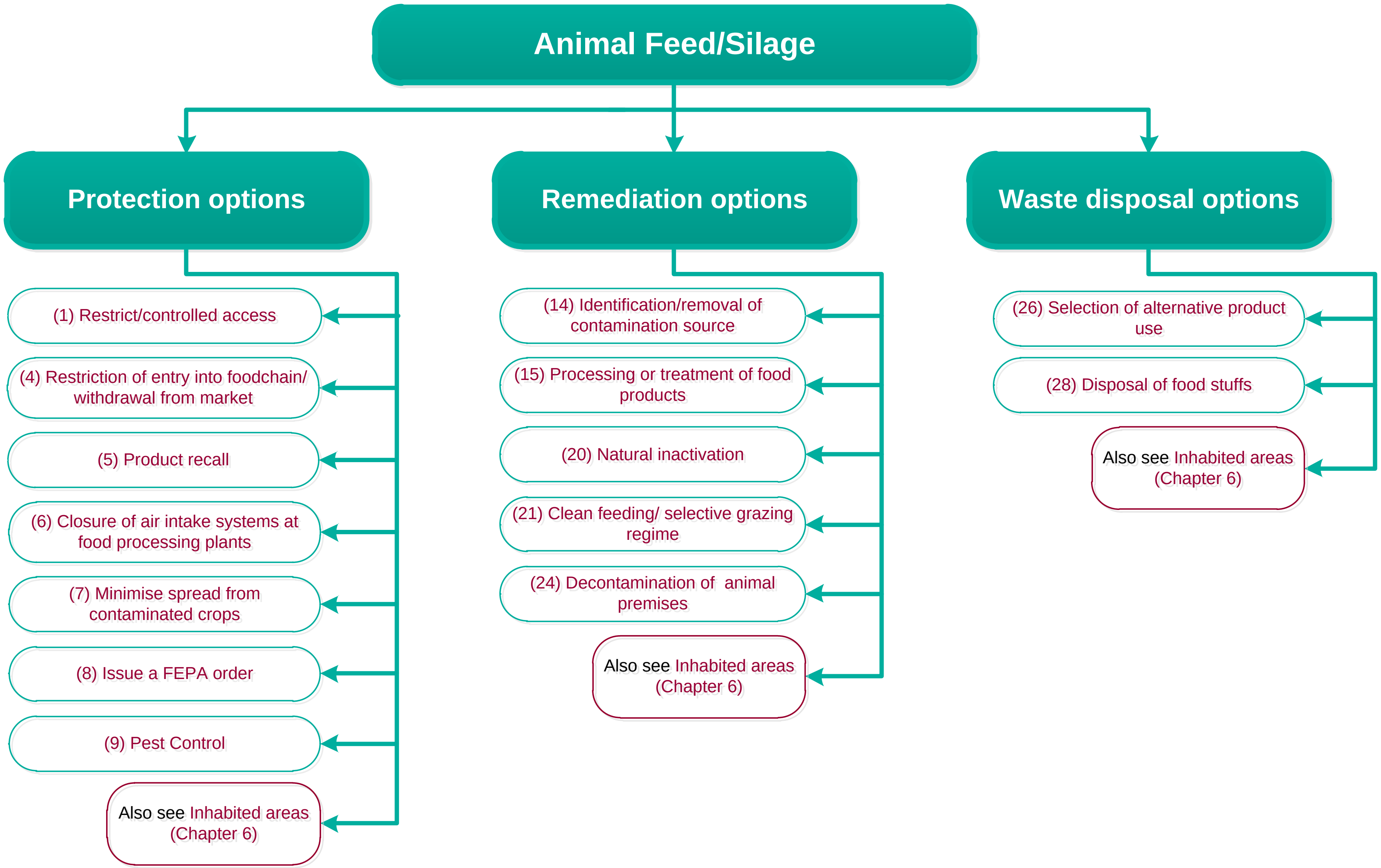

Figure 4.11: Animal feed/silage

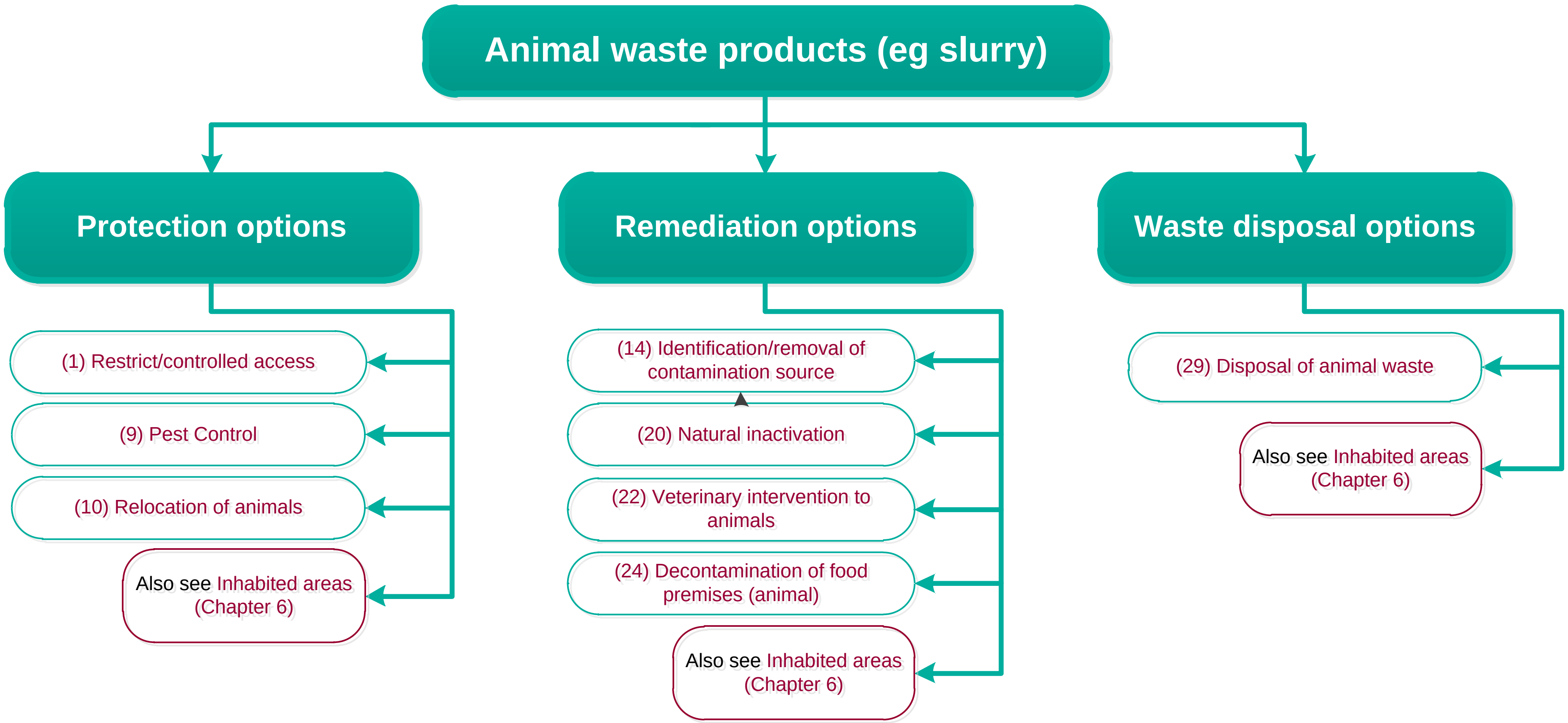

Figure 4.12: Animal waste products (eg slurry)

Step 3 Review effectiveness of recovery options

A Elimination of recovery options based on biological characteristics only

At this stage expert advice should be sought to determine and interpret the biological characteristics of the agent(s), using data identified in Table 4.6 (Step 1) to assist in eliminating any of the recovery options identified in Step 2. For example, if information obtained in Table 4.6 indicates that there is no available animal medical treatment, vaccination or prophylaxis for an agent then the recovery option (22) Veterinary intervention to animals can be eliminated at this stage. It should be noted that agent data will only be useful for elimination of certain recovery options and may not be applicable in all cases.

B Elimination of options based on recovery option effectiveness

Determining which recovery options may be further eliminated can be achieved by considering the effectiveness of the recovery option in more detail (Table 4.8).

Shading is used in Table 4.8 to give an indication of whether remediation options would be 'up to 100% effective', 'potentially effective' or have 'limited effectiveness'. The same shaded colour coding is used to give an indication as to whether there would be a 'low', 'moderate' or 'high' risk of increased exposure to biological contamination. The classification used in the selection tables is intended to be a generic guide and is not agent specific. The grading used in Table 4.8 is based on evaluation of the current evidence (ie previous incidents), stakeholder experience, advice and ongoing decontamination research. Therefore Table 4.8 should be evaluated in conjunction with the biological characteristics of the agent under consideration (see Table 4.6) and with expert advice from relevant agencies (see Appendix E).

A recovery option should only be eliminated if it is deemed to have 'limited effectiveness' (dark shading) ***OR*** 'high risk' potential worker exposure and there are other, more effective or lower risk recovery options available. It should be noted that if a recovery option is deemed to have 'limited effectiveness' this does not mean that it is ineffective but that the option may only partially remove any residual contamination; it may still need to be used if it is the only option available. Similarly, if an option is deemed to have a 'high' increased exposure risk this may mean that a higher level of PPE is required for implementing this recovery option if it is the only option available. If it is not possible to readily eliminate a recovery option at this stage then it should be retained for consideration in Step 4.

Therefore, options are considered to be applicable if:

- there is direct evidence that it would be effective against the agent (known applicability)
- the mechanism of action is such that it is highly likely to be effective against the agent (probable applicability)

An option is taken as not being applicable if one or more of the following criteria are met:

- there is direct evidence that the option would not be applicable to the agent
- the agent's properties are such that the option would not be expected to have any effect
- the hazard posed by the agent would not be reduced
- the time taken to implement the recovery option would be longer than the agent's persistence in the environment
- there is a risk that implementing the recovery option could make the hazard worse
- implementation of this option would place operatives at an unacceptable risk

Table 4.8: Overview of recovery option effectiveness

Key: Effectiveness	Up to 100% effective	Potentially effective	Limited effectiveness
Key: Potential worker exposure	**Low risk**	**Moderate risk**	**High risk**

Recovery options	Effectiveness	Potential worker exposure
Protection options		
(1) Restrict/controlled access		
(2) Precautionary (food safety) advice		
(3) Medical intervention		
(4) Restriction of entry into food chain/ withdrawal from market		
(5) Product recall		
(6) Closure of air intake systems at food processing plants		
(7) Minimise spread from contaminated crops		
(8) Issue a FEPA order		
(9) Pest control		
(10) Relocation of animals		
(11) Restriction of animal transport/movement		
(12) Restriction on animal breeding		
(13) Ban or restriction on hunting, fishing and foraging		
Remediation options		
(14) Identification/removal of contamination source		
(15) Processing or treatment of food products		
(16) Selection of alternative land use		
(17) Removal of topsoil		
(18) Capping of contaminated land		
(19) Liquid decontamination of soil		
(20) Natural inactivation		
(21) Cleaning feeding/selective grazing regime		
(22) Veterinary intervention to animals		
(23) Culling of livestock		
(24) Decontamination of animal premises		
(25) Decontamination of food premises		
Waste disposal options		
(26) Selection of alternative product use		
(27) Burning in-situ (pre-harvested crops)		
(28) Disposal of foodstuffs		
(29) Disposal of animal wastes		

Step 4 Review key considerations and constraints

Each recovery option will have a number of considerations or constraints associated with its implementation. Table 4.9 describes some of the key issues (public health, waste, social, technical, cost and time) for each recovery option. More detailed descriptions of these considerations can be found in the recovery option sheets (Chapter 5). Table 4.8, 4.9 and the recovery option sheets in Chapter 5 can be used to further eliminate recovery options based on their constraints and considerations.

Table 4.9 gives an overview of the major and moderate considerations for the recovery options. The classification used in the table is intended to be a generic guide and is not agent specific. The considerations used in this table are based on evaluation of the evidence (ie previous incidents), stakeholder experience and advice or ongoing decontamination research. Major considerations, while not applicable in all incidents, identify issues that might prohibit the use of the recovery option and should be considered in more detail to ensure they will not affect the remediation strategy. Moderate considerations highlight areas that can cause a recovery option to be limited in its effectiveness, such as having an effective media strategy to keep the public informed during that recovery option. Minor considerations have not been included in the table because they will depend more strongly on each individual incident compared to the major and moderate considerations, so can be thought of during the decision-making process by the recovery coordination group (RCG). Table 4.9 should be evaluated in conjunction with the biological characteristics of the agent under consideration (see Table 4.6) and with expert advice from the relevant agencies (eg PHE and GDS, see Appendix E).

If an important (key) constraint is identified, it does not indicate that the recovery option should necessarily be eliminated but that this constraint will need to be taken into consideration when evaluating the option, as this may be the only option available.

Options can be eliminated based on their constraints:

- public health – implementation of the option would increase the risk to public health
- waste – would produce more waste than other available options
- social – would be socially unacceptable when other, more acceptable options are available
- technical – would take longer to implement than the persistence of the agent or requires more technical expertise than other available options
- cost – would cost more than other available options
- time – would take longer to implement than other available options

Table 4.9: Overview of considerations for recovery options for food production systems

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Protection options		
(1) Restrict/controlled access	**None**	**Social** – Effective communication is required to inform the public about the restriction and the potential health risks posed by the contaminant with the aim of ensuring compliance. Possible disruption and restricted access to an area may not be well received by members of the public with pressure to reopen the area
(2) Precautionary (food safety) advice	**None**	**Social** – This is an advice option and is difficult to enforce. Food safety legislation does not apply to home grown produce **Technical** – There may be difficulty ensuring that advice reaches all consumers
(3) Medical intervention	**Technical** – It may be difficult to administer prophylaxis and/or vaccinations to everyone who needs it. Medical professionals will be needed to administer these treatments **Cost** – The cost of this measure will be influenced by the number of people needing treatment, the cost of the treatment itself and the number of medical professionals needed to administer the treatment	**Social** – Effective communication is required to inform the individuals at risk that treatment may be necessary and to avoid panic among the general public **Time** – This option could extend for large periods of time as those that are affected or/and 'at risk' will need to be identified and then brought in for treatment. These people will then need to be continually monitored over a set period of time which could extend for months
(4) Restriction of entry into food chain/withdrawal from market	**Waste** There may be significant amounts of contaminated food products that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence. Long-term restrictions (eg FEPA order) may also lead to culling and disposal of livestock	**Cost** – There may be a cost associated with disposal of contaminated food
(5) Product recall	**Waste** – There may be significant amounts of contaminated recalled food products that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence	**Social** – Consumers may lose confidence in the product, manufacturer or store **Technical** – Contacting members of the public **Cost** – There may be a cost associated with disposal of contaminated food **Time** – The time between contamination and recall is important as a delay between these events increases consumer exposure
(6) Closure of air intake systems at food processing plants	**None**	**Technical** – Access to machinery and controls. Processes of closing air intake systems can be complex **Time** – This option will need to be implemented as soon as contamination is apparent and will need to remain in place until contamination has been removed

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(7) Minimise spread from contaminated crops	**None**	**Public health** – Potential for increased exposure of farm workers while protecting crops **Waste** – Disposal of contaminated crops **Technical** – Availability of materials to protect crops **Cost** – May be high, considering equipment, personnel and volume of the affected crop area that needs protection
(8) Issue of a FEPA order	**Time** – A FEPA order is likely to be in place for a long period of time which will significantly impact on production	**Social –** Economic loss occurring as a result of long-term restrictions being imposed
(9) Pest control	**Technical** – This is likely to have to be sourced externally from specialist contractors **Cost** – This option could be quite costly depending on the extent of pest control needed	**Public health** – Large numbers of carcasses that are not cleared up immediately have the potential to spread further disease **Waste** – This option could result in large quantities of waste and the need to dispose of contaminated carcasses **Social** – It may be unacceptable to the public to see pest control measures being undertaken, especially if this results in a large number of carcasses being in view of the public. It would be necessary to remove any carcasses as soon as possible
(10) Relocation of animals	**Technical** – Availability of suitable housing with water supply, distance between pastures and shelters and availability of stored feed	**Public health** – Exposure of farm workers while moving animals **Waste** – If animals are relocated to indoor shelters there may be manure, slurry and used bedding that will need to be disposed of **Cost** – May be high, considering equipment, infrastructure (ie farm buildings) personnel and number of animals requiring sheltering **Time** – This option may need to be put in place for a long time depending on the persistence of the organism
(11) Restriction on animal transport/movement	**None**	**Social** – There may be an issue with compliance of farmers. There may be a negative impact on public perception as it may be seen that animal welfare is at risk **Technical** – There may be an issue with overcrowding if animal movements are restricted **Cost** – Increase in cost of food if animal movements are restricted. There also may be a need for culling of livestock and disposal which will increase costs **Time** – This option could be in place for a long time
(12) Restriction on animal breeding	**None**	**Social** – There may be an impact on public confidence and public perception of animal welfare. There may be an issue with compliance of farmers **Time** – This recovery option needs to be implemented for a long period of time

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(13) Ban or restriction on hunting, fishing and foraging	**None**	**Social** – There is a potential for consumers to ignore the restrictions. Consumers may lose confidence in produce from the affected area after the incident has been remediated **Technical** – Difficulties with enforceability and policing
Remediation options		
(14) Identification/removal of contamination source	**Time** – This option will need to be undertaken prior to any other remediation option being carried out	**Technical** – There may be problems with accessibility as the contamination source might be in an inaccessible location **Cost** – This will be dependent on the incident in question as the cost will vary depending on the accessibility and type of contamination
(15) Processing or treatment of food products	**Technical** – Availability, capability and capacity of facilities to process contaminated foods	**Waste** – There may be significant amounts of contaminated food products (ie crops) and production processes that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence **Cost** – May be high, considering equipment, personnel, type of contaminated food product and waste disposal
(16) Selection of alternative land use	**Time** – This option is semi-permanent to permanent	**Public health** – Will have to consider residual contamination if public access exists on the land **Social** – Land blighted **Technical** – Restrictions imposed by environmental protection scheme. This depends on what the site will be used for (eg golf course or parkland)
(17) Removal of topsoil	**Waste** – There may be significant amounts of contaminated soil that will require a suitable disposal route, and may require disposal under a waste transfer licence **Cost** – May be high, considering equipment, personnel, size of the affected area and volume of topsoil requiring disposal	**Social** – Resistance to topsoil removal (together with associated flora and fauna) and to aesthetic consequences of garden or allotment changes. Stigma associated with affected area
(18) Capping of contaminated land	**None**	**Social** – There may be stigma associated with the land after capping has taken place. The public may still not want to use the land **Cost** – The cost could be high depending on what materials are used to cap the land
(19) Liquid decontamination of soil	**Technical** – There may be numerous technical issues with this recovery option including, but not limited to, chemical composition of soil, depth of contamination, water content of soil, organic content of soil and organisms	**Public health** – The chemicals used to decontaminate the soil could be hazardous and should be used with caution to ensure the general public is not affected, ie leaching
(20) Natural inactivation	**Time** – This option can take long periods of time dependent on the persistency of the agent in question	**Public health** – Potential for leaching of biological agents into groundwater. Access to land may have to be restricted while contamination levels are high **Social** – This option may be perceived as doing 'nothing' by the public, which has negative implications and may be unacceptable to members of the public

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(21) Clean feeding/selective grazing regime	**None**	**Waste** – Slurry or manure produced while livestock are fenced in or housed **Social** – Selective grazing regime depends on the willingness of farmers at receiving farms to accept contaminated livestock, and to participate. Also, stigma, impact on public confidence and disruption **Technical** – Depends on the availability of suitable housing with water, power supply, and straw for bedding, ventilation and alternative clean feeds **Cost** – May be high, considering number of affected animals, consumables (eg fencing) and personnel
(22) Veterinary intervention to animals	**None**	**Social** – There may be a compliance issue with farmers and there may be an impact on public perception of food, especially where food is certified as organic **Technical** – This option may require large amounts of antibiotics and/or vaccination which will have to be administered by a registered veterinary practitioner. There may be an issue with ensuring all animals get treated especially where there are large herds
(23) Culling of livestock	**Waste** – There may be significant amounts of condemned livestock carcases that will require further action (ie disposal) **Social** – Major disruptions to food business and farmers. Culling requires the consent of the owner, and there may be resistance of the public and impact on the farming community and cost	**Public health** – There is the potential for increased worker exposure (ie driver and operators at abattoir). There is also potential for the abattoir and vehicles to become contaminated
(24) Decontamination of animal premises	**None**	**Waste** – This option may generate large quantities of waste depending on the decontamination method chosen **Technical** – Some decontamination methods may require specialist operators and equipment
(25) Decontamination of food premises	**None**	**Waste** – This option may generate large quantities of waste depending on the decontamination method chosen **Technical** – Some decontamination methods require specialist contractors **Cost** – May be a high cost in this recovery option as there will be large areas to decontaminate and specialist contractors may be required **Time** – This recovery option may need to be implemented over a long period of time

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Waste disposal options		
(26) Selection of alternative product use	**Technical** – Depends on the nature of the biological agent, and marketing for alternative products and knowledge **Waste** – There may be significant amounts of contaminated food products (ie crops) and by-products from processing that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence	**None**
(27) Burning in-situ (pre-harvested crops)	**None**	**Public health** – Large amounts of smoke can have a negative impact on those with respiratory conditions in the local area **Waste** – There may be significant amounts of pyre ash that will need to be disposed of through the appropriate route **Social** – Acceptability with the general public, visually highly emotive and perception of risk, with land subsequently being blighted **Technical** – Suitability of land, associated land blight afterwards, transportation, and disposal of remaining pyre ash to landfill
(28) Disposal of foodstuffs	**None**	**Social** – There may be a negative impact on public perception if large amounts of food are being seen to be thrown away **Cost** – The cost may be high if there are large amounts of crops to be disposed of
(29) Disposal of animal wastes	**None**	**Cost** – The cost may be high if there are large amounts of crops to be disposed of

Step 5 Consult recovery option sheets

Individual recovery option sheets (Chapter 5) can now be referred to for all remaining options that have been identified in the selection process. This step involves a detailed analysis of all remaining options by careful consideration of the information presented in the recovery option sheets. This step can only be completed on an incident-specific basis and in close consultation with local stakeholders to take into account local circumstances.

Step 6 Compare the remaining recovery options

The remaining recovery options now need to be compared and evaluated to eliminate any further options that may not be required. For example, if the remaining options include (10) Relocation of animals and (11) Restriction of animal transport/movement, and it has been determined that these options are contradictive to each other for the contaminated area, then one of the options can be eliminated as both cannot be used.

Once a recovery strategy has been implemented, the remaining steps are to monitor to determine if the recovery strategy has been effective and to report on the incident and subsequent response, including the effectiveness of the handbook (see Figure 4.2). These steps are outside the scope of the handbook and are not discussed further.

4.6 References

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5 Food Production Systems Recovery Options

(1) Restrict/controlled access

(2) Precautionary (food safety) advice

(3) Medical intervention

(4) Restriction of entry into food chain/withdrawal from market

(5) Product recall

(6) Closure of air intake systems at food processing plants

(7) Minimise spread from contaminated crops

(8) Issue a FEPA order

(9) Pest control

(10) Relocation of animals

(11) Restriction of animal transport/movement

(12) Restriction on animal breeding

(13) Ban or restriction on hunting, fishing and foraging

(14) Identification/removal of contamination source

(15) Processing or treatment of food products

(16) Selection of alternative land use

(17) Removal of topsoil

(18) Capping of contaminated land

(19) Liquid decontamination of soil

(20) Natural inactivation

(21) Clean feeding/selective grazing regime

(22) Veterinary intervention to animals

(23) Culling of livestock

(24) Decontamination of animal premises

(25) Decontamination of food premises

(26) Selection of alternative product use

(27) Burning in-situ (pre-harvested crops)

(28) Disposal of foodstuffs

(29) Disposal of animal wastes

(1) Restrict/controlled access

Objective	To reduce potential exposure of the public and workforce to biological contamination in food production systems and to enable some of the workforce to remain in the contaminated area on a limited basis where necessary. This would also apply to the control of the workforce going into the area as part of the recovery option
Other benefits	Any necessary recovery options will be implemented more easily while the population and workforce are absent This option will also prevent the spread of contamination
Recovery option description	This option can be implemented in the short and long term Restrict access: where rights of way exist across contaminated land or land is open to the public (eg woodland), access can be restricted to prevent contact with the infectious agent. Access may also be restricted while remediation and clean-up are ongoing. Appropriate security measures will need to be put in place (eg signs and barriers). This option may also be applicable for food premises such as food processing plants and restaurants Controlled access: workers should be supplied with appropriate PPE and should follow appropriate infection control and prevention measures (hand washing and work boot decontamination) Employers have a duty of care towards their employees; therefore it will not generally be acceptable for employees to work in a contaminated area unless employees are providing an essential service Land is only likely to be fenced-off in the long term if it is privately owned. Public land would be controlled with notices and barriers on main access routes (if practicable)
Key information requirements	What is the land use? Do rights of way exist across the land? Is there livestock that will need tending? Do the public frequent the area (eg restaurants, community gardens and city farms)?
Linked recovery options	This is a protection option and should be linked to remediation options
Target environment	Lands with existing rights of way Workplaces where it is necessary for a workforce to remain Public places
Targeted organisms	This recovery option is applicable to all biological agents that pose a risk to public and animal health, especially if persistent and easily spread. However, the biological characteristics of the agent will determine whether or not this option is necessary. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Inhalation, dermal (skin) contact and inadvertent ingestion of biological contamination Animal to animal transmission, animal to human transmission
Time of application	There is a maximum benefit if this option is carried out as soon as the risk is apparent. However, this option can be applied at any time for any duration

Considerations

Public health considerations	Potential for exposure to contamination for any remaining workforce Exposure received by members of the public cannot be controlled if partial restrictions are in place
Legal implications and obligations	Seek specialist advice and guidance. This option may require legislation to restrict access to land, depending on ownership Employers have a duty of care to protect employees from hazards and risks in the workplace and must comply with the Health and Safety at Work etc Act (HSWA) Further information can be found in Appendix A
Social implications	There may be issues with acceptability of this option (and enforcement). Partial restrictions cannot be controlled easily There is a risk that this could change public perception of the acceptability of the affected area, which may affect public confidence Workers may not be willing to enter or work in a contaminated environment An effective public information strategy will be essential

(1) Restrict/controlled access	
Environmental considerations	Prohibition of access to countryside may benefit flora and fauna Outdoor areas may not be maintained
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	Exposure should be reduced significantly if implemented and enforced appropriately but may be variable for workers who need to remain on site
Technical factors influencing effectiveness of recovery option	Effective exclusion might be difficult to demonstrate Success of barriers and fences (if used) Compliance with restrictions by the public
Feasibility and intervention costs	
Specific equipment	Signs, barriers, fencing and appropriate PPE, monitoring equipment for workforce entering the affected area
Utilities and infrastructure	System to control and monitor exposure to workforce
Consumables	Signs and barriers
Skills, personnel and operator time	Seek specialist advice and guidance Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of area that are contaminated
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Monitoring health and safety when there is only a skeleton workforce in an affected area may be required Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Costs may be influenced by: • size of area(s) where public access is to be restricted • erecting and manufacturing signs and barriers • level and amount of PPE required for remaining workforce
Waste	
Amount and type	Disposal of PPE and other work-necessary items which now may be considered contaminated. Disinfectants used to decontaminate PPE may need specialist disposal
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance
Factors influencing waste issues (eg cost)	Level and amount of contaminated PPE requiring disposal. Amount and type of disinfectants used
Exposure	
Averted exposure	Potential exposure to members of the public will be reduced by 100% if access is effectively restricted. Exposure to workers who are required to work in a contaminated area will be closely monitored; they will receive an additional exposure compared to other members of the public There may be issues with public acceptability and compliance (partial restrictions cannot be controlled and it will not be possible to control the exposure received by members of the public) Success of barriers (if used)
Potential increased worker exposure	Seek specialist advice and guidance. Employers have a duty of care to protect employees from hazards and risks in the workplace. Specifically to infectious diseases employers have to comply with

(1) Restrict/controlled access

	the HSWA to ensure that workers entering the contaminated area use appropriate PPE and follow appropriate infection prevention and control measures (hand washing and work boot decontamination) Monitoring of workers entering the affected area may be required to ensure that exposure limits are not exceeded. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving controlled workforce access Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands Exposure routes from transport and disposal of waste are not included

Other considerations

Agricultural impact	There may be animal welfare issues that should be considered Crops may be lost Seek specialist advice and guidance
Compensation issues	There may be requests for compensation for costs associated with lost produce Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Agencies and departments should consider the use of social media alongside conventional routes to disseminate pertinent information to the required audience

Additional information

Practical experience	During the foot and mouth incident, public rights away across farm and woodland were restricted to prevent the spread of further disease (Defra, 2004)
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Defra. Animal Health and Welfare: FMD Data Archive. 2004. Available (September 2015) at http://footandmouth.fera.defra.gov.uk/ Ihekweazu C, Carroll K, Adak B, Smith G, Pritchard GC, Gillespie IA, et al. Large outbreak of verocytotoxin-producing Escherichia coli O157 infection in visitors to a petting farm in South East England, 2009. Epidemiol Infect. 2012;14:1400–1413
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(2) Precautionary (food safety) advice

Objective	Avoids risk to health from the consumption of contaminated food and indirect exposure through cross-contamination
Other benefits	Helps people maintain their way of life Reduces the need for food disposal Enables informed choice of the public
Recovery option description	Provision of advice and information to consumers in general, on the risks associated with the consumption of contaminated produce and cross contamination. This would include: • issuing of guidance on which foodstuffs can be eaten and those which should be avoided completely. Advice can also include methods for safe preparation (eg wash, scrub or peel), storage and cooking of raw foods (chicken, eggs, etc) • provision of advice on additional recovery options that can be carried out to either reduce contamination levels in foodstuffs or provide reassurance that the product is safe to eat Much of the information, advice, and guidance would come from the local authority (advised by the Food Standards Agency (FSA) and be communicated through the FSA website, local media, leaflets and through the press (ie newspapers and magazines). Social media can also be used to disseminate messages This is a self-help measure, and improves personal control and ability to make informed choices
Key information requirements	What is the biological agent? What foodstuffs are affected?
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options
Target environment	Consumers
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion of contaminants at a potentially harmful level
Time of application	No restrictions on time. For as long as selected foodstuffs are contaminated
Considerations	
Public health considerations	Food safety information may not reach all consumers and the level of exposure received by the public cannot be controlled for. It is important to have an effective communication strategy to reach as many consumers as possible
Legal implications and obligations	Seek expert advice and guidance For more information on relevant legislation please see Appendix A
Social implications	This measure is likely to have more positive than negative social consequences (trust, personal control and informed choice) when the population has trust in the institutions or experts advising dietary restrictions For socially isolated or independent populations, eg crofting communities, a key issue may be trust (or lack of trust) in the institutions or experts advising dietary restrictions
Environmental considerations	None
Ethical considerations	None
Effectiveness	
Recovery option effectiveness	Compliance with the recommendations can be 100% effective at reducing exposure to a safe level, but this is unlikely to be reached as food safety information may not reach all consumers
Technical factors influencing	Foodstuffs and methods of preparation Willingness of affected population to accept the advice to avoid or limit consumption of certain foods. This

(2) Precautionary (food safety) advice	
effectiveness of recovery option	may depend on the extent to which the food has a cultural and economic significance in the population Replacement foods may be required
Feasibility and intervention costs	
Specific equipment	None
Utilities and infrastructure	None
Consumables	Printing and distributing leaflets
Skills, personnel and operator time	The time used for providing information, advice and guidance will depend on the communication method (press releases, social media, television interviews, public meetings, magazine articles, letters, leaflets, internet, telephone, fax, etc) Communication skills (including the ability to explain the relevant risks in lay terms)
Safety precautions	N/A
Other limitations/ factors influencing costs	Scale of incident
Waste	
Amount and type	None directly, although information on disposal of contaminated food may be need to be disseminated
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion of contaminated foods
Potential increased worker exposure	N/A
Other considerations	
Agricultural impact	None
Compensation issues	Possible liability issues in the case of unforeseen health effects If advice incorrectly identifies the source of infection then there may be a case for compensation
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments The methods of communication may need to be flexible (eg local radio, social media, news, newspapers and magazines) to ensure the information reaches the target audience. It is essential that advice is kept simple and comprehensible
Additional information	
Practical experience	An outbreak of Shiga-toxin producing *E. coli* associated with sprouted seeds in Europe led to the issue of food safety advice to the public not to consume potentially contaminated sprouted seeds in an effort to reduce the number of cases (EFSA, 2011)

(2) Precautionary (food safety) advice

Key references	European Food Safety Authority. Shiga toxin-producing E. coli (STEC) O104:H4 2011 outbreaks in Europe: taking stock. EFSA Journal. 2011;9(10):2390 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
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(3) Medical intervention

Objective	To reduce or prevent any ill-health in individuals that have been exposed to biological contamination in foodstuffs or are considered to be 'at risk' of infection
Other benefits	Can prevent or reduce the transmission of infection
Recovery option description	Medical intervention can include a number of measures to reduce/prevent ill-health in individuals who have been exposed to contamination or are considered to be 'at risk' There are several different forms of treatment, including antibiotics, antivirals, antifungals and vaccination These treatments must be administered/prescribed by a registered medical practitioner/nurse Treated individuals will need to be monitored for infection and adverse treatment effects while undergoing treatment. The level of protection afforded by each medical intervention has to be balanced (as is normal medical practice) against the potential side effects of the intervention and the ability of the 'at risk' individuals to clinically respond to the intervention. This needs to be clearly communicated
Key information requirements	How many people have been exposed or are considered to be 'at risk'? What is the biological agent? Is there treatment available? Are the appropriate resources available?
Linked recovery options	This is a protection option and should be linked to remediation option
Target environment	People who have potentially ingested or been exposed to contaminated foodstuffs
Targeted organisms	This option is applicable to all biological organisms which can contaminate the food chain and pose a risk to public health. This option requires medical treatments to be available and should consider the risk of further transmission within food production systems. However, the properties of the biological agent will influence whether or not this option is suitable. Expert clinical guidance should be sought on an incident- and site-specific basis
Scale of application	Any, although on larger scales, larger effective communication strategies and greater logistical support will be imperative and appropriate resources need to be available
Exposure pathway prevention	Transmission of infection from foodstuff to person and transmission from infected person to person
Time of application	There is maximum benefit if this option is carried out soon after the source of infection is identified. People who may have been exposed or affected will need to be quickly identified
Considerations	
Public health considerations	There may be some side effects associated with medical intervention. As a result, this recovery option can only be implemented by trained/qualified medical personnel
Legal implications and obligations	Seek specialist advice and guidance For more information on relevant legislation please see Appendix A
Social implications	This option may raise concerns among the community, which in turn may cause an increased burden on the community health services. Implementation and the communication strategy of this option will need to be managed effectively to reduced alarm
Environmental considerations	None
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	Development of symptoms and the further transmission of infection should be reduced significantly if implemented quickly and efficiently
Technical factors influencing effectiveness of recovery option	Identifying all affected individuals Adequate stocks of medical supplies Appropriate infrastructure and personnel to support this option, eg healthcare clinics

(3) Medical intervention

Feasibility and intervention costs	
Specific equipment	Medical supplies, medicines and vaccines
Utilities and infrastructure	Hospitals, NHS walk-in centres and/or GP surgeries
Consumables	Medical consumables for delivering treatment
Skills, personnel and operator time	Registered medical practitioners
Safety precautions	All medical personal should take effective precautions when dealing with potentially exposed individuals, including the use of safe practices and PPE
Other limitations/ factors influencing costs	Costs may be influenced by the number of individuals needing medical treatment
Waste	
Amount and type	Medical waste may be generated. The amount will depend on the number of individuals that need to be treated. Medical waste is classified as 'hazardous waste' and should be disposed of carefully, through appropriate routes (eg incineration)
Possible transport, treatment, disposal and storage routes	Medical waste should be disposed of through the correct disposal routes which will be outlined by the facility dispensing treatment
Factors influencing waste issues (eg cost)	Increase in cost for disposing of additional clinical waste
Exposure	
Averted exposure	Person to person transmission of infection will be decreased
Potential increased worker exposure	None
Other considerations	
Agricultural impact	None
Compensation issues	N/A
Public information	It is essential that prior to, during and after the response to a biological incident clear communication strategies are developed and implemented to ensure the affected individuals are kept up to date There is a probability that the biological incident will attract media and government interest at the local, regional, national and international levels and this should be considered before information is released Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Additional information	
Practical experience	Four men became ill with hepatitis A and investigations revealed that all four cases had visited the same public house between 15 and 31 December. They have no other risk factors for hepatitis A and six further cases were reported. The barman at this public house had been ill with jaundice in the first weeks of January and was subsequently diagnosed with hepatitis A. Individuals were followed up and treated as appropriate (Sundkvist, 2000)
Key references	Sundkvist T, Hamilton GR, Hourihan BM, Hart IJ. Outbreak of hepatitis. A spread by contaminated drinking glasses in a public house. Commun Dis Public Health. 2000;3(1):60–62
Comments	
Document history	

(4) Restriction of entry into food chain/withdrawal from market

Objective	To protect consumers from ingesting contaminated food by preventing contaminated food from reaching the food chain and/or removing them from the shelf
Other benefits	Maintenance of confidence in food products
Recovery option description	Livestock, milk, meat, eggs and crops, and derived products, when determined as unsafe or could contain potentially harmful biological agents and/or toxins, or where there is a breach of a regulatory limit, are withdrawn from sale
Key information requirements	What is the nature and level of contamination? Relevant regulatory limits Risk assessment
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options This recovery option should be considered in conjunction with (5) Product recall and (8) Issue a FEPA order Waste disposal of contaminated foodstuffs or animals may also need to be considered, including (23) Culling of livestock, (26) Selection of alternative product use, (28) Disposal of foodstuffs and (29) Disposal of animal wastes
Target environment	Livestock, milk, meat, eggs and crops and derived products
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health, especially if persistent or toxic (eg produces toxins such as *C. botulinum*). However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion of contaminated food
Time of application	This recovery option should be implemented as soon as contamination of food is apparent

Considerations

Public health considerations	Biological contamination may not become apparent until after infection has occurred so there may be a delay in implementing this option and contaminated food products may enter the food chain
Legal implications and obligations	Under general food law Regulation (EC) 178/2002: • Article 14 places a legal obligation on food businesses not to place unsafe food on the market. Under Article 19, they must withdraw food from the market as soon as they have reason to believe it does not comply with food safety requirements. Under Article 18, they must be able to trace where they have obtained or supplied food, ingredients or food-producing animals and whom they have supplied There may be legal constraints on the disposal options for the withdrawn foodstuffs (see waste disposal recovery options) Where food implicated in the incident has been supplied to other EU member states or other countries, there may be pressure to replicate actions taken elsewhere (especially within the EU), even where these are considered excessive. For this reason, decisions need to be taken and communicated quickly. This is of particular importance where a decision is made ***NOT*** to take action There may be difficulty if contaminated food has been brought into the UK, first to trace back to the source and second to align with legislation of other countries For more information on legislation see Appendix A
Social implications	Retail trade or producers may be reluctant to implement this recovery option Potential to cause alarm within communities Usually it is when the public becomes aware of a withdrawal that some food businesses make a decision to recall products to reinforce trust and promote consumer confidence Policing the recovery option and averting fraudulent trading Potential for generating mistrust of food production systems or, conversely, possible increase in public confidence that the problem of contamination is being effectively managed There may be a negative social and psychological impact (or stigma) associated with food produced from the affected area

(4) Restriction of entry into food chain/withdrawal from market	
Environmental considerations	The fate of withdrawn foodstuffs and appropriate waste disposal routes of food products that are withdrawn from the market must be considered when implementing this recovery option
Ethical considerations	None
Effectiveness	
Recovery option effectiveness	Highly effective at removing commercially produced contaminated food from food chain and preventing further exposure
Technical factors influencing effectiveness of recovery option	Mode of implementation of the recovery option (eg how will affected food products be withdrawn?) Difficulties in monitoring for specific agents Difficulties tracing contaminated food that has been significantly distributed (eg abroad or into a wide range of products)
Feasibility and intervention costs	
Specific equipment	None. Withdrawal of contaminated food (or food that is suspected to be contaminated) can be implemented without specific equipment. Monitoring may be required to demonstrate that food complies with acceptable levels or is of low risk to the consumer
Utilities and infrastructure	Additional containers and temporary storage capacity may be needed to ensure that quarantined and unaffected batches of foodstuffs will not be mixed
Consumables	None
Skills, personnel and operator time	Logistical experts to ensure maintenance of the food supply especially in early phase Personnel will also be required to enforce this option and potentially to source alternative sources of food
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers will have to comply with Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs) If quarantined food is highly contaminated, normal storage facilities, even if separate from other storage, may be inadequate and additional safety measures may be needed to prevent the spread of contamination
Other limitations/ factors influencing costs	The scale and complexity of the affected part of the food chain may affect the practicability of withdrawal so the extent of the withdrawal must be balanced with the risk Storage costs may also need to be considered if large quantities of waste will require disposal Time and distances involved in travelling to areas under restrictions for monitoring purposes Time and distances involved in sourcing alternative foodstuffs
Waste	
Amount and type	Depending on scale of the incident, it is possible that significant quantities of contaminated waste (eg food products) will be generated (including milk, meat, eggs, crops and derived products). Contaminated waste may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance Long-term restrictions may also lead to cull and disposal of livestock
Possible transport, treatment, disposal and storage routes	See waste disposal recovery options Milk may be processed or biologically treated Livestock carcasses may be disposed of directly by rendering and incineration or burial, see (29) Disposal of animal wastes. Crops and other foodstuffs may be composted, processed or incinerated, see (27) Burning in-situ (pre-harvested crops) and (28) Disposal of foodstuffs
Factors influencing waste issues (eg cost)	Dependent on subsequent disposal route selected for withdrawn foodstuffs and quantities of waste produced Area under restrictions and duration of restrictions Acceptability of, and compliance with, waste disposal practice Local availability of suitable disposal routes Legal constraints on the fate of withdrawn foodstuffs

(4) Restriction of entry into food chain/withdrawal from market

Exposure	
Averted exposure	Ingestion of contaminated food products
Potential increased worker exposure	None directly, but subsequent recovery of large quantities of waste crops, animal carcasses and milk may incur additional exposure Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers or farming personnel use appropriate PPE (if required) and follow standard operating procedures (SOPs) Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands Exposure routes from transport and disposal of waste are not included
Other considerations	
Agricultural impact	This may be significant as dependent on the source and scale of contamination, both livestock and crops may be affected
Compensation issues	There may be requests for compensation: • farmer – for loss of earnings following restrictions on products • industry – for the difference in costs compared to normal practice
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Implementation of this recovery option is likely to meet resistance from some production or retail companies, so good stakeholder dialogue will be essential Dissemination of information about the recovery option, its rationale and possible alternatives, eg information explaining the risks associated with the levels of contamination, the uncertainty and the variance of levels will be required Good communication with members of public is essential to prevent alarm within communities. Social media should be considered as a way to disseminate information to a larger audience
Additional information	
Practical experience	This option was applied following an unexpected anthrax outbreak in a group of Swedish beef cattle kept indoors during the winter season of 2008 (Knutsson, 2012)
Key references	Knutsson R, Båverud V, Elvander M, Engvall EO, Eliasson K, Lewerin SS. Managing and learning from an anthrax outbreak in a Swedish beef cattle herd. Woodhead Publishing Series in Food Science, Technology and Nutrition. 2012;240:151–60 Public Health Canada. Pathogen Safety Data Sheets and Risk Assessment. Available (September 2015) at http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(5) Product recall

Objective	To prevent consumers from eating contaminated food that they have already purchased
Other benefits	Maintenance of confidence in food businesses and brands
Recovery option description	Recall involves advice to the public not to consume specific products but to dispose of them or return them to the retail outlet where they were purchased (normally for a refund) Food business operators must recall products when risk assessment indicates a public health concern and withdrawal alone does not provide sufficient level of protection. Product recall would normally be carried out in conjunction with (4) Restriction of entry into food chain/withdrawal from market Food businesses and retailers may also choose to initiate a recall when they consider this necessary to maintain public confidence Consumers should be informed effectively and accurately of the reason for the recall of the product and consideration given to those who may already have consumed affected products (ie to avoid unnecessary anxiety and whether or not they should seek medical advice)
Key information requirements	Details of implicated products, including any brand names, descriptions, origin, dates of manufacture, batch numbers, ie any information that will enable consumers, retailers and enforcement officers to identify and distinguish affected from unaffected products
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options This recovery option should be considered in conjunction with (2) Precautionary (food safety) advice and (4) Restriction of entry of food into the food chain/withdrawal from market Waste disposal of affected foodstuffs would also need to be considered, relevant options include (28) Disposal of foodstuffs
Target environment	People who have purchased the affected products
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion of contaminated food products
Time of application	This recovery option has to be implemented as soon as the risk becomes apparent

Considerations

Public health considerations	The public information and communication strategy would have to be carefully considered as this option considers food that has already been purchased for consumption and people may have already eaten the affected food
Legal implications and obligations	Under general food law Regulation (EC) 178/2002: • Article 19.1 places the obligation on food businesses to recall products where necessary to protect public health. Article 18.3 obliges food business operators to maintain records of the businesses to which they supply their products The basis for enforcement under 178/2002 is risk to health. As risk assessments tend to be subjective by nature, it is possible that the need for a recall may be challenged by the food business operator There may be legal constraints on the fate of the recalled foodstuffs and how they are disposed of (see waste disposal recovery options) For more information on legislation see Appendix A
Social implications	Individuals complying with instruction to return food May be trust (or a lack of trust) in the institutions or experts advising against consumption Effects on consumers, eg price increases and food shortages in extreme incidents If extensive, recall of food products may lead to market shortages and disruption of farming and the food processing industry, particularly in the early phase of implementation There may be public anxiety for those who have already consumed recalled products Perceived contamination of all food products (and loss of confidence) Operators could be put out of business with knock-on effects on other businesses Potential for generating mistrust of food production systems or, conversely, possible increase in public confidence that the problem of contamination is being effectively managed. Negative social and psychological impact regarding contaminated food

(5) Product recall

Environmental considerations	None, although there may be indirect environmental impacts depending on disposal route selected for recalled food products
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). For complete and detailed guidance, see the Human Rights Act
Effectiveness	
Recovery option effectiveness	Compliance with the recommendation not to eat certain foodstuffs and returning/disposing of contaminated food products is very unlikely to be 100% effective at reducing exposure and will never be possible to verify in practice. Some implicated food may already have been consumed. Indeed, some incidents come to light as a result of adverse effects from consumption. Additionally, there would be no certainty that the message reaches all purchasers of affected batches
Technical factors influencing effectiveness of recovery option	Selection of suitable communication channels and clarity of information Difficulties tracing contaminated food that has been significantly distributed (eg abroad) Willingness of population to accept this type of intervention, and the extent to which advice is followed (possible language and literacy issues) There may be negative consequences for food producing companies, who may therefore challenge the basis for the recall When the population has trust in the institutions or experts advising against consumption, the recovery option is likely to have more positive than negative social consequences (eg trust, personal control and informed choice)
Feasibility and intervention costs	
Specific equipment	No specialist equipment is required to implement this option; however, containers and temporary storage facilities may be needed for recalled food
Utilities and infrastructure	For a large-scale recall, specific facilities (eg temporary storage prior to waste disposal) may be required Appropriate lines of communication are of paramount importance in implementing this option
Consumables	Dependent on communication method
Skills, personnel and operator time	Communication skills
Safety precautions	None
Other limitations/ factors influencing costs	None
Waste	
Amount and type	Depending on scale of the recall, it is likely that significant quantities of contaminated food products may require disposal. Contaminated waste may come under the classification of ‘hazardous waste’. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Depending on the scale of the incident, recovery option can result in large quantities of recalled food requiring transport, storage and disposal Milk may be processed or biologically treated, see (15) Processing or treatment of food products Animal products may be disposed of directly by rendering and incineration, see (29) Disposal of animal wastes. Fruit and vegetables could be composted, processed or incinerated, see (28) Disposal of foodstuffs.
Factors influencing waste issues (eg cost)	Dependent on: • disposal route selected for recalled foodstuffs and quantities of waste produced • acceptability of, and compliance with, waste disposal practice • local availability of suitable disposal routes • legal constraints on the fate of recalled foodstuffs

(5) Product recall

Exposure	
Averted exposure	Ingestion of contaminated food products
Potential increased worker exposure	May be increased worker exposure if large amounts of waste need to be dealt with
Other considerations	
Agricultural impact	None
Compensation issues	There may be requests for compensation: • food industry – for difference in costs compared to normal practices • refund or replacement costs
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Implementation of this recovery option is likely to meet resistance from some production or retail companies, so good stakeholder dialogue will be essential Dissemination of information about the recovery option, its rationale and possible alternatives, ie information explaining the risks associated with the levels of contamination, the uncertainty and the variance of levels, will be required to all of the food businesses concerned Good communication with members of public is essential to prevent alarm within communities, with consistent information about the recall and the reasons for it All possible means of communication to consumers should be considered. These may include point-of-sale notices food business, local authority and Food Standards Agency (FSA) websites, special interest groups (eg for contaminated infant formula or baby food, organisations such as the NCT, Royal College of Midwives), newspaper and magazine advertisements, television and radio (local and/or national), social media and direct mailing (where possible and relevant)
Additional information	
Practical experience	This option is fairly routinely used when biological contamination is discovered. See the Alerts section of the FSA website at http://www.food.gov.uk/enforcement/alerts
Key references	MMWR Weekly. Vibrio parahaemolyticus infections associated with consumption of raw shellfish – three states, 2006; Aug 8, 2006/55(Dispatch);1–2 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(6) Closure of air intake systems at food processing plants

Objective	To reduce: (a) Contamination of foodstuffs from potential aerosols containing biological agents (b) Contamination of food processing facilities (c) Contamination of outside environment in positive pressure facilities In the following text these objectives are referred to as (a), (b) and (c) where comments are specific
Other benefits	Maintain the credibility of safe food production systems to consumers (a, b) Reduce inhalation of contaminated air and workers' exposure to biological agents (b) If contamination originates from the processing plant, closure of heating, ventilation, and air conditioning (HVAC) systems may reduce contamination of the outside environment and risk to the local population (c)
Recovery option description	In food industries relatively large volumes of air are used for drying, roasting and pneumatic transport of food products. Outdoor air may be used directly or after purification with filters. Due to large air volumes, sufficient filtering is not always possible or specification of filters may be inadequate to deal with biological contamination Positive pressure facilities are employed in some food processing facilities to prevent microbial contamination of food. Air is likely to be pushed out into the surrounding environment rather than being drawn in Contamination of foodstuffs and facilities can be reduced by halting these processes at risk when contamination becomes apparent
Key information requirements	Is a biological aerosol involved/does the agent in question have the potential to be transmitted through the air? Is the plant operating at positive pressure?
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options This option is likely to be carried out in conjunction with (1) Restrict/controlled access Biological contamination is not always evident until a noticeable infection has occurred. Due to the possible time delay between the contamination event and detection, foodstuffs may have already reached the consumer. Therefore, this option should be considered alongside (4) Restriction of entry into food chain/withdrawal from market and (5) Product recall This recovery option should also be considered along with protection options for the surrounding environment. Consult Chapter 6 (inhabited areas) if processing plants are located in industrial areas
Target environment	Industrial food processes: milling, roasting, drying, dairy or meat plants, bakery and catering industries, etc Food processes involving powdered foodstuffs All facilities of food processing industries (b, c)
Targeted organisms	This recovery option is applicable to all biological agents that can contaminate the food chain and pose a risk to public health. This option is also applicable to agents that can be easily aerosolised or transmitted through air. However, the characteristics of the biological agent will influence whether or not this option is necessary. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any (potentially large scale)
Exposure pathway prevention	Deposition (from air to foodstuffs) Ingestion (a); inhalation and dermal (skin) contact (b, c)
Time of application	This recovery option should be implemented as soon as the risk becomes apparent, to minimise the spread of contamination and to minimise the risk of re-aerosolisation of the agent

Considerations

Public health considerations	Biological contamination is sometimes not often evident until a noticeable infection has occurred. Due to the possible time delay between the contamination event and detection, contamination may have already spread to the surrounding outdoor environment and to food which may have already reached the consumer Closure of air intake/HVAC systems will prevent any further contamination of the outdoor environment in facilities that operate with positive pressure. However, this will contain the contamination within the facilities which may increase the risk of exposure for workers (c)

(6) Closure of air intake systems at food processing plants

Legal implications and obligations	Requirement to consider appropriate protection for workers at risk of being exposed to biological aerosols. Employers have a duty of care to protect employees from hazards and risks in the workplace Instructions for shutdown of a process or ventilation system must be followed Responsibilities regarding compensation may need to be defined For more information on legislation refer to Appendix A
Social implications	Resistance of operators to carry out procedure Resistance of food production workers to enter the affected area to retrieve food products Contamination of the outdoor environment may damage public confidence
Environmental considerations	Possible contamination of the surrounding environment due to positive pressure facilities (c)
Ethical considerations	Informed consent of workers who may be exposed to biological contamination (b, c) Inform local inhabitants if at risk of exposure (c)
Effectiveness	
Recovery option effectiveness	Due to the possible time delay between contamination event and its detection this recovery option is likely to have limited effectiveness In facilities where routine microbiological testing is carried out, this recovery option could have up to 100% effectiveness
Technical factors influencing effectiveness of recovery option	Time delay between contamination event and detection will influence effectiveness. The longer the time delay, the more likely that food and surrounding areas will become contaminated Sufficient time is needed to stop any existing processing (a). The ability or possibility to make plants air-tight will vary (b, c). Closing air systems can be complex Availability of suitably trained personnel depending on time and labour required. Operators may be reluctant to be in areas that are contaminated Windy conditions could disperse biological contamination that has already reached the outdoor environment
Feasibility and intervention costs	
Specific equipment	None
Utilities and infrastructure	Access to air intake/HVAC systems in industrial buildings and facilities
Consumables	None for implementation Air filters will need to be replaced as they may have been contaminated
Skills, personnel and operator time	Capabilities will exist on site. Competent persons would need to be available and may have to be called on to implement the recovery option out of hours
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with Health and Safety at Work etc Act to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs) Occupational monitoring of staff may be required Outdoor environments should be monitored for potential contamination
Other limitations/ factors influencing costs	Only certain individuals at the establishment may be able to implement this option, eg shift supervisor or head engineer. If they are not present then the recovery option might be delayed further Routine microbiological testing will help to detect contamination early before it can be spread to outdoor environments (c) A decision on implementation will have to consider the (potentially unknown) technical consequences of a sudden shutdown of some industrial processes
Waste	
Amount and type	Many types of waste that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance Filters in air ventilation systems may require decontamination and disposal Contaminated food may need decontamination and disposal

(6) Closure of air intake systems at food processing plants

Possible transport, treatment, disposal and storage routes	Depending on the nature of the biological agent, waste may be classified as dangerous in transport and subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Factors influencing waste issues (eg cost)	Potential for spoilage of food products if processes are shutdown Time delay between contamination event and detection will influence the amount of contaminated food that requires disposal
Exposure	
Averted exposure	Contamination of food products, processing equipment and outdoor environments
Potential increased worker exposure	Increased risk of worker exposure if positive pressure systems are shutdown (c). There may be additional exposure associated with disposal of contaminated air filters Increased risk of exposure for workers who are required to enter contaminated areas to shut down ventilation systems
Other considerations	
Agricultural impact	Possible contamination of outdoor environments due to positive pressure systems. This may be relevant if surrounding land is agricultural
Compensation issues	There may be requests for compensation for loss of earnings and production if: • production is lost as a consequence of unnecessary shutdown • plant subsequently fails because of shutdown • large quantities of food are contaminated There may be requests for compensation from owners of surrounding lands that may become contaminated and have to be remediated Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level which should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected area). This information must be developed in partnership with other experts, government agencies and departments This recovery option would have to be implemented as soon as contamination is evident, therefore rapid and comprehensive instructions to plant operators would be required. Depending upon the time of day, information on risks would need to be communicated to workers prior to entering or exiting the workplace Clear and readily available instructions should be provided in the identified processing plants' existing emergency plans/handbook. Information must be updated regularly to ensure operators are not exposed to contamination The cost of communicating the recovery option and its objectives to operators and the industry should also be considered; multiple channels may be necessary (eg advisory centre, leaflets and the internet)
Additional information	
Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	Due to the possibility that contamination may not be detected until infection has occurred, this recovery option will have limited feasibility. Despite this, this recovery option should be implemented when contamination is apparent to contain the contamination if possible and/or prevent re-aerosolisation or transmission of the biological agent
Document history	

(7) Minimise spread from contaminated crops

Objective	To prevent contamination spreading from contaminated crops to: • harvested crops • greenhouse crops
Other benefits	Reduces amount of potentially contaminated food Avoids contamination of growing medium Public confidence in food
Recovery option description	Covering or containment of contaminated crops stored on the farm to prevent further spread of contamination Switch off of ventilation systems in greenhouses to prevent passage of biological aerosols from contaminated crops and close all windows, doors and vents Water plants with clean water, ie water not directly contaminated in an incident
Key information requirements	Is a biological aerosol involved? Are spores involved? Is the water supply contaminated?
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options Biological contamination is not always evident until a noticeable infection has occurred. Due to the possible time delay between the contamination event and detection, crops from greenhouses and/or poly tunnels may have already reached the consumer. Therefore, this option should be considered alongside (4) Restriction of entry into food chain/withdrawal from market and (5) Product recall
Target	Greenhouses, poly tunnel crops and harvested crops
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could be aerosolised, transmitted through the air or water supply and pose a risk to public health, especially if the agent is persistent and has a low infectious dose. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any (potentially large scale)
Exposure pathway prevention	Direct contamination of crops, and later soil to plants
Time of application	This recovery option has to be implemented as soon as the risk becomes apparent. However, due to the time for contamination to be detected this option may have limited feasibility
Considerations	
Public health considerations	Biological contamination is not always evident until a noticeable infection occurs; therefore it is possible that contaminated products may reach the consumer before contamination has been detected. This could pose a significant health risk to the public Operators may be reluctant to carry out any protective procedures if there is a possible risk of contamination
Legal implications and obligations	Requirement to consider biological protection if there is a risk of personnel being exposed to contaminated air and water. Employers have a duty of care to protect employees from hazards and risks in the workplace
Social implications	This recovery option may help maintain public confidence regarding the quality of food products. Depending on the biological agents involved there may be disruptions in farming practice
Environmental considerations	Dependent on the biological agents involved Seek specialist advice and guidance
Ethical considerations	None
Effectiveness	
Recovery option effectiveness	Limited effectiveness due to the time for detection of contamination
Technical factors influencing	The effectiveness of this option will depend on: • properties of the biological agent involved

(7) Minimise spread from contaminated crops

effectiveness of recovery option	• how quickly contamination is detected • compliance of farmers or operators to carry out the procedure • type and condition of greenhouse and/or poly tunnel • availability of alternative water supplies
Feasibility and intervention costs	
Specific equipment	Sheets for covering contaminated crops if applicable
Utilities and infrastructure	Alternative water supply if applicable
Consumables	None
Skills, personnel and operator time	Skills are present within horticultural community Personnel may have to implement the recovery option out of hours
Safety precautions	Ensure operators are given full PPE to complete the task
Other limitations/ factors influencing costs	None
Waste	
Amount and type	Potentially contaminated water may need decontamination and disposal There is the potential for large amounts of contaminated crops if there is too long a delay in implementing this option
Possible transport, treatment, disposal and storage routes	Transport might need to be arranged if crops need to be disposed of and the disposal facility is not on site
Factors influencing waste issues (eg cost)	Potentially transport, decontamination and disposal of contaminated water Crops may require disposal if damaged or contaminated
Exposure	
Averted exposure	Contamination of crops
Potential increased worker exposure	Exposure to operators should be minimal provided appropriate protective equipment is supplied and safe procedures followed
Other considerations	
Agricultural impact	Potential spoilage of crops due to lack of ventilation
Compensation issues	There may be requests for compensation for loss of earnings and production if: • crops are spoilt or damaged as a consequence of this measure • large quantities of food are contaminated Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level which should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected area). This information must be developed in partnership with other experts, government agencies and departments Information must be updated regularly to ensure operators are not exposed to contamination The cost of communicating the recovery option and its objectives to operators and the industry should also be considered; multiple channels may be necessary (eg advisory centre, leaflets and the internet)

(7) Minimise spread from contaminated crops

Additional information

Practical experience	While not directly related, farmers have experience at covering crops to protect them from adverse weather
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	Due to the possibility that contamination may not be detected until infection has occurred, this recovery option will have limited feasibility and affected crops may have reached the consumer. This option should still be considered as a way to prevent the spread of further contamination but should be considered along with other protection options
Document history	

(8) Issue a FEPA order

Objective	To prevent the production in or movement of food or food-producing animals from a defined geographical area
Other benefits	None
Recovery option description	In the aftermath of a biological incident, the Food Standards Agency (FSA) may issue an order under the Food and Environment Protection Act (FEPA) 1985 to prohibit production or movement of food or agricultural produce within or out of a designated geographical area. It can apply to all forms of agricultural production but can also be imposed over a defined marine area to prevent the collection of fish and shellfish A FEPA order would only be applicable to commercially produced food and there is no power to prevent people growing and eating food domestically (eg from allotments and gardens)
Key information requirements	Level of risk to health (there must be a hazard to health for a FEPA order to be issued) Potential for contamination to spread within an area or through the food chain Size and number of farms or food businesses in the area affected Precise geographical boundaries of the designated area
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options This recovery option is likely to be considered in conjunction with (4) Restriction on entry into food chain/withdrawal from market and (5) Product recall It is likely to be necessary if voluntary measures are considered inadequate, affected food businesses are uncooperative, the risk to health is very significant, there is a possibility of unintentional introduction of contaminated food into the food chain or if the impact is likely to be very long term This recovery option should be considered in conjunction with the fate of affected produce options such as (23) Culling of livestock Waste disposal options will also include (27) Burning in-situ (pre-harvested crops), (28) Disposal of foodstuffs and (29) Disposal of animal wastes
Target environment	Anyone producing food within a designated geographical area that has been subject to contamination
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Entry of contaminated food into the food chain Consumption of contaminated food
Time of application	No restrictions on time. This recovery option is not time limited and can be implemented at any time but must be implemented as soon as a food safety risk comes to light. A FEPA order can remain in place indefinitely

Considerations

Public health considerations	None
Legal implications and obligations	Seek expert advice and guidance. The FSA can issue a FEPA order on behalf of the Secretary of State for Agriculture A FEPA order has provisions for prohibiting the gathering and picking of wild plants (eg fungi) and hunting wild game and fish
Social implications	There will be an impact on farmers and food businesses Changed perception of natural resources because people may feel that they are damaged or polluted Loss of traditional activities, eg gathering wild food; however, advice could maintain this as opposed to the alternative (food restrictions) Potential loss of home produced and or wild foodstuffs may have most negative impact on poorer population groups
Environmental considerations	None

(8) Issue a FEPA order

Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). For complete and detailed guidance, see the Human Rights Act As this measure is precautionary, authorities are unlikely to lose public trust even if with hindsight measures are proved to have been unnecessary
Effectiveness	
Recovery option effectiveness	Up to 100% effective if implemented soon after contamination occurs or is discovered. Difficult to enforce on people consuming domestically produced food
Technical factors influencing effectiveness of recovery option	None
Feasibility and intervention costs	
Specific equipment	None
Utilities and infrastructure	N/A
Consumables	N/A
Skills, personnel and operator time	N/A
Safety precautions	None
Other limitations/ factors influencing costs	None
Waste	
Amount and type	None directly, but may lead to large quantities of food waste
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion of contaminated foods
Potential increased worker exposure	N/A
Other considerations	
Agricultural impact	Will lead to prevention of use of agricultural land for a period of time
Compensation issues	Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments

(8) Issue a FEPA order

	Implementation of this recovery option is likely to meet resistance from some farmers, so good stakeholder dialogue will be essential. Dialogue with farmers or herders is necessary to ensure understanding of the reasons for the issue of a FEPA order, and to identify means of ameliorating negative consequences of this recovery option on other farming and related activities Effective communication would be especially important if this option was used as a precautionary measure

Additional information

Practical experience	
Key references	Food and Environmental Protection Act 1985. Available (September 2015) at http://www.legislation.gov.uk/ukpga/1985/48 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Public Health Canada. Pathogen Safety Data Sheets and Risk Assessment. Available (September 2015) at http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php
Comments	
Document history	

(9) Pest control

Objective	To reduce the spread of contamination and infection by pests, eg rats, badgers and squirrels
Other benefits	None
Recovery option description	Pests can be vectors of some infectious diseases and aid the spread of contamination. Common pests include rats, mice, squirrels, badgers, cockroaches, ticks, mosquitos, fleas and pigeons Pests are humanely culled and disposed of using trained, specialist contractors. This may involve the use of traps, poison, pesticides and fogging
Key information requirements	What pests are in the affected area? What other animals are in the affected area?
Linked recovery options	This option is a protection option and should be linked to remediation options Recovery options that may need to be considered with this option include (1) Restrict/controlled access
Target environment	Areas where pest levels are a problem
Targeted organisms	This recovery option is applicable to all organisms that pose a risk to public health and can easily be transmitted through animal vectors. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis This option may be particularly relevant to the following biological agents that are known to be transmitted through animal vectors: *Toxoplasma gondii, Yersinia pestis, Plasmodium* spp. *and Borrelia* spp.
Scale of application	Dependent on size of affected area where pests are involved
Exposure pathway prevention	Transmission from vector to animal/crop/human
Time of application	This recovery option has maximum benefit if implemented as soon as contamination is evident to prevent further spread of contamination
Considerations	
Public health considerations	The method of pest control used may be toxic to the human population or to livestock resident in the area. Any use of poisons or toxic gas must be monitored and, where appropriate, the human population or livestock should be removed from the area Ineffective removal of dead pests may later result in odour complaints (eg rats or mice may die under floorboards, which may make removing carcasses difficult)
Legal implications and obligations	Seek specialist advice
Social implications	There may be concern from the public over the welfare of livestock and other animals The method of pest control may cause public concern if it is considered to be inhumane
Environmental considerations	This is dependent on the environment of the affected area, the type of pest, the method of pest control used and the role the pest may play in the local ecosystem
Ethical considerations	There may be animal welfare considerations The most humane methods of pest control should be used where possible
Effectiveness	
Recovery option effectiveness	If implemented quickly, this recovery option should be effective at intercepting the exposure pathway of transmission from vector to animal to human
Technical factors influencing effectiveness of recovery option	This recovery option will need to be carried out by trained exterminators
Feasibility and intervention costs	
Specific equipment	Equipment needed for pest control method, eg poisons and traps
Utilities and infrastructure	N/A

(9) Pest control

Consumables	Protective equipment for specialist personnel, eg gloves
Skills, personnel and operator time	Will require specialist contractors to undertake this option, who are familiar with pest control and how to deal with the subsequent waste
Safety precautions	Will depend on the biological agent involved and the pests (vectors) that are to be removed. A risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers will have to comply with Health and Safety at Work etc Act to ensure that workers entering the contaminated area use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	N/A
Waste	
Amount and type	There may be large volumes of pest carcasses that will need removing and disposing of appropriately
Possible transport, treatment, disposal and storage routes	This will depend on the agent involved: landfill or incineration. See (29) Disposal of animal wastes
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Vector to animal
Potential increased worker exposure	There may be increased exposure to pest control operators while implementing this option. Appropriate PPE will need to be worn and care will need to be taken when disposing of contaminated carcasses
Other considerations	
Agricultural impact	Depends on nature of affected area, ie agricultural, rural or urban. There may be animal welfare issues that should be considered. Seek specialist advice and guidance
Compensation issues	Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Experience also confirms the need to ensure that other measures are put into place to keep the community informed of developments when regular briefings have been terminated. Previous incidents and exercises suggest weekly or monthly newsletters; site boards or banners around sites can be effective ways of achieving this
Other considerations	Depends on nature of affected area, ie agricultural, rural or urban. There may be animal welfare issues that should be considered. Seek specialist advice and guidance
Additional information	
Practical experience	Culls of animal vectors are often undertaken in the farming industry. Badger culls were undertaken post-2010 as a means to reduce transmission of bovine tuberculosis in cattle (Defra, 2015)
Key references	Defra. Advice to Natural England on setting minimum and maximum numbers of badgers to be culled in 2015. Available (September 2015) at https://www.gov.uk/government/publications/advice-to-natural-england-on-setting-minimum-and-maximum-numbers-of-badgers-to-be-culled-in-2015
Comments	
Document history	

(10) Relocation of animals

Objective	To avoid or limit contamination of food products derived from grazing animals by reducing the ingestion of contaminated feed or to avoid or reduce the risk of transmission of infection from other infected livestock during and after biological contamination
Other benefits	Minimise the volume of contaminated meat/milk/eggs requiring disposal Will reduce exposure of farm animals, especially to biological agents with a short persistence Public confidence in food products may increase Animal welfare benefits Will make remediation easier if animals are absent
Recovery option description	Relocation of unaffected animals to clean environments as soon as the risk becomes apparent. This may be to sheltered housing and the use of stored feedstuffs (the long-term clean feeding of livestock is dealt with in a separate recovery option) or may be to another grazing site known to be uncontaminated It is possible that this recovery option may coincide with the evacuation of the human population. If so farmers (or suitable emergency workers) will need to return at regular intervals to tend stock (until the evacuated population are allowed to return or, if evacuation is likely to be for a prolonged period, a decision is made to remove or cull the animals. For extreme emergency situations requiring the immediate evacuation of the public, this recovery option will not be possible
Key information requirements	Is a biological aerosol involved? Are spores involved? Is the water supply contaminated? Is grazing land contaminated? Are animal houses contaminated? Have other livestock become infected?
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options This option should not be considered if the options (8) Issue a FEPA order and/or (11) Restriction of animal transport/movement are implemented This recovery option should be considered in conjunction with (21) Clean feeding/selective grazing regime, (24) Decontamination of animal premises and (29) Disposal of animal wastes
Target environment	Any animals that are at risk of contamination
Targeted organisms	This recovery option is applicable to all biological agents that could be aerosolised, transmitted through the air or transmitted through a contaminated water supply and pose a risk to public health, especially if the agent is persistent and has a low infectious dose. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any (potentially large-scale depending on farming practices)
Exposure pathway prevention	Direct contamination and ingestion by animals Ingestion of contaminated products Animal to animal transmission
Time of application	This recovery option has to be implemented as soon as the risk becomes apparent. Due to the time taken between the contamination event and detection this recovery option may have limited feasibility

Considerations

Public health considerations	None
Legal implications and obligations	Requirement to consider biological protection if there is a risk of farmers being exposed to contamination Animal welfare regulations Regulations on the recovery of agricultural discharges, eg the recovery option will result in the production of manure and/or slurry on which there may be legal restrictions with regard to when it can be spread to land or how it is disposed of
Social implications	Compliance of supporting industries, eg entering the affected area to collect milk or deliver feed Acceptability of produce to food industry or consumers – need for monitoring data on foodstuffs Increase confidence that the problem of contamination is being effectively managed

(10) Relocation of animals

	Disruption or adjustment of farming and related industrial activities Depending on the nature of the biological agent involved (eg persistence in environment), there could be disruptions in farming practice (eg restricting future grazing) or stigma associated with the affected area
Environmental considerations	Housing of livestock produces large volumes of manure and/or slurry that must be disposed of appropriately to avoid cross-contamination (this is normal practice to avoid pollution from nitrates) Storage capacity on farm for manure and/or slurry
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). For complete and detailed guidance, see the Human Rights Act Redistribution of exposure from consumers to operators or owners Informed consent – there is a risk that operators may be exposed to the biological agent Ethical issues will depend on whether the recovery option is introduced as mandatory, or as advice to farmers (while the considerations will be the same, the weight of the various aspects will change)
Effectiveness	
Recovery option effectiveness	Due to the time between the contamination event and detection, this option may have limited feasibility. Effectiveness may be dependent upon housing type, water and feed supplies
Technical factors influencing effectiveness of recovery option	Due to the time between the contamination event and detection, this recovery option's effectiveness may be substantially reduced Compliance of farmers or operators to carry out procedure. They may be reluctant to be outside while there is a risk of contamination Distance between pastures and shelters Degree to which recovery option diverges from usual practice Type of housing will determine exposure to biological aerosols (eg some housing is likely to be of a more open construction and therefore contamination may still occur) Availability of forage – combined implementation with protection of harvested crops may aid in this Unlikely to be sufficient local housing and conserved foodstuffs in systems using summer grazing regimes remote from farmsteads Water sources may be contaminated – this is especially relevant to farms with a local water supply Roughage is generally exhausted at the end of winter While this option is likely to help maintain consumer confidence in foodstuffs, it may be necessary for monitoring to ensure acceptability and for reassurance purposes
Feasibility and intervention costs	
Specific equipment	Equipment to remove manure or slurry – may not be required in emergency phase Transport to move livestock if necessary
Utilities and infrastructure	Suitable housing or pasture land with water supply, and power if required Storage capacity for extra manure or slurry at new site Alternative water supply
Consumables	Stored feed must be available Bedding (straw, etc) if used
Skills, personnel and operator time	Farmers would possess the necessary skills as housing/moving animals is normal practice. Farmers may have to implement the recovery option out of hours This recovery option may result in extra work for farmer looking after housed animals and subsequently disposing of manure and/or slurry
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers will have to comply with Health and Safety at Work Act etc 1974 to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Time for which animal sheltering is required Availability of feed locally Health monitoring of animals may be required, even if only for reassurance purposes Roads must not be blocked by moving animals when people need to be evacuated

(10) Relocation of animals

Waste	
Amount and type	Manure and slurry will need decontamination and disposal
Possible transport, treatment, disposal and storage routes	Use of normal slurry or manure disposal routes is unlikely to be a problem
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion of contaminated meat, milk and other dairy products
Potential increased worker exposure	Due to delay between the contamination event and contamination, workers may have already been exposed
Other considerations	
Agricultural impact	Normally changes from grazing to conserved feeds would be progressive. In an emergency situation diet would have to be changed rapidly this may lead to reduced productivity and negative health effects in the affected animals Animal welfare issues associated with housing animals in emergency facilities (eg may not be as well prepared as when normally housed) and if housed in summer when temperature or poor ventilation may be a problem
Compensation issues	There may be requests for loss of earnings and production by the farmer for replacement feed (and bedding) and for additional work or labour
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected area). This information must be developed in partnership with other experts, government agencies and departments Advice to farmers on handling contaminated waste (manure and/or slurry)
Additional information	
Practical experience	Farmers would have experience of relocating animals as this is standard farming practice with livestock
Key references	Public Health Canada. Pathogen Safety Data Sheets and Risk Assessment. Available (September 2015) at http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	Farmers should be able to gather dairy animals relatively quickly (in about one hour). There could be animal welfare issues if adapting or introducing alternative stored feeds very quickly. The availability of alternative feed will depend on the time of year with the period from March to May likely to have fewest options for alternative feedstuffs
Document history	

(11) Restriction of animal transport/movement

Objective	To reduce the spread of contamination by restricting animal movement
Other benefits	None
Recovery option description	This recovery option restricts the movement of animals from one area to another which may be achieved by placing a temporary ban on movement or by issuing a FEPA order
Key information requirements	What is the contaminating biological agent(s)? Animals affected
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options This option should be considered alongside (8) Issue a FEPA order Waste disposal options that should be considered are (23) Culling of livestock and (29) Disposal of animal wastes
Target environment	Contaminated pasture lands
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Environment to livestock
Time of application	No restriction on time
Considerations	
Public health considerations	None
Legal implications and obligations	Animal welfare regulations including the Animal Welfare Act 2006 The Animal and Plant Health Authority (APHA) will need to be informed if the agent is a notifiable disease See Appendix A for more information
Social implications	There may be a negative response from the public if they feel animals are not treated properly; conversely, there may be a positive response if they feel the contamination is being effectively dealt with
Environmental considerations	Flora and fauna may benefit from animals being restricted in one place The area to which animals are limited may suffer
Ethical considerations	There may be animal welfare issues
Effectiveness	
Recovery option effectiveness	Should be 100% effective at reducing the spread of contamination and should limit the area needing remediation
Technical factors influencing effectiveness of recovery option	Effectiveness may be reduced if there is a large delay between the date that contamination occurred and the date the contamination was reported Time of year – contamination may occur during a time when traditionally livestock are brought indoors during the winter months. Animal welfare will have to be balanced against the level of contamination. A decision to cull the animals may need to be made if their welfare cannot be guaranteed
Feasibility and intervention costs	
Specific equipment	None
Utilities and infrastructure	Capacity to extend winter sheltering if necessary
Consumables	Feed may be required at certain times of the year
Skills, personnel and operator time	The workforce may be required to monitor the animals' welfare and provide feed and water if necessary

(11) Restriction of animal transport/movement

Safety precautions	Workers may be exposed to contamination so will need to wear appropriate PPE Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers will have to comply with Health and Safety at Work etc Act to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Length of time for which animal restrictions are is in place Availability of feed
Waste	
Amount and type	Manure and slurry will need decontamination and disposal
Possible transport, treatment, disposal and storage routes	Use of normal slurry or manure disposal routes is unlikely to be a problem
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	From animal to environment
Potential increased worker exposure	There may be increased worker exposure to those who have to tend to livestock
Other considerations	
Agricultural impact	Animals that have defined slaughter times may not be able to be sent to the abattoir. A decision may need to be made to cull the animals on site Milk production may be lost
Compensation issues	There may be requests for loss of earnings and production by the farmer for replacement feed (and bedding) and for additional work or labour
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected area). This information must be developed in partnership with other experts, government agencies and departments Advice to farmers on handling contaminated waste (manure and/or slurry)
Additional information	
Practical experience	This option is employed when contamination with a 'notifiable disease' is suspected (eg anthrax). Exclusion zones and restriction of animal movement can be put into place by Defra and APHA. Farmers will be aware of these policies
Key references	Defra and APHA. Notifiable diseases in animals. 2014. Available (September 2015) at https://www.gov.uk/government/collections/notifiable-diseases-in-animals
Comments	
Document history	

(12) Restriction on animal breeding

Objective	To reduce the spread of contamination by restricting breeding
Other benefits	Prevents young from being affected while in the womb
Recovery option description	During an incident, animal breeding may be restricted to prevent the transmission of infection from mother to young. Some microorganisms can be transmitted across the placenta or can cause birth defects and spontaneous abortion
Key information requirements	What is (are) the contaminating agent(s)?
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options
Target environment	Breeding livestock
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis This option may be more relevant to certain microorganisms that are known to cause reproductive problems including *Brucella* spp. and *Coxiella* spp.
Scale of application	Any
Exposure pathway prevention	Placental transmission Animal to animal transmission Animal to human transmission Ingestion (of contaminated eggs)
Time of application	Any, but will be more effective as soon as the risk becomes apparent

Considerations

Public health considerations	Microorganisms that can cause spontaneous abortion and birth defects are likely to be transmissible to humans. It would be advisable to restrict public access to any areas which may be affected and notices erected advising of the risk to pregnant women. See (1) Restrict/controlled access
Legal implications and obligations	Scrapie can be passed through breeding and therefore sheep can be bred for increased resistance to the disease based on genetic factors. Potential for animal welfare issues in rearing animals For more information on legislation please see Appendix A
Social implications	None
Environmental considerations	Need to consider that slurry from contaminated animals may increase contamination on agricultural land
Ethical considerations	Need an effective dialogue with farmers

Effectiveness

Recovery option effectiveness	Likely to be up to 100% effective for reducing contaminated offspring, birth defects and spontaneous abortion Can reduce the amount of waste milk requiring disposal
Technical factors influencing effectiveness of recovery option	How soon it is implemented following an incident

Feasibility and intervention costs

Specific equipment	Fencing materials for segregating animals Transport for fencing materials
Utilities and infrastructure	None

(12) Restriction on animal breeding

Consumables	Fencing
Skills, personnel and operator time	Specialists are not required, farmers will have experience at segregating livestock
Safety precautions	Farm workers will require appropriate PPE
Other limitations/ factors influencing costs	Number of animals contaminated Availability of new fields/animal housing
Waste	
Amount and type	No waste is generated directly with this recovery option; however, contaminated slurry and manure will need decontamination and disposal. See (29) Disposal of animal wastes
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion of contaminated animal products, including dairy, eggs, meat Transmission of microorganisms across the placenta Transmission of microorganisms by aerosolised agent in afterbirth, etc
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act to ensure that recovery workers (eg farmers and plant operatives) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers may be required to ensure that exposure is limited
Other considerations	
Agricultural impact	This may be significant as dependent on the source and scale of contamination, the number of livestock may be reduced, both in the immediate term and also in the longer term
Compensation issues	Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addresses Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Dialogue with farmers or herders is necessary to identify means of ameliorating the negative consequences of recovery options on other farming and related activities
Additional information	
Practical experience	Farmers have experience of restricting animal breeding as part of breeding practices Between 2001 and 2009, the Ram Genotyping Scheme was introduced in the UK to allow owners to breed for Scrapie resistance: http://tna.europarchive.org/20130814101929/http://www.food.gov.uk/about-us/how-we-work/our-board/boardmeetoccasionalpapers/2008/int080205
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical

(12) Restriction on animal breeding

	Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	Could be implemented relatively easily as it is regularly implemented on farms as normal procedure, effectively changing animal breeding season
Document history	

(13) Ban or restriction on hunting, fishing and foraging

Objective	To prevent the consumption of contaminated meat, fish and foraged foods by banning or restricting hunting, fishing and foraging to certain times where relevant
Other benefits	Hunting for game can be preserved, but the meat will not be allowed to be consumed Limit exposure from surface contamination on wild or free foods
Recovery option description	Hunting: during the hunting season, either a complete ban can be placed on the hunting of particular species or a restriction can be placed on the food entering the food chain, ie animals can be hunted but cannot be eaten Fishing: this includes the ban or restriction on fishing of any species that may enter the food chain. This will also include the harvesting of shellfish such as oysters and mussels which are likely to concentrate contamination within them. Fishing may be allowed to continue for sport providing the fish does not enter the food chain and depending on the type of contamination Foraging: advice against gathering of wild or free food products, such as nuts, mushrooms, honey, fruits and berries, will reduce exposure by preventing the consumption of these foodstuffs
Key information requirements	What is the biological contaminant and where has the contamination occurred?
Linked recovery options	This is a protection option and should be linked to remediation and waste disposal options This recovery option should be considered in conjunction with (2) Precautionary (food safety) advice
Target environment	Farmers, land owners, gamekeepers and hunters (ie those involved in the hunting of waterfowl, wildfowl, game fowl, ground game and deer) Anglers and fishermen: all fish and shellfish People who gather and/or consume wild or free foods – fruits, berries, herbs, honey, edible flowers, aquatic plants, nuts and mushrooms
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion of contaminated fish, meat and foraged foods
Time of application	No restrictions on time. This recovery option is not time limited but should be considered as soon as the contamination comes to light

Considerations

Public health considerations	Would need to consider that not all the public will receive information on bans and restrictions. Bans and restrictions on foraged foods cannot be completely controlled for
Legal implications and obligations	A FEPA order has provisions for prohibiting the gathering and picking of wild plants (eg fungi), and hunting wild game and fish. See (8) Issue a FEPA order
Social implications	Resistance from hunters and foragers Recovery option may be met with disappointment from local populations and business for which the collection of wild foods has a cultural and economic significance Acceptability of reducing the hunting season If implemented successfully (ie hunters avoid the contaminated areas) there are possible negative consequences for the community or owner (for private hunting lands) or ecosystems. Disruption to people's image of countryside as 'clean' Negative social and psychological impacts caused by, for example, the loss of traditional activities and loss of cheap food sources
Environmental considerations	Impact on ecosystem (due to lack of game management), population dynamics, breeding, mortality or birth rate, competition, etc The continuous management of large game species through hunting licences is of utmost importance to keep the number of animals at a sustainable level. It is therefore important to keep hunting (culling) under all circumstances even if the meat does not enter the food chain Closed hunting seasons exist to allow time for breeding and for populations to recover from previous hunting or fishing seasons

(13) Ban or restriction on hunting, fishing and foraging

	Hunting closed season: varies with species and location, but is typically March to August for game birds and wildfowl Fishing closed season: varies with species (coarse or game) and location, details can be found at the Environment Agency's local byelaw pages (https://www.gov.uk/government/collections/local-fishing-byelaws) If contamination levels in the affected species were such that the overall length of the hunting or fishing season was significantly reduced or completely excluded in a year, then a recovery programme would have to be considered. For example, culling species normally hunted if over populated, removing fish from waters if over stocked and the meat or fish prevented from entering the food chain The Environment Agency carries out regular surveys on principal rivers to determine fish populations. Thus, if the fishing season had to be reduced significantly or excluded then these checks will be an important method of establishing whether a management programme is required
Ethical considerations	None
Effectiveness	
Recovery option effectiveness	Effectiveness will be 100% if bans and restrictions are complied with. However it may be difficult to enforce compliance with this option and restrictions of foraging cannot be controlled for Will reduce the likelihood of consumption of contaminated foodstuffs
Technical factors influencing effectiveness of recovery option	Success of communicating information regarding the restrictions to hunters, anglers or gatherers. Individual willingness to comply with restrictions Possibility of continued exposure
Feasibility and intervention costs	
Specific equipment	Seek expert advice and guidance as specialist monitoring equipment may be required Typical hunting equipment if management programme is required. Surveying equipment to establish fish populations
Utilities and infrastructure	Communication lines to inform those about restrictions
Consumables	Dependent on communication method. Production of leaflets and notices to inform anglers, farmers, gamekeepers, hunters and foragers Production and erection of signs in areas known to be used by gatherers. Information and advice distributed through specialist associations or societies For hunting: distribution of this information through associations or societies to their members or through firearms registration certificates from the police, in associations or societies' magazines, firearm dealers, etc For anglers: distribution of this information through associations or societies to their members or through those providing rod licences and fishing permits
Skills, personnel and operator time	Depends on communication method, eg design and distribution of leaflets Communication lines to inform those about restriction and 'policing' to ensure compliance
Safety precautions	If the hunting season is shortened then there may be an increased number of hunters visiting forests during a shorter season, which may have an adverse effect on their safety
Other limitations/ factors influencing costs	Infrastructure available for communication and exchange of information during processing of information, decision making and implementation of recovery option Reduced financing of game management due to cancellation of hunting licences Methods used to ensure compliance
Waste	
Amount and type	None. However, waste in the form of contaminated carcasses would only be produced if the hunting or fishing season is significantly reduced in length or excluded completely and a recovery programme is initiated that involves culling to maintain livestock at appropriate levels
Possible transport, treatment, disposal and storage routes	N/A

(13) Ban or restriction on hunting, fishing and foraging

Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion of contaminated fish, meat and wild foods
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act to ensure that recovery workers (eg farmers and plant operatives) use appropriate PPE (if required) and follow standard operating procedures (SOPs) The only potential risk posed is by workers putting up warning signs in affected areas
Other considerations	
Agricultural impact	May cause an increase in the numbers of herbivores, which may have an impact on grassland, forestry and other environments Increase in predator numbers may have an impact on farm animal husbandry Possible increased grazing on agricultural lands if the hunting season delayed, especially if extended over winter when food sources may be low
Compensation issues	There may be requests for compensation for the payments for unused hunting or fishing licences, eg if the hunting or fishing season is significantly reduced or for cancelled hunting parties Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments The methods of communication may need to be flexible (eg local radio, social media, news, newspapers and magazines) to ensure the information reaches the target audience. It is essential that advice is kept simple and comprehensible Media interest is likely to be high compared to some other recovery options
Additional information	
Practical experience	
Key references	Public Health Canada. Pathogen Safety Data Sheets and Risk Assessment. Available (September 2015) at http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	Delaying the start of the hunting season or cancelling the season altogether would be an acceptable option
Document history	

(14) Identification/removal of contamination source

Objective	To identify and treat the source of contamination to prevent further contamination from entering the food chain
Other benefits	None
Recovery option description	If the source of contamination can be identified (eg dead animal, animal faeces or drains) then it should be removed and disposed of and the area should be treated/decontaminated using reactive liquids such as bleach If the contamination is found to be in an enclosed area, eg food processing plant, then consult Chapter 6 (inhabited areas) for recovery options on liquid decontamination
Key information requirements	What is the contamination source? Is the contamination source located in an enclosed area? Is the area amenable to liquid disinfection?
Linked recovery options	This is a remediation option and should be linked to protection and waste disposal options This recovery option should be considered in conjunction with (1) Restrict/controlled access and (29) Disposal of animal wastes
Target environment	Contamination source
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion Animal to animal/human transmission
Time of application	Should be considered as soon as contamination is evident
Considerations	
Public health considerations	This will depend on the method used to remove the contamination and where the source of contamination is located
Legal implications and obligations	Seek specialist advice and guidance For matters involving public health, specific laboratories may need to be involved in appropriate accredited testing
Social implications	Success of this option will improve public perception of the incident as the public will feel reassured that the source of contamination is known and dealt with
Environmental considerations	This will depend on where the contamination is located and how the contamination is removed
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). For complete and detailed guidance, see the Human Rights Act
Effectiveness	
Recovery option effectiveness	If contamination source can be identified and remediated this will be 100% effective at preventing further contamination of the food chain
Technical factors influencing effectiveness of recovery option	Effectiveness is dependent on being able to identify the contamination source and acceptable remediation options being available
Feasibility and intervention costs	
Specific equipment	Sampling equipment for identification Equipment necessary for remediation
Utilities and infrastructure	Laboratory service for sampling analysis
Consumables	Consumables dependent on the method of sampling and remediation

(14) Identification/removal of contamination source

Skills, personnel and operator time	Qualified personnel for sampling Laboratory personnel for sampling analysis Experienced personnel for remediation techniques
Safety precautions	Appropriate PPE will be required for collection of samples. Laboratories where analysis will take place will have standard operating procedures (SOPs) already in place for sampling analysis Appropriate PPE will be required for remediation of contamination source
Other limitations/ factors influencing costs	Number of samples needing to be collected and analysed may affect costs
Waste	
Amount and type	Contaminated PPE Waste from remediation of contamination source Contamination source may need disposal (if applicable)
Possible transport, treatment, disposal and storage routes	Depending on the nature of the biological agent and contamination source, waste may be classified as dangerous in transport and subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Factors influencing waste issues (eg cost)	Access to the contaminated site and the size of the contaminating area
Exposure	
Averted exposure	Continuing contamination of the food chain
Potential increased worker exposure	Individuals involved in sampling and remediation will be at greater risk of exposure Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act to ensure that recovery workers (eg farmer and plant operatives) use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other considerations	
Agricultural impact	This may depend on where the contamination source is and the methods used to remediate
Compensation issues	Landowners may claim compensation if the contamination source is found on their land and the remediation option has an adverse effect on this land Farmers may claim compensation for any loss if restrictions are placed on their farms during an investigation
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Additional information	
Practical experience	This recovery option is usually employed in the initial stages of an outbreak of infection involving a foodstuff or microorganism that is reportable to Defra. There will already be a capacity with the APHA laboratories for sampling during such an incident
Key references	Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(15) Processing or treatment of food products

Objective	To remove or significantly reduce biological contamination within food products so that they can be safely placed on the market for sale and consumption
Other benefits	Reduces the amount of waste food products requiring disposal
Recovery option description	This option requires food to be processed to remove the biological contamination. Processing could be standard practice or modified accordingly to reflect the amount of contamination that needs to be removed. The process would need to be conducted under appropriately controlled conditions with verification and validation to show that it is effective in controlling the hazard Implementation of this option in the UK would require an evaluation of economic considerations (eg major food shortage) and consultation with the food production industry
Key information requirements	What is the biological agent and what are its properties?
Linked recovery options	This is a remediation option and should be linked to protection and fate of affected produce (waste disposal) options This recovery option should be considered in conjunction with (4) Restriction of entry into food chain/ withdrawal from market
Target	Contaminated food products
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small
Exposure pathway prevention	N/A
Time of application	No restrictions on time. This recovery option is not time limited as long as the food in question remains fit for use after processing but would need to be considered as soon as contamination comes to light
Considerations	
Public health considerations	If executed correctly, the process should prevent a risk to public health. Extensive sampling may be necessary to show that treatment has been successful. It may, however, be more appropriate to ensure that critical control points of the process (eg cooking) have been applied
Legal implications and obligations	See Appendix A for details
Social implications	Acceptability to consumers and food processors Social acceptability of consuming food products that were previously contaminated
Environmental considerations	None
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). For complete and detailed guidance, see the Human Rights Act
Effectiveness	
Recovery option effectiveness	Up to 100% if implemented correctly
Technical factors influencing effectiveness of recovery option	Properties of the biological agent(s) involved Availability, capability and capacity of facilities for processing
Feasibility and intervention costs	
Specific equipment	Seek expert advice and guidance as specialist equipment is likely to be required to implement this option
Utilities and infrastructure	Power supply and water

(15) Processing or treatment of food products

Consumables	Food processing materials
Skills, personnel and operator time	Training may be required if food processing practices are changed significantly
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg food processing personnel) use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Factors will vary dependent on the contamination and process used
Waste	
Amount and type	Would vary dependent on the contamination and process used. Disposal routes would have to be identified for any non-usable by-products
Possible transport, treatment, disposal and storage routes	Transport will need to be considered if the food products need to be moved to a different site for treatment
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion of contaminated food products
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg food processing personnel) use appropriate PPE (if required) and follow SOPs Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant) Exposure routes from transport and disposal of waste are not included
Other considerations	
Agricultural impact	None
Compensation issues	Insurance companies should also be consulted as they may be within their rights not to compensate where a decision not to reprocess had no public health basis
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments The methods of communication may need to be flexible (eg local radio, social media, news, newspapers and magazines) to ensure the information reaches the target audience. It is essential that advice is kept simple and comprehensible The main communication needed would be a clear record of the action taken and the evidence that it would not compromise food safety, agreed between the food business concerned and the competent authority
Additional information	
Practical experience	

(15) Processing or treatment of food products

Key references	Public Health Canada. Pathogen Safety Data Sheets and Risk Assessment. Available (September 2015) at http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	For any incident after which processing to decontaminate might be a recovery option, the issues should be considered objectively (eg dairies may be unwilling to accept contaminated milk into their processing plants)
Document history	

(16) Selection of alternative land use

Objective	To change agricultural land use so that it can still be used for productive activities
Other benefits	Keeps land in use and provides income to farmers
Recovery option description	Contaminated land may be used for non-food production, such as flax for fibre and linseed oil, rapeseed for biodiesel, sugar beet for bioethanol and perennial grasses or coppice for biofuel In some circumstances, land may be used for forestry, or may be given over to recreational use dependent on the organism and transmission route Land may undergo a management system over a period of years until such a time when contamination has decreased to acceptable levels
Key information requirements	What is the biological agent involved?
Linked recovery options	This is a remediation option and should be linked to protection and waste disposal options May also be linked to (20) Natural inactivation as a change in use until contamination has reduced to safe levels
Target	Farmland
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Soil to plant Soil to animal Ingestion of contaminated crops, meat or milk
Time of application	No restrictions on time. This recovery option is not time limited and can be implemented at any stage during a biological incident
Considerations	
Public health considerations	Would need to consider whether, if public access is permitted, residual contamination would be a hazard. Also need to consider the risk of exposure from any non-food products
Legal implications and obligations	Seek expert advice and guidance For more information on legislation please see Appendix A
Social implications	There may be a perception that the land remains contaminated Disruption or adjustment of farming and related industrial activities or maintenance of farming and associated communities, and effects on people's livelihoods (eg farmers) Stigma, disruption to people's image or perception of the 'countryside'. Possible loss of confidence in products; conversely, an increased confidence in food products knowing that the land is not being used to grow food There may be the perception that contamination is not being effectively dealt with
Environmental considerations	The agricultural characteristics of the affected land – this will determine the crops and practices that the land can support. Implementing this recovery option may bring about changes in the local ecosystem (eg wildlife habitats)
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). For complete and detailed guidance, see the Human Rights Act
Effectiveness	
Recovery option effectiveness	This recovery option does not remove contamination but is a method for re-appropriating land use
Technical factors influencing effectiveness of recovery option	Expertise in growing different crops Acceptability of alternative crops to farmers. Ease of substitution of non-edible crops for farmers and associated industries Willingness of industry to accept non-edible crops that are likely to be contaminated

(16) Selection of alternative land use

Feasibility and intervention costs	
Specific equipment	Sowing or harvesting equipment for alternative crop type if different May be dependent on future land use, eg landscaping equipment if turned into recreational facilities
Utilities and infrastructure	Dependent on a permanent alternative land use. New infrastructure may need to be put in place to support a permanent change
Consumables	Seed stock of alternative crop (availability may be limited) Dependent on new use
Skills, personnel and operator time	Expertise in cultivation of alternative crop Dependent on new use Landscape or land management consultant may be required
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act to ensure that recovery workers use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Crop type New equipment, if required Training
Waste	
Amount and type	Will depend on the new use of the land
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion of contaminated crops, meat or milk
Potential increased worker exposure	Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded. Due to the specific nature of the tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would need to be assessed on a case-by-case basis
Other considerations	
Agricultural impact	Change in crop type may impact on crop rotation and management plans
Compensation issues	There may be requests for compensation for loss of earnings from farmers or food producers for: • changes in land use on the farm • requirements for additional manpower • training and equipment • potential economic loss from the land Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments

(16) Selection of alternative land use

	Dissemination of information about the recovery option, its rationale and possible alternatives, ie explaining the risks associated with the levels of contamination, the uncertainty and the variance of levels, and the reasons for the increase. This recovery option would need to be discussed in detail with the farmers/landowners to agree to implement this option as it could not be imposed on them. Information would also need to be disseminated to farmers about replacing food crops with non-food crops

Additional information

Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(17) Removal of topsoil

Objective	To remove the source of soil contamination and to stop any further spread of contamination
Other benefits	This recovery option will reduce contamination uptake by commercial (ie crops, including pasture) and non-commercial (ie kitchen gardens) produce. The local authority (LA) is the owner of allotments and, as such, would be responsible for making the final decision on actions for allotments (eg closure and sale to developers) Limited waste if soil is relocated or reused in other non-food areas (eg road landscaping, forestry and recreation), all subject to public health concerns being satisfied
Recovery option description	Topsoil removal (for commercial sites) If crop is present this option has to be preceded by harvest or the topsoil would have to be removed with the crop. If the crop is also considered to be contaminated you may also consider (27) Burning in-situ (pre-harvested crops) If no crop is present, the top layer is removed using road construction equipment such as a mini-bulldozer. In this way, much of the contamination is removed When the amount of waste is taken into consideration, this recovery option may only be applicable on a relatively small scale Removal/relocation of topsoil (non-commercial sites) In kitchen gardens topsoil can be removed by spade and relocated or used for another purpose (eg flower bed). Occasionally, topsoil could be removed from gardens and disposed of to landfill sites or purpose-built repositories. Topsoil may also be removed from sections of allotments if a non-food production area is available
Key information requirements	What is the biological contamination? Are spores involved?
Linked recovery options	This is a remediation option and should be linked to protection and fate of affected produce (waste disposal) options
Target	Commercial sites include pasture or fallow arable land Non-commercial sites include areas used for non-commercial food production such as allotments or kitchen gardens
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small (amount of waste produced limits scale of application)
Exposure pathway prevention	Soil to plant transfer (some people keep chickens as well) Ingestion of contaminated food products
Time of application	No restrictions on time. This recovery option is not time limited and can be implemented at any stage during a biological incident. However, in the case of allotments and domestic gardens, action would probably need to be rapid for social reasons

Considerations

Public health considerations	There is the potential for nuisance dust complaints if close to populations. There may also be concerns over the transportation of lorry loads of contaminated soil through inhabited areas. Aerosols containing spores may be generated in the case of some organisms. A risk assessment will need to be undertaken. Consider using (1) Restrict/controlled access during operation of recovery option
Legal implications and obligations	The LA is the owner of allotments and, as such, would be responsible for making the final decision on actions for allotments Non-commercial sites: seek expert advice and guidance as there are contaminated land regulations that may apply Commercial sites: potential implications if farms participate in environmental stewardship or organic farming schemes Legal restrictions may also apply in nitrate vulnerable zones (NVZs) Consents may be required before implementing this option on a site of special scientific interest or an area of special scientific interest Other considerations before implementing this option include national nature reserves and archaeological areas

(17) Removal of topsoil

Social implications	There may be suspicion over the LA's motive for closing allotments There may be wider concern about health implications of living on a contaminated plot, or stigma associated with affected areas Disruption to farming and other related activities (eg tourism)
Environmental considerations	Soil biota may be affected Loss of biodiversity Large volumes of waste generated
Ethical considerations	Potential redistribution of exposure to workers, as well as inequity due to redistribution of exposure to populations living close to waste disposal areas Free informed consent of workers and members of the public
Effectiveness	
Recovery option effectiveness	Up to 100% effective at removing contamination but will vary according to the agent involved. May be difficult to demonstrate 100% effectiveness as there is likely to be a variable contamination gradient in the soil (ie deciding how deep to go may be difficult)
Technical factors influencing effectiveness of recovery option	Agent properties Soil type and texture, and depth of removal that is required Presence of vertical cracks in the soil Operator skill ensuring contamination is not ploughed into clean surface during removal Time between incident and implementation (for agents mobile in soil) As contaminated topsoil is being removed (not treated), it will probably have to be replaced with clean soil
Feasibility and intervention costs	
Specific equipment	Non-commercial sites (eg kitchen gardens) Typical garden equipment (eg spade and wheelbarrow) Commercial sites Mini-bulldozer or bulldozer Vehicle's to transport waste
Utilities and infrastructure	Suitable disposal site Roads to transport waste
Consumables	Fuel for vehicles Transporters
Skills, personnel and operator time	Can be carried out by already-skilled operators such as municipal workers and additional operators could be instructed within a day Possible need for biological protection training of workers
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work Act (HSWA) to ensure that recovery workers use appropriate PPE (if required) and follow standard operating procedures (SOPs). For example, consider respiratory protection and protective clothing if very dry conditions
Other limitations/ factors influencing costs	There are risks of exposure to members of the public and recovery workers when implementing this option Factors influencing costs include: • type of equipment • soil type and conditions, field size and shape, topography and operator experience • distances of contaminated site to equipment hire and to disposal site
Waste	
Amount and type	Contaminated waste may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance Non-commercial sites (ie kitchen gardens): none, if soil is relocated to other areas of the allotment or if the kitchen garden is not used for food production; if 5 cm of topsoil is removed, 70 kg/m^2 of waste

(17) Removal of topsoil

	would be produced Commercial sites: can result in tonnes of waste being produced if implemented over a large area
Possible transport, treatment, disposal and storage routes	Disposal to landfill sites or purpose-built repositories. Waste topsoil could also be used for non-food related landscaping (eg forestry and recreational areas). Waste could also be subject to off-site treatment
Factors influencing waste issues (eg cost)	Contamination level of waste Volume of waste Acceptability of waste disposal options (eg landfill or re-use of contaminated topsoil for non-food related uses) Location of disposal site, especially if outside the affected area Non-commercial sites: if waste soil cannot be relocated to another area of the allotment or kitchen garden, it may have to be disposed of to landfill, which will result in subsequent transport and landfill costs Commercial sites: transport to landfill site and subsequent landfill costs (including landfill tax) Siting and building of purpose-built repository Cost can be significant for removal and disposal covering large areas
Exposure	
Averted exposure	Ingestion of contaminated crops
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers use appropriate PPE (if required) and follow SOPs Workers must be aware of the symptoms of infection associated with the agent to allow them to contact relevant medical care if infection occurs Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant)
Other considerations	
Agricultural impact	Soil fertility may be affected by the loss of topsoil Fertilisation may be required The underlying soil may be compacted with implications for subsequent cultivation Vegetation needs to be re-established
Compensation issues	There may be requests for compensation for loss of earnings from farmers or food producers for: • loss of grazing areas and re-establishment of vegetation • cost of replacing contaminated topsoil • for additional feeding stuffs if required while improvements are being carried out
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Provision of information on correct application of procedure. Need for dialogue regarding selection of areas for treatment. Dialogue with gardeners, local communities and farmers required concerning timing and selection of land to be remediated Clarify the costs and benefits before decisions on the intervention are made
Additional information	
Practical experience	

(17) Removal of topsoil

Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(18) Capping of contaminated land

Objective	To protect the surrounding area from the contaminating agent by constructing an impervious cap over the contamination
Other benefits	Will allow for building and/or alternative site use when the cap has been completed
Recovery option description	This option requires a hardwearing and impervious structure to be constructed over the contamination which will prevent its spread. An example of a cap is reinforced concrete used over a waterproof lining
Key information requirements	What type of land has been contaminated? What is the extent/area of the land that is contaminated?
Linked recovery options	This is a remediation option and should be linked to protection and fate of affected produce (waste disposal) options
Target	Contaminated land
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could enter the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. In this case the recovery option is more likely to be used with a persistent agent that is also resistant to decontamination. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small
Exposure pathway prevention	Ingestion and inhalation of the agent
Time of application	No restrictions on time. This recovery option is not time dependent and can be implemented at any stage during a biological incident. However, implementing as soon as the risk becomes apparent would help to minimise the spread of contamination

Considerations

Public health considerations	The source of contamination must first be assessed to confirm that capping is an appropriate remediation method. The work must be managed to ensure no further release/spread of contamination while the capping is being carried out, and the area secured to prevent access to any exposed contamination
Legal implications and obligations	Contaminated land is covered by the Environmental Protection Act 1990 (Part 2A) and the enforcing authority is normally the local authority (LA), although this may be handed over to the Environment Agency if the land is deemed to be a 'Special Site'
Social implications	Depending on the location of the land, there may be an impact on the local population due to restrictions while the remediation is being undertaken Following capping, most sites are redeveloped to make them aesthetically pleasing and there should not be a risk posed to anyone using the land
Environmental considerations	The area to be capped will need to be reviewed to consider aspects such as drainage, impact on the environment and future use of the land
Ethical considerations	None

Effectiveness

Recovery option effectiveness	Highly effective if managed correctly as contamination is fully contained at source
Technical factors influencing effectiveness of recovery option	Need to ensure complete containment using an appropriate method. This is often seen as a cheap method of remediation and therefore can be more timely and cost effective than other recovery options. It should also allow the land to be reused once remediation works are complete

Feasibility and intervention costs

Specific equipment	Mechanical and building equipment to complete the remediation works
Utilities and infrastructure	Dependent on contamination source, eg open or concealed Power and water supply Transport infrastructure to site

(18) Capping of contaminated land	
Consumables	Dependent on the specifics of the process selected
Skills, personnel and operator time	Seek specialist advice and guidance, as skilled personnel are likely to be required to undertake this recovery option. Operator time and personnel requirements will vary depending on the type of contamination source
Safety precautions	A risk assessment will need to be undertaken Correct use of PPE to protect from hazards due to initial contamination but also those posed by use of heavy machinery and other such hazards during the work process
Other limitations/ factors influencing costs	Relatively cheap and simple to complete if correct planning put in place and followed
Waste	
Amount and type	Building works waste but should not be any biological waste produced as all capped at source
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Reduced contaminant loading and spread to surrounding environments
Potential increased worker exposure	Worker exposure may be increased depending on the type of contamination present. PPE must be worn to mitigate risk
Other considerations	
Agricultural impact	This is dependent on where the contamination is located and will be considered on a case-by-case basis
Compensation issues	There may be requests for compensation for loss or damage to property Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	Notices to inform the public regarding the nature of the work which is being undertaken, the expected completion time and any changes in the use of the land
Additional information	
Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(19) Liquid decontamination of soil

Objective	To decontaminate soil using a liquid disinfectant and decrease the risk of infection and spread of the contamination
Other benefits	None
Recovery option description	The identified contaminated area can be treated using applications of a liquid disinfectant. The disinfectant will be spread over the surface of the soil and potentially injected into the soil depending on the depth the contamination has reached. Multiple applications may be needed to ensure the contamination has been reduced to the required level. The Environment Agency should be consulted prior to treatment to ensure there are no issues with the introduction of the disinfectant to the area and potential leaching to the water table
Key information requirements	What is the contaminating biological agent? What is the extent/area of the contamination? Where is the nearest watercourse? What is the chemical make-up of the soil (eg any reactive compounds, organic matter and pH)?
Linked recovery options	This is a remediation option and should be linked to protection and fate of affected produce (waste disposal) options
Target	Contaminated land
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could enter the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small to medium
Exposure pathway prevention	This options will protect against inhalational, ingestion and cutaneous exposure
Time of application	This option should be applied as soon as contamination has been determined

Considerations

Public health considerations	Some liquid decontaminants can be harmful. These liquids should be handled with care, using appropriate PPE, and the manufacturer's instructions should be followed. The identified area should be secured to prevent public access during the decontamination process
Legal implications and obligations	The local authority (LA) is the owner of allotments and, as such, would be responsible for making the final decision on actions for allotments Non-commercial sites: seek expert advice and guidance as there are contaminated land regulations that may apply Commercial sites: potential implications if farms participate in environmental stewardship or organic farming schemes Legal restrictions may also apply in nitrate vulnerable zones (NVZs) Consents may be required before implementing this option on a site of special scientific Interest or an area of special scientific interest Other considerations before implementing this option include national nature reserves and archaeological areas
Social implications	There may be wider concern about the health implications of living on a contaminated plot, or stigma associated with affected areas There may be concern regarding the use of harsh chemicals to decontaminate an area of land and any long-term effects that may have Disruption to farming and other related activities (eg tourism)
Environmental considerations	The toxicity of decontamination products would need to be considered Contaminated waste products from treatment (eg effluent) could run on to other surfaces (roads, soil, grass, etc) if not controlled effectively, resulting in a transfer of contamination which may require subsequent clean-up thus generating more waste Long-term effect of decontaminants at the site of application on both fauna and flora
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)

(19) Liquid decontamination of soil

Effectiveness	
Recovery option effectiveness	The effectiveness of this technique depends on: • liquid decontaminant used • physiological characteristics of the biological agent • composition of the soil to be decontaminated If the biological contaminant is decontaminated effectively, there should be a significant reduction in potential exposure Some liquids may be more effective for decontamination than others: • alcohol-based disinfection solutions may not be as effective against bacterial spores as oxidising agents • some oxidising agents such as hydrogen peroxide will be less effective against catalase positive bacteria and mycobacterium • chlorine is very effective (>4 log kill) for disinfection and decontamination of *Listeria monocytogenes,* MRSA*,* norovirus and VHF • alcohol is very effective (>4 log kill) for disinfection and decontamination of norovirus and *Salmonella* spp. and has some effectiveness (2–4 log kill) for *M. tuberculosis* • quaternary ammonium compounds have limited effectiveness (<2 log kill) for disinfection and decontamination of *M. tuberculosis,* norovirus and *Salmonella* spp.
Technical factors influencing effectiveness of recovery option	This option may need to be repeated several times to effectively decontaminate and disinfect the contaminated surface
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination and waste removal operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service Monitoring equipment to determine efficacy of recovery option Appropriate containers for removal and transport of contaminated objects
Utilities and infrastructure	N/A
Consumables	Liquids and chemicals used in decontamination Material to contain and allow safe and appropriate removal of waste from the site
Skills, personnel and operator time	Dependent on location and area of soil to be decontaminated
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Factors influencing the costs of this option include: • specialist personnel (if required) • biological agent involved • weather • size of area to be decontaminated • access to contaminated area • proximity of water supplies • use of PPE
Waste	
Amount and type	Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance

(19) Liquid decontamination of soil

Possible transport, treatment, disposal and storage routes	In urban environments decontamination will mainly generate aqueous wastes or slurries which may contain high concentrations of the disinfectant. Products or solutions that may be hazardous to people or the environment must be neutralised before they can safely be discharged into the sewerage system. Contaminated waste effluent and liquids must be transported in suitable tank vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles
Factors influencing waste issues (eg cost)	Will depend on the reactive liquids used, size and scale of affected area and volume of contaminated waste produced
Exposure	
Averted exposure	Elimination of exposure to the biological agent
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure
Other considerations	
Agricultural impact	Soil fertility may be affected by the use of disinfectants Fertilisation may be required The underlying soil may be compacted with implications for subsequent cultivation Vegetation needs to be re-established A review would need to be conducted to establish the period of time for which the soil needs to be left if it is to be used for growth of foodstuffs or if it is on farming land
Compensation issues	There may be requests for compensation for loss of earnings from farmers or food producers for: • loss of grazing areas and re-establishment of vegetation • cost of replacing contaminated topsoil • for additional feeding stuffs if required while improvements are being carried out
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Provision of information on correct application of procedure including chemical hazards. Need for dialogue regarding selection of areas for treatment. Dialogue with gardeners, local communities and farmers required concerning timing and selection of land to be remediated Clarify the costs and benefits before decisions on the intervention are made
Additional information	
Practical experience	Gruinard Island was heavily contaminated with the spores of *Bacillus anthracis* during biological weapons trials in World War II. Liquid decontamination was used as part of the remediation process several decades later (Manchee, 1994)
Key references	Manchee et al. Formaldehyde solution effectively inactivates spores of Bacillus anthracis on the Scottish Island of Gruinard, Appl Environ Microbiol 1994, 60(11):4167–71 Fisher RG, Chain RL, Hair PS, Cunnion KM. Hypochlorite killing of community-associated methicillin-resistant Staphylococcus aureus. Pediatr Infect Dis. J 2008 Oct;27(10):934–5 Sagripanti JL, Eklund CA, Trost PA, Jinneman KC, Abeyta C Jr, Kaysner CA, et al. Comparative sensitivity of 13 species of pathogenic bacteria to seven chemical germicides. Am J Infect Control. 1997 Aug;25(4):335–9

(19) Liquid decontamination of soil

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Comments

Document history

(20) Natural inactivation

Objective	To allow contamination to return to an acceptable or background level with no active intervention
Other benefits	No active implementation required
Recovery option description	Natural weathering by rain may lead to increased dissemination of biological agents from soil. Also includes natural inactivation of agents by exposure to sunlight, temperature and desiccation. The decision maker needs to consider weather conditions When the contamination involves an agent that has a short persistency, then simply allowing sufficient time for the contamination to inactivate due to natural sources of temperature variations, radiation (eg sunlight) and desiccation can decontaminate agricultural land
Key information requirements	What is the biological contaminant? Levels of contamination and persistence of agents of concern in soil
Linked recovery options	This is a remediation option and could be considered with (16) Selection of alternative land use (this could be temporary or permanent)
Target environment	N/A
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could pose a risk to public health and either have a short persistence or for which there is no other method to remediate the area. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Soil to plant Plant to animal Soil to animal
Time of application	N/A

Considerations

Public health considerations	Contamination may remain an infection risk until it has been reduced to a safe level. Risk of contamination disseminating into groundwater and contaminating watercourses
Legal implications and obligations	Need to consider potential contamination of waterways For more information on legislation please see Appendix A
Social implications	May be unacceptable to the public to 'do nothing'
Environmental considerations	The procedure imposes an environmental risk, ie it could bring contamination closer to ground water with dissemination which may lead to the transfer of biological agents to other areas and affect other populations Biodiversity could be affected, particularly for soil dwelling organisms
Ethical considerations	Potential redistribution of exposure from individuals ingesting food products to new populations

Effectiveness

Recovery option effectiveness	This recovery option does not remove the biological contamination from the affected area, the contamination may inactivate but this may take a prolonged period of time
Technical factors influencing effectiveness of recovery option	Biological properties of the agent (eg spore former) Soil type Weather conditions (season) Vicinity to waterways

Feasibility and intervention costs

Specific equipment	Monitoring equipment. This option cannot be used without checks on its effectiveness and the land may not be suitable again for food production until contamination is shown to have reduced to a 'safe' level. Monitoring of any 'at risk' watercourses would also be necessary
Utilities and infrastructure	None

(20) Natural inactivation

Consumables	Any consumables required for sampling, monitoring and analysis work May require fencing and signs to prevent access to land
Skills, personnel and operator time	Skilled personnel to sample, analyse and interpret monitoring data
Safety precautions	Will depend on the agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance
Other limitations/ factors influencing costs	Size of area Nature of contamination
Waste	
Amount and type	This recovery option does not generate any waste
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	None
Potential increased worker exposure	N/A
Other considerations	
Agricultural impact	May result in agricultural land being unusable for a prolonged period of time
Compensation issues	There may be requests for compensation for loss of earnings from farmers or food producers if they are unable to use the land Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments This option requires dialogue between farmers, ecologists and the public because of the potential for ground water or surface water contamination
Additional information	
Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(21) Clean feeding/selective grazing regime

Objective	To reduce the biological contamination in animal feed to prevent transfer to animals and through the food chain
Other benefits	None
Recovery option description	Commercial livestock: • provide animals with less or uncontaminated feedstuffs/clean pasture. If contamination has occurred from animal bedding/housing they may also be replaced as appropriate. Target animals may be those grazing contaminated pastures or already-housed animals which would otherwise be receiving contaminated diets. Clean feeding can be used to prevent animals from becoming contaminated in the first place or to minimise the time needed for metabolism and excretion to reduce the contamination to an acceptable level • commercial livestock may be fenced in enclosures or housed to prevent grazing on contaminated pasture. The animals are then given nutritionally balanced diets comprising uncontaminated and/or less contaminated feed so that the final animal product has biological agent concentrations below relevant standards • for meat producing animals, clean feeding is only required for a suitable period prior to slaughter • animals are housed and clean fed for the time it takes for the contaminant to come down to compliant levels; there is a requirement for monitoring to demonstrate compliance Non-commercial livestock (eg home apiaries (bee hives), chicken coops (hens) and other non-commercial livestock): • non-commercial livestock may be fenced in or housed to prevent grazing on contaminated pasture. The animals are then given nutritionally balanced diets comprising uncontaminated or less contaminated feed • bee hives may be moved to uncontaminated areas
Key information requirements	What is the biological contaminant?
Linked recovery options	This is a remediation option and should be linked to protection and fate of affected produce (waste disposal options) Clean feeding may also be used in conjunction with (22) Veterinary intervention to animals Waste disposal options that need to be considered are (28) Disposal of foodstuffs and (29) Disposal of animal wastes
Target	All livestock destined for the food chain
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any. However, large-scale application may be dependent on supply of suitable clean feed at a reasonable price
Exposure pathway prevention	Ingestion of contaminated feedstuff
Time of application	This recovery option has to be implemented as soon as the risk becomes apparent. The time between notification and contamination is important and this may limit the feasibility of this option

Considerations

Public health considerations	None
Legal implications and obligations	Standards of animal husbandry and welfare and regulations governing feed storage would need to be observed as some certification schemes may be contravened Free range and organic schemes may be restricted following an accident, if animals have to be housed Animal welfare issues need to be considered Local regulations on the use and siting of buildings must be consulted, which may include restrictions in archaeological areas There may be potential implications if farms participate in environmental stewardship or organic farming schemes For more information on legislation please see Appendix A

(21) Clean feeding/selective grazing regime

Social implications	Disruption to people's image or perception of the 'countryside', eg if there are no animals in the fields, with potential impacts on tourism, etc Willingness of farmers to participate Stigma associated with affected areas May impact on public confidence, eg loss of confidence that farm produce and derivative products (eg cheese) from affected areas are 'safe' Increased confidence that the problem of contamination is being effectively managed Disruption to farming and other related activities (eg tourism)
Environmental considerations	Housing or moving herds of livestock to alternative sites will produce large volumes of slurry or manure. This must be stored and disposed of at suitable times (under suitable weather conditions), taking into account possible contamination of land Inappropriate disposal of additional slurry or manure could lead to pollution of watercourses and/or further agricultural areas Possible changes in landscape due to siting of new buildings There may be restrictions on where temporary fences can be erected, eg in national parks and environmentally sensitive areas Change in biodiversity of fenced area. Contamination of agricultural land with slurry with increased concentrations of biological agent(s)
Ethical considerations	Animal welfare issues if animals are housed in the summer when temperature and ventilation could be a problem (eg humidity and high levels of ammonia in buildings) Animal welfare issues may also arise when enclosures are used (eg parasite burden and general animal hygiene) This is a self-help option for the farmer; however, there could be a knock-on effect for public use of amenities if areas are fenced off

Effectiveness

Recovery option effectiveness	The effectiveness of this option will depend on time of implementation and biological properties of the contaminant
Technical factors influencing effectiveness of recovery option	Properties of biological agent involved Willingness and ability of farmers or herders to adapt to the new regime Capacity for feed measurements and live monitoring Availability and level of contamination of alternative feeds Compliance with the recovery option Animals: the rate at which alternative diet is introduced and duration of feeding regime. If grazing is stopped and the new (less contaminated) diet comprises root crops and cereals, a period of adaptation of two weeks is desirable. This is less important if the uncontaminated diet contains silage and hay Willingness and ability of livestock to adapt to the new regime The requirement for clean feeding and the availability of conserved feed will be dependent on the time of year that an accident occurs. For example, in winter there would be little impact for housed livestock being fed stored feeds. Finishing lambs grazing forage crops, however, would have to be housed and given conserved clean feed. Late spring would be the worst time for a contamination event, as cattle and lambs would be grazing outside and no new hay or silage would have been harvested. If the incident was later in summer, animals could be fed hay or silage that had been cut before the incident For some of the alternative diets, a reduction in grazing is only worth considering for restrictions lasting more than a few weeks because of time required to introduce alternative diets Bees: the distance that the bees need to be moved should be considered and the availability of nectar around the new site

Feasibility and intervention costs

Specific equipment	Monitoring equipment to assess contamination status of the land Machinery to aid construction of fences or temporary housing and to restrict access of animals to contaminated land. Fencing in or housing livestock to administer alternative diets should be possible on most livestock farms (particularly dairy and systems where animals are normally housed). Existing fences or farm buildings could be used to house livestock prior to sale, although some would require modification to penning and feeding arrangements or ventilation

(21) Clean feeding/selective grazing regime

	New, purpose-built sheds could also be considered if the period of clean feeding warranted this Storage facilities for clean feed Storage facilities for slurry or manure Feeding and drinking troughs, and possibly shelters for these where being used outdoors Possibly animal transporters and vehicles to deliver feed Forage harvester to cut grass for pasture recovery (see below)
Utilities and infrastructure	Water Power supply Ventilation
Consumables	Alternative feeds. Organic feed may be required to maintain organic status of some farms Straw for bedding
Skills, personnel and operator time	Farmers would possess the necessary skills as housing animals is an existing practice Farmers and herders: • obtaining uncontaminated feed (and harvesting grass pre-contamination) • looking after animals not normally housed or fenced • implementation of the alternative feeding regime • collection, storage and disposal of slurry/manure • time required for construction of additional enclosures, housing, etc
Safety precautions	General precautions for animal handling
Other limitations/ factors influencing costs	Must ensure that alternative diets are nutritionally balanced and introduced at a rate such that gut flora can adapt Availability of housing, fences, feeds, machinery and manpower The period of clean feeding required will be influenced by the initial biological contamination within livestock
Waste	
Amount and type	Slurry or manure produced while livestock are fenced in or housed Non-compliant milk or eggs
Possible transport, treatment, disposal and storage routes	Slurry or manure should be stored and may require subsequent disposal
Factors influencing waste issues (eg cost)	Length of time during which animals are producing non-compliant food Storage, transport and disposal of contaminated food and slurry
Exposure	
Averted exposure	Ingestion of contaminated feedstuff
Potential increased worker exposure	Will depend on the agent involved Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act to ensure that recovery workers (eg farmers or herders) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers may be required to ensure that they have not been infected with the biological agent Exposure pathways for recovery workers could be: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers’ hands (unlikely to be significant)
Other considerations	
Agricultural impact	Reduced grazing on fields If clean feeding occurs in areas with high stocking rate surface vegetation will be destroyed Greater volumes of manure or slurry

(21) Clean feeding/selective grazing regime

Compensation issues	There may be requests for compensation by farmers or herders: • using up stores of alternative feed • additional work • for additional labour required in moving animals to less contaminated pasture • for accepting stock from other farms • loss of income from not adhering to conservation schemes Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Explaining recovery option to farmers or herders Ensuring communication re harvesting of grass in early (hours to days) phase, prior to contamination

Additional information

Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(22) Veterinary intervention to animals

Objective	Reduce the number of animals affected by biological contamination by offering prophylaxis or treatment
Other benefits	Better animal welfare Reduces number of animals to be culled Prevent spread of biological contamination
Recovery option description	If animals become contaminated with a biological agent, antibiotic treatment can be given to reduce infection, or vaccination can be given to prevent unaffected animals from being contaminated. Antibiotics may also be given to unaffected animals from the same herd/flock to prevent disease transmission
Key information requirements	What is the biological contaminant? Is treatment or vaccination available for the agent in question?
Linked recovery options	This is a remediation and/or protection option and should be linked to other protection and waste disposal options This recovery option should be considered in conjunction with (21) Clean feeding/selective grazing regime
Target environment	Animal livestock
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion of contaminated animal products Inhalation and dermal (skin) contact
Time of application	This recovery option is most beneficial if implemented as soon as the risk becomes apparent
Considerations	
Public health considerations	The treatment selected could accumulate or persist in the animals which may be ingested if the animals enter the food chain Veterinarians not only have a responsibility to protect the health of animals, but also have a larger public health role too with regard to the development of resistant organisms
Legal implications and obligations	There are specific European guidelines governing the use of antibiotics as prophylaxis or metaphylaxis in animals, which can be referred to for further information (EMA/CVMP/261180/2012)
Social implications	If this is used as a protection option, with little risk to consumers, it is likely to help maintain public confidence in the safety of food products and promote trust in authorities
Environmental considerations	Prophylaxis treatments may enter the food chain
Ethical considerations	Overuse of antibiotics may have negative ethical results
Effectiveness	
Recovery option effectiveness	This is dependent on the biological contaminant as to whether treatment is available and the success of that treatment
Technical factors influencing effectiveness of recovery option	Availability of veterinarians or trained medical staff to implement the treatment procedure Length of time required for treatment
Feasibility and intervention costs	
Specific equipment	Batch stocks of prophylaxis/metaphylaxis treatment
Utilities and infrastructure	Suitable housing or facilities to house the animals needing prophylaxis
Consumables	Medical consumables for injectable treatment
Skills, personnel	Competent medical staff would need to be available and may have to be called on to implement the

(22) Veterinary intervention to animals	
and operator time	recovery option out of hours
Safety precautions	Operators will have to wear appropriate PPE. Sharps such as needles may be used as a treatment delivery method and will require appropriate disposal
Other limitations/ factors influencing costs	Available prophylaxis may be costly
Waste	
Amount and type	Significant quantities of waste are not expected to be generated by this recovery option, and there may be a reduction in the amount of unfit food requiring disposal
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Animal to animal and animal to person transmission will decrease
Potential increased worker exposure	Higher worker exposure to animals than routinely expected for delivery of medication and routine monitoring checks. Additionally, potential worker exposure to high volumes of antibiotics, some of which can be sensitising agents
Other considerations	
Agricultural impact	Estimated to be limited as treatment can be used to prevent other remediation methods being enforced
Compensation issues	Farmers and livestock owners are normally covered for such incidents through insurance, although compensation may be sought if it can be demonstrated that the source of the contamination was not their fault
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Clarify the costs and benefits before decisions on the intervention are made
Additional information	
Practical experience	Only slight modification to normal farming practices. Those who own livestock should be familiar with medical intervention for other purposes and therefore should have a dialogue with a local veterinarian prior to the event
Key references	European Medicines Agency. Guidelines for the demonstration of efficacy for veterinary medicinal products containing antimicrobial substances. 2013. Available (September 2015) at http://www.ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2013/05/WC500143698.pdf Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015
Comments	
Document history	

(23) Culling of livestock

Objective	To remove the source of contaminated milk/meat (ie animals) that is not expected to re-achieve compliance, from the food chain
Other benefits	Allows restocking (assuming contamination source and/or pathway have been removed) Maintains consumer confidence in food products Potentially reduces suffering from an animal welfare perspective
Recovery option description	Culling could be considered for those animals whose milk/meat is so contaminated that it would be considered unfit for human consumption for a significant proportion of their productive life, even when placed on clean feeding regimes It could also be considered on animal welfare grounds in areas where stock keepers were evacuated leaving animals un-milked and possibly unfed or suffering due to infection or illness caused by the biological agent It is likely that, following a large-scale incident, free bullets or chemical euthanasia would be the primary method of culling considered initially (at the abattoir or farm). Other options would include culling an animal on the farm or at a slaughterhouse using a bullet and gun Condemnation completely removes contaminated food from the market but can leave large quantities of animal waste needing disposal
Key information requirements	The main driver is whether or not the animals will be able to produce safe and/or compliant food within a reasonable time, taking account of the normal productive lifetime of the animal as well as the associated socioeconomic factors. That is, is it cheaper to replace the animals quickly or spend money maintaining them while they are unproductive? The balance of risks is also important when considering implementation ofthis recovery option. Are the risks to public health real or marginal? For example, has a safety margin been eroded but the risk of physical harm probably remained very low? What are the risks and/or costs of culling compared with the perceived benefits?
Linked recovery options	This is a remediation option and should be linked to protection and waste disposal options This recovery option should be considered in conjunction with (29) Disposal of animal wastes
Target environment	Dairy, egg or meat producing animals
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any. Scale will depend on severity of the incident
Exposure pathway prevention	Ingestion of contaminated animal food products, including dairy (cream, butter, cheese and milk), eggs and meat
Time of application	No restrictions on time. There are no restrictions on time with implementing this recovery option (hours to years), although it should be considered as soon as the risk is recognised

Considerations

Public health considerations	None
Legal implications and obligations	Animal welfare issues need to be considered, especially if animals are suffering due to infection with the biological agent It is unlikely a slaughterhouse would be used due to the risk of cross-contamination Animal by-products regulations would need to be considered for disposal routes Legislative issues, eg in the UK burning or burial of carcasses on the farm, is prohibited by the Animal By-Products Order 1999 except if it is a place where access is difficult or in certain limited circumstances
Social implications	Resistance to culling due to the impact on the farming community and cost Resistance to the selection process for areas where recovery option is to be applied Resistance of the public to large-scale culling of animals Resistance of the public to culling of rare breeds (eg individual animals) May impact on public confidence, eg loss of confidence that farm produce and derivative products from affected areas is ‘safe’ (ie may result in loss of employment in local ‘cottage’ industries or growth of a black market)

(23) Culling of livestock

	Increased confidence that the problem of contamination is being effectively managed Possible stigma associated with the area affected Disruption of farming and associated communities, disruption to people's image or perception of the 'countryside' (eg if there are no animals in the fields), with potential impacts on tourism, etc Market shortages of dairy (ie milk), eggs and meat products Negative psychological impact, especially on farming community
Environmental considerations	Potential for contamination of surface waters due to run off from carcasses Cull sites outside of controlled premises are likely to require an environmental impact assessment Indirect effects depend on the disposal route selected for carcasses
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). For complete and detailed guidance, see the Human Rights Act Animal welfare must not be compromised by extra time spent at, or waiting to be sent to, slaughterhouses prior to slaughter or in travelling long distances to remote slaughterhouses Political, production-related and animal welfare motives should be transparent to all stakeholders before decisions on implementing this recovery option are made
Effectiveness	
Recovery option effectiveness	Highly effective (ie 100%) as this option removes contaminated animals and animal products from the food chain
Technical factors influencing effectiveness of recovery option	Appropriate selection of priority areas Availability of licensed operatives to visit farms in the immediate aftermath of the incident Availability of transport to move animals In large-scale incidents, movement of animals may be infeasible and risk the spread of contamination Waste products (eg meat) require careful control to prevent recycling back into the food chain
Feasibility and intervention costs	
Specific equipment	Abattoir, slaughterhouse or culling equipment on farm (eg firearms) Vehicles for transport of livestock to abattoir or slaughterhouse if necessary
Utilities and infrastructure	Disposal routes for carcasses, eg incinerators, rendering plants, burning and burial sites
Consumables	Fuel for transport to abattoir or slaughterhouse if necessary Cartridges for firearms, etc
Skills, personnel and operator time	Culling must be carried out by licensed operatives with necessary skills Time to cull livestock Time to transport livestock if necessary
Safety precautions	None above normal for handling and culling of livestock unless an additional hazard is posed by the biological agent which is being remediated If being used on animal welfare grounds in conjunction with evacuation of population, health advice or monitoring and protective clothing will be required
Other limitations/ factors influencing costs	Capacity of disposal routes Whether culling is carried out at an abattoir, slaughterhouse or on the farm
Waste	
Amount and type	Condemned livestock carcasses Disinfectants used to prevent disease if carcases cannot be moved quickly; animal body fluids and faeces will need to be managed on the culling site
Possible transport, treatment, disposal and storage routes	Disposal by (29) Disposal of animal wastes
Factors influencing	Acceptability of and compliance with waste disposal practice

(23) Culling of livestock

waste issues (eg cost)	Transportation of carcasses to rendering or incineration plant or burial or burning site Costs of the chosen disposal route: incineration, rendering, burning and burial
Exposure	
Averted exposure	Ingestion of contaminated animal food products, including dairy products (ie milk), eggs and meat
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act to ensure that recovery workers (eg farmers and plant operatives) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker (eg farmer and plant operative) exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident processing or treatment of food products as a remediation technique Exposure pathways for recovery workers could be: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant)
Other considerations	
Agricultural impact	If the entire herd or flock is culled, under-grazing of pasture will occur but this can be remedied by cutting forage for hay, etc, except on land unsuitable for agricultural vehicles
Compensation issues	There may be requests for compensation: • farmers or herders: for immediate culling and/or for milk unable to be sold, for loss of livestock and for maintaining pastures if all livestock is removed • abattoir or slaughterhouse: for decontamination of culling premises, if necessary Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Implementation of this recovery option is likely to meet resistance from some farmers, so good stakeholder dialogue will be essential. Dialogue with farmers or herders is necessary to ensure understanding of the reasons and conduct of slaughter, and to identify means of ameliorating the negative consequences of this recovery option on other farming and related activities Effective communication would be especially important if used as an early-phase precautionary measure
Additional information	
Practical experience	Current UK government guidelines state that the government has powers to cull animals to control the spread of some animal diseases
Key references	Defra. Compensation for animals culled to control animal diseases. 2014. Available (September 2015) at https://www.gov.uk/compensation-for-animals-culled-to-control-animal-diseases Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015
Comments	
Document history	

(24) Decontamination of animal premises

Objective	To reduce potential exposure of animals to contamination by decontaminating animal housing using an appropriate decontamination technology
Other benefits	Reduces the number of animals for culling
Recovery option description	Reactive gases (eg hydrogen peroxide and chlorine dioxide), reactive liquids (eg bleach, hydrogen peroxide and alcohol), ultraviolet (UV) irradiation and physical and water-based decontamination methods, such as scrubbing and steam cleaning, can be used to decontaminate animal housing to remove contamination
Key information requirements	What is (are) the contaminating biological agent(s)? What surface(s) or type of housing has (have) been contaminated? Availability of skilled personnel to carry out decontamination
Linked recovery options	This is a remediation option and should be linked to protection and fate of affected produce (waste disposal) options
Target environment	Animal housing
Targeted organisms	This recovery option is applicable to all biological agents that could pose a risk to public and animal health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small/medium (this option is only applicable to indoor environments)
Exposure pathway prevention	Housing – livestock Ingestion of contaminated animal products Inhalation of contaminated materials
Time of application	Maximum benefit if carried out as soon as contamination is evident to prevent further spread of contamination. Multiple applications may be necessary to reduce contamination to acceptable levels
Considerations	
Public health considerations	Seek specialist advice and guidance. There may be a potential risk that the reactive gases or vapours used for the remediation remain in the environment or on surfaces, which could pose a risk to public health. It is important that any enclosed space is completely sealed to prevent leakage of the vapour It is also important to ensure that harmful residues do not remain behind in the air or on surfaces after remediation activities are completed Some reactive liquids can be harmful. These liquids should be handled with care, using appropriate PPE, and manufacturer's instructions should be followed
Legal implications and obligations	Seek specialist advice and guidance. There may be liability issues with regard to possible damage to property Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Social implications	Potential for damage to sensitive objects, surfaces, buildings or infrastructure (eg by corrosion, erosion or oxidation; however, this will depend on the volume and concentration of solutions applied) Access to facility to carry out disinfection
Environmental considerations	The toxicity of degradation products would need to be considered Contaminated waste products from treatment (eg effluent) could run on to other surfaces (roads, soil, grass, etc) if not controlled effectively, resulting in a transfer of contamination which may require subsequent clean-up thus generating more waste Extreme temperatures and humidity can influence the effectiveness of gaseous decontamination
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	The effectiveness of this technique depends on: • reactive liquids used

(24) Decontamination of animal premises

	• physiological characteristics of the biological agent • surface requiring disinfection/decontamination (eg if easily accessible and/or whether a robust or sensitive surface) If the biological contaminant is decontaminated effectively, there should be a significant reduction in potential exposure Some reactive liquids may be more effective for decontamination than others: • alcohol-based disinfection solutions may not be as effective against bacterial spores as oxidising agents • some oxidising agents such as hydrogen peroxide will be less effective against catalase positive bacteria and mycobacterium • chlorine is very effective (>4 log kill) for disinfection and decontamination of *L. monocytogenes,* MRSA*,* norovirus and VHF • alcohol is very effective (>4 log kill) for disinfection and decontamination of vegetative bacteria such as *Salmonella* spp. and has some effectiveness (2–4 log kill) for norovirus and *M. tuberculosis* • quaternary ammonium compounds have limited effectiveness (<2 log kill) for disinfection and decontamination of *M. tuberculosis,* norovirus and *Salmonella* spp.
Technical factors influencing effectiveness of recovery option	The robustness of surfaces when exposed to reactive liquids should be considered. This option may be less effective where contamination has been absorbed into porous surfaces or has penetrated inaccessible surfaces (eg under flooring) This option may need to be repeated several times to effectively decontaminate and disinfect the contaminated surface

Feasibility and intervention costs

Specific equipment	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination and waste removal operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service Monitoring equipment to determine efficacy of recovery option
Utilities and infrastructure	N/A
Consumables	Reactive liquids and chemicals used in decontamination Paper towels, mops, buckets and general wiping materials
Skills, personnel and operator time	This is a self-help recovery option as specialist personnel and suppliers may not be required to undertake this option. Some reactive liquids (eg sodium hypochlorite) are household cleaning products (eg bleach) and specialist skills are not required for small-scale disinfection and remediation Specialist skills, operator time and personnel will vary depending on the size, nature and scale of biological incident
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Factors influencing the costs of this option include: • specialist personnel (if required) • biological agent involved • weather • building size • access to contaminated area • proximity of water supplies • proximity to edible crops • use of PPE

(24) Decontamination of animal premises

Waste	
Amount and type	Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance. In addition, building materials and interiors may still require disposal after decontamination albeit at a lower level to landfill
Possible transport, treatment, disposal and storage routes	Products or solutions that may be hazardous to people or the environment must be neutralised before they can safely be discharged into the sewerage system. Contaminated waste effluent and liquids must be transported in suitable tank vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles
Factors influencing waste issues (eg cost)	Will depend on the reactive liquids used, size and scale of the affected area, and volume of contaminated waste produced
Exposure	
Averted exposure	This technique is to reduce exposure to animals while they are being housed. Averted exposure will be dependent on specific situations and the types of surfaces cleaned. Averted exposure may be influenced by the consistency in implementing this option effectively over a large area
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring may be required to ensure the recovery workers are not exposed to decontamination chemicals in excess of their exposure, and to confirm that the remediation is having the desired effect on the biological agent. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving the implementation of a reactive gas or vapour as a remediation technique
Other considerations	
Agricultural impact	Temporary (or permanent) new housing will have to be found for animals while their housing is undergoing decontamination
Compensation issues	There may be requests for compensation related to the length of time for which the animal housing cannot be used for and the re-accommodating of animals
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Additional information	
Practical experience	A number of children developed Shiga-toxin producing *E. coli* O157 infection linked to an open farm. Part of the remediation involved decontamination of animal premises (Milne, 1999)
Key references	Milne LM, Plom A, Strudley I, Pritchard GC, Crooks R, Hall M, et al. Escherichia coli O157 incident associated with a farm open to members of the public. Commun Dis Public Health. 1999;2(1):22–26 Belliot G, Lavaux A, Souihel D, Agnello D, Pothier P. Use of murine norovirus as a surrogate to evaluate resistance of human norovirus to disinfectants. Appl Environ Microbiol. 2008 May;74(10): 3315–18 Fisher RG, Chain RL, Hair PS, Cunnion KM. Hypochlorite killing of community-associated methicillin-resistant Staphylococcus aureus. Pediatr Infect Dis J. 2008 Oct;27(10):934–5 Sagripanti JL, Eklund CA, Trost PA, Jinneman KC, Abeyta C Jr, Kaysner CA, et al. Comparative sensitivity of 13 species of pathogenic bacteria to seven chemical germicides. Am J Infect Control. 1997 Aug;25(4):335–9

(24) Decontamination of animal premises

Best M, Sattar SA, Springthorpe VS, Kennedy ME. Efficacies of selected disinfectants against Mycobacterium tuberculosis. J Clin Microbiol. 1990 Oct;28(10):2234–9

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Kanerva M, Maunula L, Lappalainen M, Mannonen L, von Bonsdorff C-H, Anttila V-J. Prolonged norovirus outbreak in a Finnish tertiary care hospital caused by GII.4-2006b subvariants. J Hosp Infect. 2009 Mar;71(3):206–13

Lin W-R, Lu P-L, Siu L-K, Chen T-C, Lin C-Y, Hung C-T, et al. Rapid control of a hospital-wide outbreak caused by extensively drug-resistant OXA-72-producing Acinetobacter baumannii. Kaohsiung J Med Sci. 2011 Jun;27(6):207–14

Cherifi S, Delmee M, Van Broeck J, Beyer I, Byl B, Mascart G. Management of an outbreak of Clostridium difficile–associated disease among geriatric patients. Infect Control Hosp Epidemiol. 2006 Nov 1;27(11):1200–1205

Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications

Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance

Comments

Document history

(25) Decontamination of food premises

Objective	To reduce contamination of the food chain by decontaminating food processing plants using a number of decontamination methodologies
Other benefits	To reduce the risk of infection to the workers
Recovery option description	Reactive gases (eg hydrogen peroxide and chlorine dioxide), reactive liquids (eg bleach, hydrogen peroxide and alcohol), ultraviolet (UV) irradiation and physical and water-based decontamination methods (such as scrubbing and steam cleaning) can be used to decontaminate food processing plants to remove the contaminating agent(s). The decontamination process might need to be accompanied by dismantling of the contaminated machinery to ensure all of the surfaces have been contacted
Key information requirements	What is the contaminating biological agent? What surface or type of building has been contaminated? Availability of skilled personnel to carry out decontamination
Linked recovery options	This is a remediation option and should be linked to protection and waste disposal options It might be necessary to consult Chapter 6 (inhabited areas) if other properties have been contaminated
Target environment	Food processing plants
Targeted organisms	This recovery option is applicable to all biological agents that could enter the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small to medium (this option is only applicable to indoor environments)
Exposure pathway prevention	Ingestion of contaminated products Inhalation of aerosolised agent(s)
Time of application	Maximum benefit if carried out as soon as contamination has been determined
Considerations	
Public health considerations	Need to ensure no contamination of food produce with the decontaminants used Seek specialist advice and guidance. There may be a potential risk that the reactive gases or vapours used for the remediation remain in the environment or on surfaces, which could pose a risk to public health. It is important that any enclosed space is completely sealed to prevent leakage of the vapour It is also important to ensure that harmful residues do not remain behind in the air or on surfaces after remediation activities are completed as these can cause harm to anyone who contacts them Some reactive liquids can be harmful. These liquids should be handled with care, using appropriate PPE, and manufacturer's instructions should be followed
Legal implications and obligations	Seek specialist advice and guidance. There may be liability issues with regard to possible damage to property Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Social implications	Potential for damage to sensitive objects, surfaces, buildings or infrastructure (eg corrosion, erosion or oxidation; however, this will depend on the volume and concentration of solutions applied) Access to facility to carry out disinfection
Environmental considerations	The toxicity of degradation products would need to be considered Contaminated waste products from treatment (eg effluent) could run on to other surfaces (roads, soil, grass, etc) if not controlled effectively, resulting in a transfer of contamination which may require subsequent clean-up thus generating more waste Extreme temperatures and humidity can influence the effectiveness gaseous decontamination
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)

(25) Decontamination of food premises

Effectiveness	
Recovery option effectiveness	The effectiveness of this technique depends on: • reactive liquids used • physiological characteristics of the biological agent • surface requiring disinfection/decontamination (eg if easily accessible and/or whether a robust or sensitive surface) If the biological contaminant is decontaminated effectively, there should be a significant reduction in potential exposure Some reactive liquids may be more effective for decontamination than others: • alcohol-based disinfection solutions may not be as effective against bacterial spores as oxidising agents • some oxidising agents such as hydrogen peroxide will be less effective against catalase positive bacteria and mycobacterium • chlorine is very effective (>4 log kill) for disinfection and decontamination of *L. monocytogenes,* MRSA*,* norovirus and VHF • alcohol is very effective (>4 log kill) for disinfection and decontamination of vegetative bacteria such as *Salmonella* spp. and has some effectiveness (2–4 log kill) for norovirus and *M. tuberculosis* • quaternary ammonium compounds have limited effectiveness (<2 log kill) for disinfection and decontamination of *M. tuberculosis,* norovirus and *Salmonella* spp.
Technical factors influencing effectiveness of recovery option	The robustness of surfaces when exposed to reactive liquids should be considered. This option may be less effective where contamination has been absorbed into porous surfaces or has penetrated inaccessible surfaces (eg under machinery) This option may need to be repeatedly several times to effectively decontaminate and disinfect the contaminated surface
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination and waste removal operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service Monitoring equipment and biological indicators to determine efficacy of recovery option
Utilities and infrastructure	N/A
Consumables	Reactive liquids and chemicals used in decontamination Paper towels, mops, buckets and general wiping materials
Skills, personnel and operator time	This is a self-help recovery option as specialist personnel and suppliers may not be required to undertake it. Some reactive liquids (eg sodium hypochlorite) are household cleaning products (eg bleach) and specialist skills are not required for small-scale disinfection and remediation Specialist skills, operator time and personnel will vary depending on the size, nature and scale of biological incident
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Factors influencing the costs of this option include: • specialist personnel (if required) • biological agent involved • weather • building size • access to contaminated area • proximity of water supplies • use of PPE

(25) Decontamination of food premises

Waste	
Amount and type	Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance. In addition, building materials and interiors may still require disposal after decontamination, albeit at a lower level to landfill
Possible transport, treatment, disposal and storage routes	Products or solutions that may be hazardous to people or the environment must be neutralised before they can safely be discharged into the sewerage system. Contaminated waste effluent and liquids must be transported in suitable tank vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles
Factors influencing waste issues (eg cost)	Will depend on the reactive liquids used, size and scale of the affected area, and volume of contaminated waste produced
Exposure	
Averted exposure	Reduces contamination within the food chain and also eliminates contamination at the site of production/packaging to reduce future effects
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring may be required to ensure the recovery workers are not exposed to decontamination chemicals in excess of their exposure, and to confirm that the remediation is having the desired effect on the biological agent. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving the implementation of a reactive gas or vapour as a remediation technique
Other considerations	
Agricultural impact	N/A
Compensation issues	There may be requests for compensation from the affected company depending on the original source. Additionally, requests for compensation may come from those affected by the contamination to the foodstuffs produced
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Additional information	
Practical experience	
Key references	Belliot G, Lavaux A, Souihel D, Agnello D, Pothier P. Use of murine norovirus as a surrogate to evaluate resistance of human norovirus to disinfectants. Appl Environ Microbiol. 2008 May;74(10): 3315–18 Fisher RG, Chain RL, Hair PS, Cunnion KM. Hypochlorite killing of community-associated methicillin-resistant Staphylococcus aureus. Pediatr Infect Dis. J 2008 Oct;27(10):934–5 Sagripanti JL, Eklund CA, Trost PA, Jinneman KC, Abeyta C Jr, Kaysner CA, et al. Comparative sensitivity of 13 species of pathogenic bacteria to seven chemical germicides. Am J Infect Control. 1997 Aug;25(4):335–9 Best M, Sattar SA, Springthorpe VS, Kennedy ME. Efficacies of selected disinfectants against Mycobacterium tuberculosis. J Clin Microbiol. 1990 Oct;28(10):2234–9 Magulski T, Paulmann D, Bischoff B, Becker B, Steinmann E, Steinmann J, et al. Inactivation of murine norovirus by chemical biocides on stainless steel. BMC Infect Dis. 2009 Jul 7;9:107

(25) Decontamination of food premises

Kanerva M, Maunula L, Lappalainen M, Mannonen L, von Bonsdorff C-H, Anttila V-J. Prolonged norovirus outbreak in a Finnish tertiary care hospital caused by GII.4-2006b subvariants. J Hosp Infect. 2009 Mar;71(3):206–13

Lin W-R, Lu P-L, Siu L-K, Chen T-C, Lin C-Y, Hung C-T, et al. Rapid control of a hospital-wide outbreak caused by extensively drug-resistant OXA-72-producing Acinetobacter baumannii. Kaohsiung J Med Sci. 2011 Jun;27(6):207–14

Cherifi S, Delmee M, Van Broeck J, Beyer I, Byl B, Mascart G. Management of an outbreak of Clostridium difficile–associated disease among geriatric patients. Infect Control Hosp Epidemiol. 2006 Nov 1;27(11):1200–1205

Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications

Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance

Comments

Document history

(26) Selection of alternative product use

Objective	To identify alternative uses for products originally intended for the food and/or food chain
Other benefits	Reduces amount of waste food products requiring disposal
Recovery option description	Contaminated crops may be used for non-food production Examples: • non-compliant guar gum redirected to non-food applications (about 40% of global guar gum production goes to non-food applications). Some contaminated products (eg crops/meats) may be acceptable as ingredients for pet food. Vegetable oil intended for human food could also be redirected to biofuel • animal feed ingredients may be diverted for other uses (eg vegetable oils for biofuels) • not all crops or animal products will have an alternative use. The effects that the biological contamination will have on the non-food product produced would also need to be considered
Key information requirements	Potential non-food uses Potential markets Costs involved
Linked recovery options	This is a fate of affected produce (waste disposal) option and should be linked to protection and remediation options
Target environment	Any food or feed products
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion of contaminated food products
Time of application	No restrictions on time. This recovery option is not time limited and can be implemented at any stage during a biological incident. Depending on the scale, time would be required to source alternative markets and assess any necessary reprocessing operations (eg cost and effectiveness of technique) For perishable foods, action would need to be taken while these remained suitable for the proposed alternative use
Considerations	
Public health considerations	None
Legal implications and obligations	Seek expert advice and guidance as there is legislation for alternative product (eg biofuel regulations) Monitoring by enforcement bodies may be required to ensure affected products do not re-enter the food chain
Social implications	None
Environmental considerations	Potentially beneficial if product is reused rather than discarded
Ethical considerations	None
Effectiveness	
Recovery option effectiveness	The main reason for selecting this option would be economic and therefore the effectiveness of this option will depend on the accuracy of cost calculations
Technical factors influencing effectiveness of recovery option	Acceptability to processors and regulators of using contaminated crops or animal products to make non-food products Proof of technical feasibility
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance, as this option will depend on the affected product and processing technique used

(26) Selection of alternative product use

Utilities and infrastructure	Power supply Storage and possibly processing facilities for chosen crop or animal product
Consumables	Processing materials
Skills, personnel and operator time	Training may be required if processing practises are changed significantly
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg production personnel) use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Use of this option will be very much cost-driven. The selection (and subsequent processing) of contaminated products for alternative product use should be cheaper than waste disposal alone to make this option feasible Costs should be considered, eg if it is necessary to pay a processing plant to get the food into a suitable condition for a non-food use, this would have to be included in the cost model
Waste	
Amount and type	Depends on the production process Contaminated by-products from, for example, the refining of rapeseed and sugar beet to biodiesel and bioethanol, may be generated in processing plants
Possible transport, treatment, disposal and storage routes	On-site treatment plants or sewage treatment works for processing by-products
Factors influencing waste issues (eg cost)	Incineration Landfill capacity
Exposure	
Averted exposure	Ingestion of contaminated food products
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg processing plant operatives) use appropriate PPE (if required) and follow SOPs Exposure pathways for recovery workers could be: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant)
Other considerations	
Agricultural impact	None
Compensation issues	None
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Dissemination of information about the recovery option, its rationale and possible alternatives, ie explaining the risks associated with the levels of contamination, the uncertainty and the variance of those levels. This recovery option would need to be discussed in detail with the food businesses concerned, in conjunction with prospective customers and enforcement bodies

(26) Selection of alternative product use

Additional information

Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015
Comments	This recovery option makes use of existing commercial processes
Document history	

(27) Burning in-situ (pre-harvested crops)

Objective	To reduce the volume of contaminated crops for disposal
Other benefits	None
Recovery option description	Open air burning involves the burning of plant material in open fields, on combustible heaps called pyres and with other burning techniques that are unassisted by incineration equipment. Open air burning is generally prohibited in the UK. Therefore it can only be used in exceptional circumstances involving large-scale biological contamination where there are major waste disposal issues Plant materials are burnt in the open air on the site where they were originally kept or grown. This option can be used on all waste types provided the material contains at least 30% solids. Drying prior to burning is preferable but may require extra time To promote clean combustion, it is advisable to dig a shallow pit with shallow trenches to provide a sufficient supply of air
Key information requirements	What is the biological contaminant and potential degradation products?
Linked recovery options	This is a fate of affected produce (waste disposal) option and should be linked to protection and remediation options This recovery option should be considered in conjunction with (4) Restriction of entry into food chain/ withdrawal from market
Target environment	Contaminated pre-harvest crops
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Medium/large
Exposure pathway prevention	Plant to animal Plant to human
Time of application	No restrictions on time. This recovery option is not time limited and can be implemented at any stage during a biological incident

Considerations

Public health considerations	There are public health constraints associated with this recovery option, including psychosocial aspects Poor air quality may impact on susceptible groups (children, elderly and individuals with chronic respiratory disease such as asthma or COPD)
Legal implications and obligations	Seek expert advice and guidance, as restrictions or prohibitions may apply (eg burning of straw on farms is restricted and burning of carcasses is usually prohibited) For more information on legislation please see Appendix A
Social implications	Impact on local communities. Suggested minimum distance of 2 miles to the community
Environmental considerations	Availability and capacity of suitable land. Animal carcasses and crops must be burned and the ash disposed of without endangering human health or harming the environment Negative impacts through gaseous emissions. Burning may increase the aerosolisation or volatilisation of the contamination hazard Ground water contamination may occur potentially from hydrocarbons used as fuel for initial burning Burning in windy areas poses a threat as a fire hazard Burning could create a bigger or longer-term problem
Ethical considerations	The ethical considerations should be taken into account, particularly following the public outcry of burning in-situ of animal carcasses following the foot and mouth epidemic in 2000

Effectiveness

Recovery option effectiveness	Open air burning does not have a constant temperature range. However, if metallic fuel (or, alternatively, diesel) is used, temperatures of 1200–1400°C can be reached. The higher the temperature, the more effective the procedure. There will not always be certainty of 100% destruction of the biological agents concerned

(27) Burning in-situ (pre-harvested crops)

Technical factors influencing effectiveness of recovery option	This recovery option provides a relatively quick solution but the slowest of all incineration processes. The type of crops being burned will influence the time. The biological contaminant involved will influence the effectiveness of this option
Feasibility and intervention costs	
Specific equipment	None
Utilities and infrastructure	Transport and fuel for vehicles
Consumables	Fuel, eg diesel
Skills, personnel and operator time	Depends on the biological incident and the scale and size of affected area. Limited skills required to implement this option
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg farmers) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Consider protective clothing. Respiratory protection is recommended whenever materials are handled or moved, and when there may be the potential of harm from the vapours given off during burning
Other limitations/ factors influencing costs	Type and extent of biological contamination
Waste	
Amount and type	Pyre ash
Possible transport, treatment, disposal and storage routes	Ash from burning process is usually disposed of to landfill
Factors influencing waste issues (eg cost)	Composition of waste (eg crops)
Exposure	
Averted exposure	Ingestion of contaminated food products
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg farmers) use appropriate PPE (if required) and follow SOPs Exposure pathways for recovery workers could be: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant)
Other considerations	
Agricultural impact	May damage and contaminate agricultural land with fuel used for burning
Compensation issues	There may be requests for compensation from farmers for damage to agricultural land Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments

(27) Burning in-situ (pre-harvested crops)

	Dissemination of information about burning of contaminated produce to farmers and the public Essential to have good communication with local inhabitants

Additional information

Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015
Comments	
Document history	

(28) Disposal of foodstuffs

Objective	To dispose of foodstuffs such as dairy products, eggs and processed produce that have been contaminated
Other benefits	Maintain the credibility of safe food production systems for consumers
Recovery option description	Foodstuffs are sent for incineration or to landfill. Foodstuffs will need to be treated before being sent to landfill
Key information requirements	What is the contaminating biological agent?
Linked recovery options	This is a fate of affected produce (waste disposal) option and should be linked to protection and remediation options This recovery option should be considered in conjunction with (4) Restriction of entry into food chain/ withdrawal from market, (5) Product recall and (15) Processing or treatment of food products
Target environment	Dairy products, eggs and any other processed food
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Not applicable, this is a waste disposal option
Time of application	No restrictions on time

Considerations

Public health considerations	No issues unless there is a delay in implementing this option and contaminated food products enter the food chain
Legal implications and obligations	Under general food law Regulation (EC) 178/2002: • Article 14 places a legal obligation on food businesses not to place unsafe food on the market. Under Article 18, they must be able to trace where they have obtained or supplied food, ingredients or food-producing animals and whom they have supplied. Under Article 19, they must withdraw food from the market as soon as they have reason to believe it does not comply with food safety requirements Where food implicated in the incident has been supplied to other EU member states or third countries, there may be pressure to replicate actions taken elsewhere (especially within the EU), even where these are considered excessive. For this reason, decisions need to be taken and communicated quickly. This is of particular importance where a decision is made ***NOT*** to take action There may be legal constraints on the disposal options for the withdrawn foodstuffs, for more information on legislation please see Appendix A
Social implications	Retail trade or producers may be reluctant to implement this recovery option Potential to cause alarm within communities Usually it is when the public become aware of a withdrawal that some food businesses make a decision to recall products to reinforce trust and promote consumer confidence Policing the recovery option and averting fraudulent trading Potential for generating mistrust of food production systems; conversely, possible increase in public confidence that the problem of contamination is being effectively managed There may be a negative social and psychological impact (or stigma) associated with food produced from the affected area
Environmental considerations	The fate of withdrawn foodstuffs and appropriate waste disposal routes of food products that are withdrawn from the market must be considered when implementing this recovery option
Ethical considerations	Disposal of high volumes of foodstuffs which may be able to be reused in other areas. Individuals may consider this as unnecessary wastage

Effectiveness

Recovery option effectiveness	Assuming all food is disposed of appropriately, this option should be 100% effective

(28) Disposal of foodstuffs

Technical factors influencing effectiveness of recovery option	Properties of biological agent Time from discovery of contamination to implementation of recovery option
Feasibility and intervention costs	
Specific equipment	Appropriate packaging of foodstuffs prior to disposal/treatment Vehicles to transport waste to treatment centre or incinerator
Utilities and infrastructure	Suitable disposal site Roads to transport waste Additional containers and temporary storage capacity may be needed to ensure that quarantined and unaffected batches of foodstuffs will not be mixed
Consumables	Fuel and packaging materials
Skills, personnel and operator time	If foodstuffs are to be taken to landfill then they will need to be appropriately decontaminated first. This may require a skilled operative, although it would be expected that these skills would be found within the workplace for dealing with other issues If foodstuffs are to be incinerated then prior decontamination may not be required Logistical experts needed to ensure maintenance of the food supply especially in the early phase Personnel will also be required to enforce this option and potentially to source alternative foodstuffs
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs) If quarantined food is highly contaminated, normal storage facilities, even if separate from other storage, may be inadequate and additional safety measures may be needed to prevent the spread of contamination
Other limitations/ factors influencing costs	The scale and complexity of the affected part of the food chain may affect the practicability of withdrawal so the extent of the withdrawal must be balanced with the risk Storage costs may also need to be considered if large quantities of waste will require disposal Time and distances involved in travelling to areas under restrictions for monitoring purposes Time and distances involved in sourcing alternative foodstuffs
Waste	
Amount and type	Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Routes need to be established for the transport of the foodstuffs to be disposed of
Factors influencing waste issues (eg cost)	Dependent on the subsequent disposal route selected for withdrawn foodstuffs and quantities of waste produced Area under restrictions and duration of restrictions Acceptability of, and compliance with, waste disposal practice Local availability of suitable disposal routes
Exposure	
Averted exposure	Ingestion of contaminated food products
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs
Other considerations	
Agricultural impact	None

(28) Disposal of foodstuffs

Compensation issues	There may be requests for compensation: • food producer: for loss of earnings following restrictions on products • industry: for the difference in costs compared to normal practice Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Implementation of this recovery option is likely to meet resistance from some production or retail companies, so good stakeholder dialogue will be essential Dissemination of information about the recovery option, its rationale and possible alternatives, ie information explaining the risks associated with the levels of contamination, the uncertainty and the variance of levels will be required Good communication with members of public is essential to prevent alarm within communities

Additional information

Practical experience	
Key references	Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
Document history	

(29) Disposal of animal wastes

Objective	To dispose of animal carcasses following culling/slaughter
Other benefits	No treatment of carcasses needed prior to disposal (unless going to landfill), therefore a risk of additional contamination of rendering plants, incinerators, etc
Recovery option description	Contaminated animal waste such as bedding or manure can be sent for either incineration or landfill. Animal waste that is to be sent to landfill will need to be treated first
Key information requirements	What is the contaminating biological agent?
Linked recovery options	This is a fate of affected produce (waste disposal) option and should be linked to protection and remediation options
Target environment	Animal waste
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate the food chain and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Not applicable, this is a waste disposal option
Time of application	No restrictions on time
Considerations	
Public health considerations	No issues, unless there is a delay in implementing this option. Effective segregation at source will eliminate potential exposure to the public
Legal implications and obligations	The HSE guidance document 'Managing offensive/hygiene waste safely' http://www.hse.gov.uk/pubns/waste22.pdf can be consulted as this provides information on the management of animal hygiene waste (including animal bedding)
Social implications	Minimal if managed correctly
Environmental considerations	Increase in use of reactive liquids to decontaminate prior to sending to landfill
Ethical considerations	None
Effectiveness	
Recovery option effectiveness	This option assists with the removal of contamination but does not necessarily remove the source of contamination and therefore needs to be implemented alongside other recovery options
Technical factors influencing effectiveness of recovery option	Properties of biological agent Time from discovery of contamination to implementation of recovery option
Feasibility and intervention costs	
Specific equipment	Appropriate packaging of animal waste prior to disposal/treatment Vehicles to transport waste to treatment centre or incinerator
Utilities and infrastructure	Suitable disposal site Roads to transport waste
Consumables	Fuel Packaging materials
Skills, personnel and operator time	If food animal wastes are to be taken to landfill then they will need to be appropriately decontaminated first. This may require a skilled operative, although it would be expected that these skills would be found within the workplace already
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)

(29) Disposal of animal wastes

Other limitations/ factors influencing costs	Storage costs may need to be considered if large quantities of waste will require disposal Time and distances involved in travelling to areas under restrictions for monitoring purposes Time and distances involved in sourcing alternatives to replace what has been disposed of
Waste	
Amount and type	Potentially large quantities of contaminated bedding and other animal wastes Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Routes need to be established for the transport of animal wastes to be disposed of
Factors influencing waste issues (eg cost)	Dependent on subsequent disposal route selected for animal wastes and quantities of waste produced Area under restrictions and duration of restrictions Acceptability of, and compliance with, waste disposal practice Local availability of suitable disposal routes
Exposure	
Averted exposure	Prevention of exposure of contaminated animal waste to workers and animals, therefore reducing risk of infection
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits to chemicals used in the recovery process are not exceeded
Other considerations	
Agricultural impact	None
Compensation issues	There may be requests for compensation from animal owners for replacement bedding, etc
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Additional information	
Practical experience	Foot and mouth disease (UK). Outbreaks of anthrax in Canada (1993) and South East Missouri (2001)
Key references	World Health Organization. Anthrax in humans and animals (4th edition). 2008. Available (September 2015) at http://www.who.int/csr/resources/publications/AnthraxGuidelines2008/en/ Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
Document history	

6 Inhabited Areas

What is an 'inhabited area'?

Inhabited areas are places where people spend their time. They can be divided into a number of sub-areas such as residential, industrial and recreational. These sub-areas contain a variety of surfaces such as buildings, roads, woodlands and parks. This may also include vehicles and places of transition and it is important to be aware that these areas may have high levels of utilities.

The sub-areas considered within the scope of the handbook are described in Tables 6.1–6.3. Guidance on the importance of outdoor land surfaces is summarised in Table 6.4.

Following a biological incident, decision makers require a framework which allows them to select appropriate recovery options to produce a remediation strategy for recovering a contaminated inhabited area. This handbook is a tool to help users evaluate potential recovery options by providing a decision making framework and the relevant information needed to support decisions; enabling implementation of timely and effective remediation strategies[1].

For small-scale biological incidents the recovery strategy may comprise of one or two recovery options that could be applied over the first few days. For example, an outbreak of norovirus on one hospital ward may only require protective options such as (1) Restrict public access and (2) Controlled workforce access until the outbreak attenuates[2]. However, for a widescale biological release involving persistent agents, eg the intentional release of anthrax spores, the recovery strategy is likely to be more complex, comprising multiple recovery options which include both protection and remediation options. These options would be implemented over different phases of the incident response and affect a large range of inhabited areas[3]. Some aspects of recovery can be considered in advance of an incident as part of contingency planning. A series of checklists is provided in Chapter 3 to highlight the type of information that can be gathered under non-crisis conditions to help manage the pre-release and early phases of an incident. Decision makers will need input and guidance from the relevant experts to supplement the information, particularly to provide advice on the suitability of recovery options for the biological agent in question and the practicability of their implementation[1].

Contamination of inhabited areas can present a number of challenges. It is essential to have as much information as possible about the biological agent in question (eg agent form, pathogenicity and persistence in the environment) when evaluating applicable recovery options. However, there are other site-specific factors that also need to be taken into consideration, which include:

- presence of critical assets or infrastructure (eg hospitals)
- population density of the contaminated area
- length of time the public/workers have spent in the area
- activities of people within the area (eg whether resident or employed or if the area is used for recreation)
- susceptibilities of different population groups within the area (eg elderly, infants or the immunocompromised)

- range of different contaminated surface types in the area
- presence of high value or irreplaceable items (eg heritage sites, precious objects, personal items or important documentation)
- acceptability of remediation to the affected population
- interactions with animals (eg wildlife, companion animals and pests who may spread contamination)

The recovery options applicable to inhabited areas are concerned with reducing or eliminating the exposure to and the transmission of infectious agents present on surfaces or in the air[1].

6.1 Inhabited areas within the handbook

The range of sub-areas, surfaces and surface types considered within the scope of the handbook are summarised in Tables 6.1, 6.2 and 6.3, respectively[1,4].

Guidance on the importance of outdoor land surfaces is summarised in Table 6.4.

6.2 Flooding in inhabited areas

In recent years, flooding has become a more frequent occurrence in the UK. Flood waters can bring with them any number of non-pathogenic and pathogenic microorganisms which are likely to remain when the waters recede. As well as rivers bursting their banks and coastal flooding, problems with sewers can lead to raw sewage in flood waters causing further risk to the affected population. Furthermore, dampness caused by flooding can result in building deterioration including the development of mould. This may not present a health hazard through an infection risk, but, as previously mentioned may cause ill-health as a result of allergic responses to the fungi.

After the water recedes, remediation of affected areas needs to take place and the question remains ***'How to effectively clean-up?'*** Further details can be found in a worked example within Chapter 10.

6.3 Health protection criteria for inhabited areas

It is important that any measures taken to protect public health and reduce the risk of infection (eg PPE, infection control measures and evacuation) are appropriate to the level of risk of the biological contaminant in question. They, therefore, must also take into account all the wider consequences of the proposed protective measure; for example, costs and disruption to implement the measure must be balanced against the pathogenicity of the agent and the expected benefits of implementation including public reassurance. This balance must take into account the specific circumstances of the event, which are likely to vary between incidents[1,4]. At present there are no national regulations outlining remediation criteria following an incident involving a biological release in the UK; however, in some specific areas, there are localised guidance notes on how to deal with biological incidents (see, for example, guidelines issued by the HPA for dealing with norovirus on cruise liners: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/362998/2007_guideline_norovirus_cruiseships.pdf).

Table 6.1: Types of sub-area in inhabited areas

Area	Description
Residential	Areas used for residential purposes (eg houses, small settlements, housing estates and block of flats)
Non-residential	Areas accessed by the public for services and employment (eg commercial districts, hospital, schools, shopping centres, supermarkets, town and city centres) *Note:* There may be overlap between residential and non-residential areas (eg where a flat is above a shop
Industrial	Non-residential areas where production and/or commercial activities are undertaken (eg industrial estates and factories)
Recreational	Outdoor areas accessed by the public for recreational purposes
Sub-areas may comprise:	
Buildings	Buildings used for residential, public, commercial and industrial purposes. Includes buildings having important roles in the provision of infrastructure in an area such as railway stations, airports and water treatment plants. Also includes buildings used for essential services such as hospitals and fire/ambulance stations
Outdoor areas	Areas with private access from residential dwellings (eg playing areas, driveways, patios and gardens) and areas with public access (eg pavements, car parks, gardens, playing fields and playgrounds)
Transport networks (above ground)	Areas essential for public/private transport. Include airports, railway lines, roads and seaports
Transport networks (below ground)	Areas specific to underground transport networks (eg tunnels, tracks and stations)
Parks and open spaces	All gardens, parks, children's play areas and sports fields with public access. Size of these areas is typically greater than 300 m^2
City farms and allotments	City farms and allotments may be found in inhabited areas. However, these are also considered in the food production systems section of the handbook
Woods and forests	Managed and unmanaged deciduous and coniferous woods and forests used for recreational purposes by the public
Countryside	Managed and unmanaged areas used for recreational purposes by the public (eg footpaths, national parks and moorland)
Underground spaces	Includes areas that could potentially be used by members of the public. Also includes car parks, service ducts and subways
Swimming pools	Buildings and infrastructure surrounding indoor and outdoor swimming pools are considered an inhabited area but contaminated swimming pool water is considered in the water environments section of the handbook

Table 6.2: Surfaces in inhabited areas

Surface	Description of surface
Buildings (external surfaces)	External surfaces (eg walls, roofs, windows, treated timber and doors of all buildings)
Buildings (indoor surfaces and objects)	Indoor building surfaces (eg walls, floors, ceilings, soft furnishings and furniture) In addition, objects (eg precious) for which disposal is unacceptable and for which normal decontamination methods may cause unacceptable damage (eg museum pieces, artwork, original documents and personal items such as mobile phones and computers/laptops)
Roads and paved areas	All roads, pavements, large paved or asphalt areas (eg playgrounds, yards and car parks)
Street furnishings	Includes all traffic lights, signs and bollards
Vehicles	All vehicles used for public or private transport (eg cars, lorries, trains, buses, trams and aircraft)
Soil and vegetation (including grass, plants, shrubs and trees)	Includes lawns, flowerbeds and vegetable pots, trees, shrubs and bushes within the gardens of residential dwellings, landscaping around commercial and public buildings, allotments, parks, playing fields and other managed green areas

Table 6.3: Surface material types in inhabited areas

Surface type*	Description of surface
Robust	Robust surfaces can normally withstand potentially damaging decontamination techniques (eg marble, steel and vinyl tile). Potentially damaging recovery options would include the use of reactive liquids and pressure hosing
Sensitive	Sensitive surfaces that are less likely to withstand, or for which it is unacceptable to use, potentially damaging decontamination techniques. Examples include the wall of a heritage building, electrical equipment or upholstery fabric. It is likely that less damaging recovery options would be used on these surfaces such as storage, covering and gentle cleaning of precious objects or vacuum cleaning
Absorbent	Surfaces that are permeable or porous that have the potential to absorb biological contamination (eg wood and fabric). These surfaces are usually more difficult to decontaminate than non-absorbent surfaces
Non-absorbent	Surfaces that are neither permeable nor porous so do not have the potential to absorb biological contamination (eg steel and glass). These surfaces are usually easier to decontaminate as biological contamination lies 'free' on the surface
Inaccessible	Inaccessible surfaces include the interior of electrical equipment (eg computers), the space between a screw and bolt, and air conditioning systems as examples. Inaccessible surfaces are usually more difficult to decontaminate. A likely recovery option would be reactive gases and vapours

* Surface materials may have one or more of these properties or traits, which can influence the remediation strategy

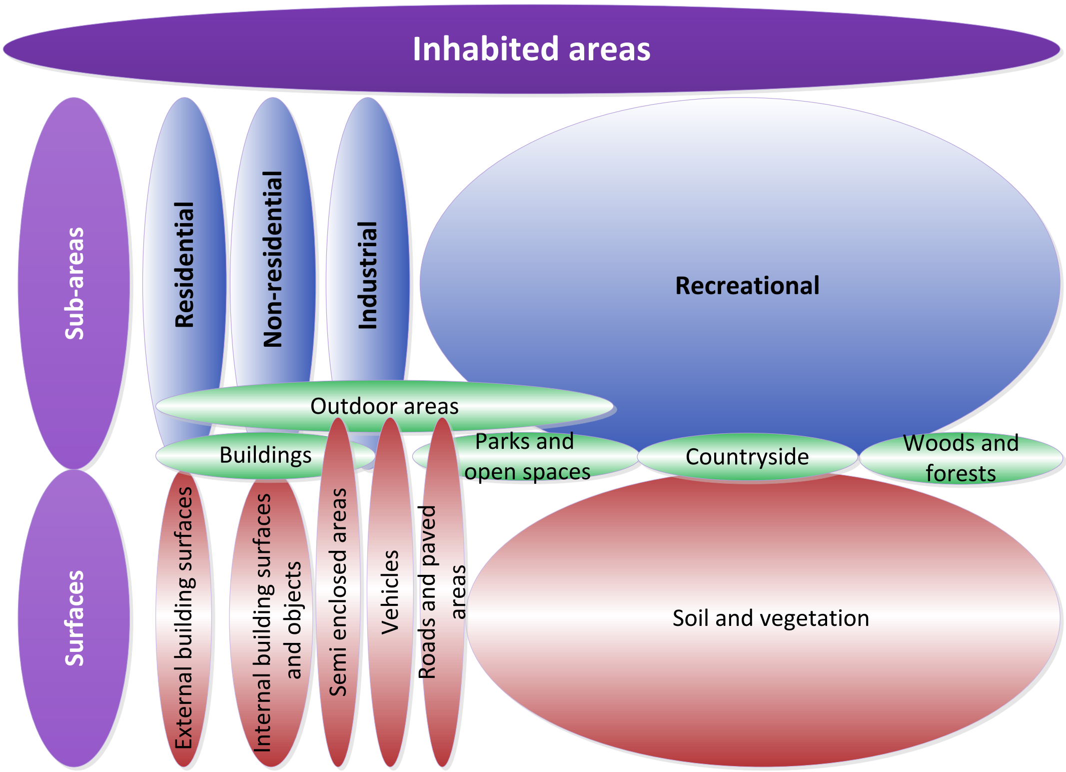

Figure 6.1: Links between inhabited areas and surface types

Table 6.4: Guidance on the importance of outdoor land surfaces

Question	Possible importance
1 Do you know the extent of biological contamination in the environment?	**No** – If there is epidemiological evidence of contamination then sampling may be undertaken to determine the extent of contamination **Yes** – Information can be used to help identify which surfaces are likely to be contributing to exposure
2 How much of the outdoor area is covered by soil or grass compared to roads or paved areas?	Different recovery options will need to be undertaken depending on the type of surface found in outdoor areas Soil and grass can be considered an absorbent surface which, if not removed, has the potential to continually expose the public to contamination Road and paved areas are likely to be more robust surfaces where cleaning with reactive liquids can remove contamination easily which therefore removes the likelihood of any further contamination
3 Do people spend a significant amount of time outdoors in the area?	The total outdoor exposure is a function of the time people spend outdoors If people do not spend significant time outdoors in this area, it may not be necessary to undertake substantial clean-up of outdoor surfaces. However, these surfaces also contribute to indoor exposure and therefore, although exposures are substantially lower indoors, they may be reduced by cleaning outdoor land surfaces
4 Can the outdoor area (or part of it) be cordoned off to restrict access?	Outdoor exposure can be reduced by cordoning off the area. This may reduce the need to clean-up outdoor surfaces, particularly if the biological agent has a short persistence

It is recognised that, through published advice for radiation and chemical incidents, some clean-up techniques, such as (8) Reactive gases and vapours, are considerably more resource intensive and disruptive than others[1,4]. This can also be applied to biological contamination. In addition, it is difficult to specify clean-up goals in advance of an incident as background levels of biological contaminants are often not known and should be considered alongside other aspects of planning for a response (see Chapter 3). Following an incident, it is recommended that assessments of the remediation strategy should be completed, examining both the risk and the consequences. These consequences should include cost, timescales, public acceptability and the availability of the necessary resources. Any information relevant to these assessments (ie potential efficacy, resource requirements, identification and preparation of appropriate equipment and contractors, and cost) would enable the completion of such assessments quickly and efficiently in the event of an incident. Potential strategies that involve high levels of cost and disruption should only be undertaken if the risk to public health is also high, thereby maintaining a balance between the expected harms and benefits of the strategy[1,4].

6.4 Generation of waste from inhabited areas

Depending on the biological agent(s) in the affected inhabited area, some or all of the contaminated material (directly contaminated material that cannot be decontaminated in-situ, decontaminated material that is no longer required or the by-products of decontamination processes) may require disposal through appropriate waste disposal routes. Some types of waste that can be encountered during a biological incident may be classified as 'hazardous waste'. National guidance is available to help determine if a waste is deemed to be described as 'hazardous' or not[5]. Depending on the specific situation and the biological agent in question, various options exist for the disposal of wastes. The Environment Agency, Scottish Environment Protection Agency (SEPA) and Northern Ireland Environment Agency (NIEA) can be consulted for advice on appropriate waste management strategies[6].

For further information and a list of guidance, regulations and legislation on the various aspects of waste management see Appendix A.

6.5 Estimating exposure in inhabited areas

The potential for exposure of an individual to biological contamination following an incident can be difficult to estimate. There are many factors which govern the estimated exposure of an individual in such a situation and these include the properties of the biological agent in question, the extent of the contamination in the affected area, the time spent by the individual living/working in the contaminated environment, the potential exposure routes, activities carried out by the individual in the affected environment and the individual's immune status.

Any individual should be protected from exposure to pathogenic agents at home, during recreational time and in the workplace. When evaluating recovery options, the potential exposure or any increase in exposure of an individual should be considered and all necessary precautions should be taken to protect the affected individual. If there are very good reasons as to why individuals may need to be in areas where the likelihood of exposure is high, eg those maintaining critical facilities and infrastructure, there should be appropriate health monitoring to detect any symptoms of infection[1,4].

6.6 Constructing a recovery strategy for inhabited areas

Constructing a remediation strategy and selecting appropriate recovery options involves multiple steps. An overview of the decision-making framework for developing a recovery strategy is given in Figure 6.2. It is important to note that this framework should not be considered as a substitute for expert specialist advice, but provides a framework for requesting, recording and evaluating the advice (Steps 1–3). The decision-making framework (Figure 6.2) comprises six steps which involve the elimination of inappropriate recovery options through the use of a decision tree, selection diagrams, tables and checklists.

Step 1 of the framework describes the identification of the biological agent (if possible) and the gathering of information relevant to the incident. Step 2 then leads the user to the decision tree in Figure 6.3 and the selection tables in Figure 6.4. The decision tree guides the user through the initial decision-making process and the range of considerations that need to be taken into account, as well as allowing the user to select all the available appropriate recovery options for the incident in question. Steps 3–5 then provide a methodology for eliminating options that are unsuitable or ineffective by evaluating their efficacy and characteristics. From the remaining options, a recovery strategy can then be developed (Step 6). A template table is provided (Table 6.6) that can be used to help record the decisions made during the recovery option elimination process. Once the recovery strategy has been developed, it can be executed and monitoring can be performed to confirm whether acceptable levels have been reached and the area can be returned to normality. If acceptable levels have not been reached then the user can return to the decision tree in Step 2.

The final step is to document the incident and evaluate the recovery response with the formation of a report, including the effectiveness of the handbook. This report can then be used to determine any lessons that should be learnt from the response. It would also be helpful to forward the report on to the handbook project team (biological.recovery@phe.gov.uk) as the information can then be incorporated into the databases which support the document.

Further details of the steps are given in the following sections. The inhabited areas decision framework does not include a strategy for performing a risk assessment or for designing or implementing a monitoring strategy following a biological incident, this falls outside the scope of the handbook

To view an example of how this process works, please see Chapter 10: Worked Examples.

Step 1: Obtain relevant information regarding the incident

Identify affected inhabited area(s) and, if applicable, determine the agent's characteristics
Obtain expert advice

Step 2: Consult flow chart and decision tree for inhabited areas

Identify potentially applicable recovery options
Consult food production systems and water environments sections of the handbook (if applicable)

Step 3: Determine the effectiveness of recovery options

A: Eliminate options based on the agent's characteristics
B: Eliminate options based on effectiveness

Step 4: Review key considerations and constraints

Eliminate further options according to other considerations
(public health, waste social, technical, cost and time)

Step 5: Consult recovery option sheets

Eliminate further options following a detailed analysis of options on a site and incident specific basis

Step 6: Compare remaining recovery options

Based on steps 1 – 5, select and combine options for managing each phase

Implement recovery strategy/report and evaluate

Yes
Return to normality and report

Was recovery strategy effective?

No
Return to Step 2/review recovery options

Figure 6.2: Key considerations for recovery

Step 1 Obtain relevant information regarding the incident

When a biological incident occurs, the initial steps are to identify the biological agent(s) involved and seek technical (biological) expertise. It may not always be possible to identify the biological agent (eg vomiting) and there may be cases where there are multiple agents in a contaminated area (eg soil). There may also be delays before the laboratory identification of the agent. However, by consulting the appropriate experts it may be still possible to gather information on the likely contaminants that may be found. An example of this can be found in Chapter 10.

Having identified the biological agent (if possible), information should then be collected on the agent's biological characteristics, eg persistence and mode of transmission. The handbook has identified a subset of biological characteristics and properties that need to be considered – see Table 6.5. These properties will then be used to eliminate options in Step 3 of the decision-making process. Only when this information is available can an appropriate recovery strategy be developed.

Table 6.5: Important physiological characteristics of biological agents

<table>
<tr><th rowspan="2">Agent characteristics</th><th rowspan="2">Description</th><th rowspan="2">Interpretation</th><th colspan="2">Biological agent</th></tr>
<tr><th>Characteristic</th><th>Interpretation</th></tr>
<tr><td>Agent's species</td><td>Agent's taxonomy</td><td>Further details about the agent can be determined from literature searches and consultation with experts
For example, Clostridium difficile<table><tr><td>Genus</td><td>Clostridium</td></tr><tr><td>Species</td><td>difficile</td></tr></table>The persistence of and efficacy of disinfection techniques can be determined by agent species, genus or family</td><td><table><tr><td>Genus</td><td></td></tr><tr><td>Species</td><td></td></tr></table></td><td></td></tr>
<tr><td>Organism form</td><td>Bacteria, bacterial spore, virus, fungi, parasite, oocyte</td><td>The form of the organism will help to determine the persistence of the agent and types of disinfection methods that are most effective for decontamination. It is possible that more than one form may be present, in which case the method of disinfection should consider the more resistant form
For example, alcohol-based solutions are very effective for disinfection of some vegetative bacteria; however, they are ineffective against bacterial spores</td><td></td><td></td></tr>
<tr><td>Persistence</td><td>How long will the agent survive in the environment?</td><td>How long a biological agent can persist in the environment will influence which recovery options should be considered for the remediation strategy (consult the persistence database)
An additional factor that should be considered is 'What is the environment used for?' This may also influence which recovery options are selected
For example, protective options (restrict public access) could be used if an agent has limited persistence (1–2 days) as natural inactivation (natural weathering) would eliminate the agent from the environment. However, this would not be appropriate for persistent agents, more active decontamination or removal options need to be considered</td><td></td><td></td></tr>
<tr><td>Resistance</td><td>Is the agent known to be resistant to disinfection processes or methods?</td><td>If the biological agent exhibits increased resistance to a disinfection method (eg vapour hydrogen peroxide) then alternative recovery options should be considered (consult the disinfection database)
Repeating disinfection with more effective disinfection techniques may result in delays and increase costs for remediation</td><td></td><td></td></tr>
</table>

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Person to person spread/route of transmission	Can the agent be spread from person to person or animal to human? How is the agent infectious? (gastrointestinal/inhalation) Is the agent zoonotic?	Further recovery options might be necessary to stop the spread of the agent from person to person The route of transmission will affect the prioritisation of recovery from the agent *For example, a scenario where an agent causes gastrointestinal upset but is not infectious through the aerosol route may lend more time to develop a recovery strategy than a scenario with highly infectious or contagious agents that would need to be dealt with as a priority*		
Prophylaxis, vaccination and treatment	Is there medical intervention available with activity against the agent?	The risk to the public and workers will be increased if there is no prophylaxis or treatment available		
Hazard group	What is the ACDP hazard group of the agent?	Agents with a hazard group of 3 or 4 are more likely to cause serious infection and pose a significant risk to public health The recovery from incidents involving hazard group 3 or 4 agents could have increased cost implications, may take longer to remediate, require appropriate levels of worker PPE, and may involve specialist techniques		
Production of toxins	Does the agent produce a toxin? What is the stability of the toxin?	Toxins might persist in the environment after the destruction of the parent agent. Therefore consideration should be given to potential release of harmful toxins from the parent agent. Additionally, they may also be volatile and therefore difficult to contain Recovery options will need to be effective against the parent agent and subsequent toxins (eg mycotoxin). Seek expert advice and guidance for information on toxicology of toxic compounds Some toxins are heat resistant and may not be inactivated by processes used to inactivate microbial agents		
Background level of agent	Are the levels of the agent within the environment before the incident known?	This level will determine the extent of the contamination and the levels that need to be achieved during decontamination. The recovery phase must return the agent's level to at least the background amount		
Will the agent multiply in the environment?	Is the agent able to replicate in the environment in which it is found?	If the agent has the ability to replicate in the environment in which it is found then the level and spread of contamination could increase If the agent can replicate in the environment then the decontamination recovery options will need to be employed earlier to limit the growth and spread of the agent. This will be further dependent on the environmental conditions at the time, including the availability of water and nutrients, the relative humidity and the ambient temperature		

Step 2 Consult decision tree/diagrams for inhabited areas

The decision tree should be consulted (Figure 6.3); this guides the user through a number of questions investigating the affected environment and purpose of the contaminated area. The decision tree also highlights any immediate protection options that should be considered. The protection recovery options shown in the yellow boxes are there to identify options that should have been implemented during the response phase. If they are deemed appropriate to the incident but have yet to the implemented they can be put in place during the recovery phase. Examples on how the decision steps should be used are located in Chapter 10 of this handbook; further help can be sought by contacting PHE.

The decision tree then leads into Figure 6.4, which identifies applicable recovery options that are specific for each type of contaminated surface found in the inhabited area. This step will need be repeated for each different surface type identified to select the relevant recovery options.

This step is essentially an ‘inclusive’ step, identifying all potentially applicable recovery options prior to the elimination of options which will be carried out in Steps 3–5. Table 6.6 has been produced to allow the user to record the recovery options that have been identified as potentially applicable for use in remediation of the incident. As the user works through Steps 3–5 then this table can be used to identify if the option is still applicable and whether it should be removed from consideration. The reasons for removal should be recorded in the spaces provided; these can be used later in the review of the recovery of the incident and during the production of the report. This will allow anyone auditing the choices made during the remediation to ascertain why recovery options were not used and allows for a clear and open decision-making process.

The selection tables (Figure 6.4) include recovery options for the following surfaces:

- external building surfaces (including street furnishings, eg bricks, concrete and steel)
- internal building surfaces and objects (including furniture, carpets and personal items)
- semi-enclosed areas (eg surfaces in subways/train stations)
- roads and paved areas
- vehicles (including aeroplanes, cars, trains and boats)
- soil and vegetation (eg grass shrubs, plants and trees)

In some instances, there may be cross-over between sections of the handbook – food production systems (Chapter 4) and water environments (Chapter 8) – if other environments have been contaminated. This is highlighted in Figure 6.3 where applicable.

Table 6.6: Recording and analysis of identified recovery options

Recovery option name	**Step 1** Obtain information regarding the incident	**Step 2** Identify preliminary options for affected inhabited area (refer to Figures 6.3 and 6.4)	**Step 3** Determine applicability of recovery options, eliminate options on:		**Step 4** Review key considerations and constraints (refer to Table 6.8)	**Step 5** Consult recovery option sheets (Chapter 7)	**Option applicable?**	**Reason for elimination?**
			3A Agent characteristics (refer to Table 6.5)	**3B** Effectiveness of option (refer to Table 6.7)				

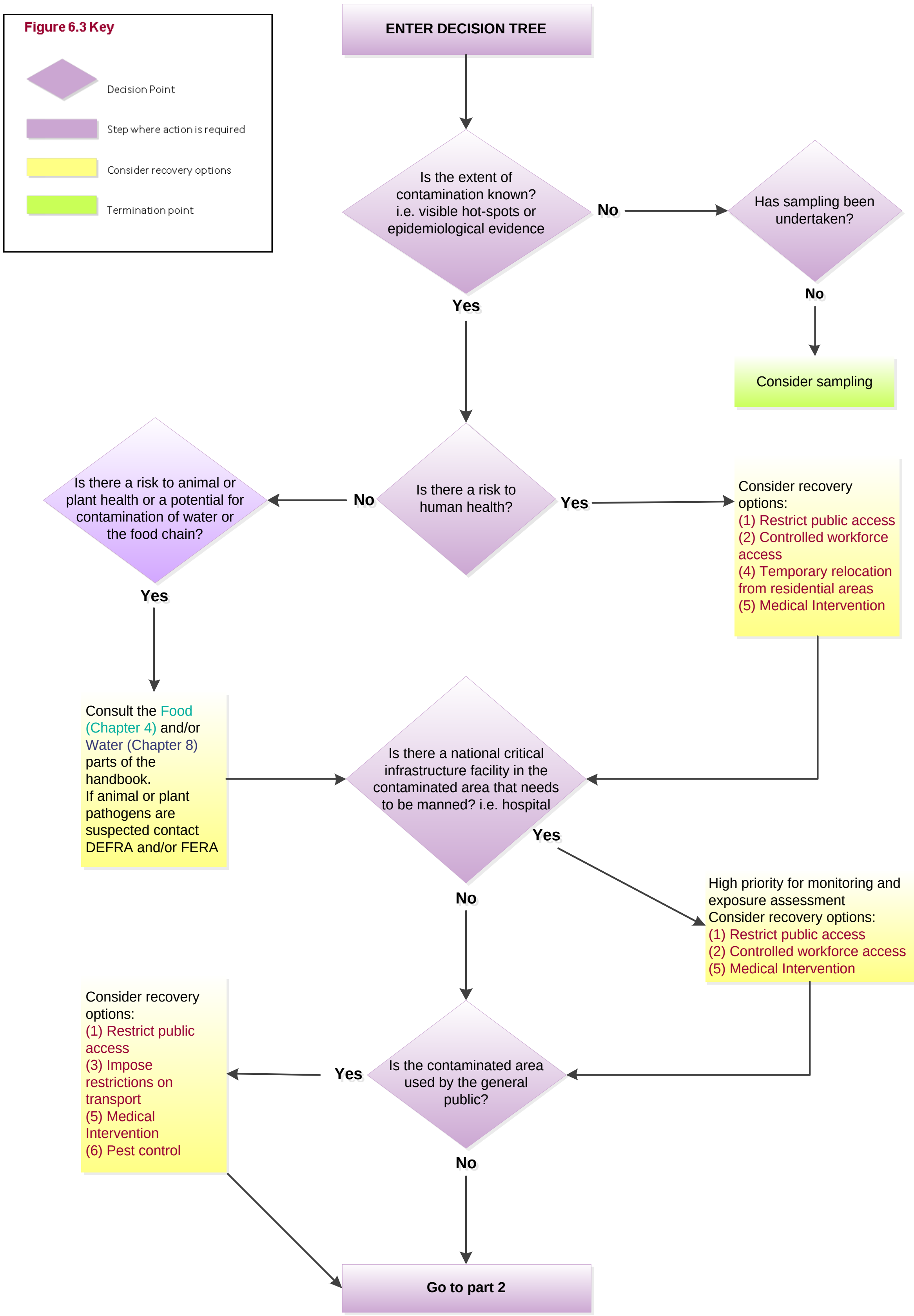

Figure 6.3: Inhabited areas decision tree (part 1)

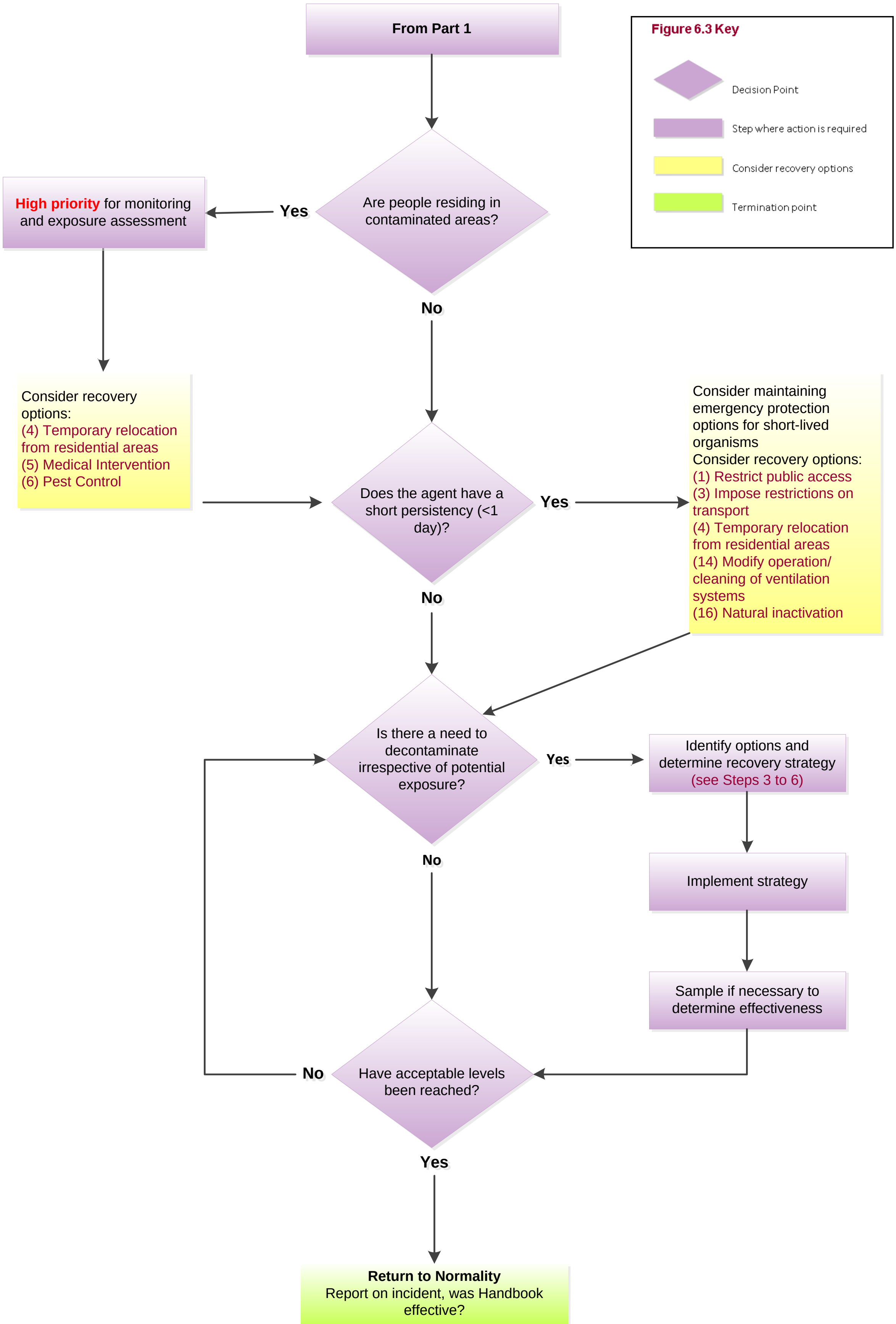

Figure 6.3 *(continued)*: Inhabited areas decision tree (part 2)

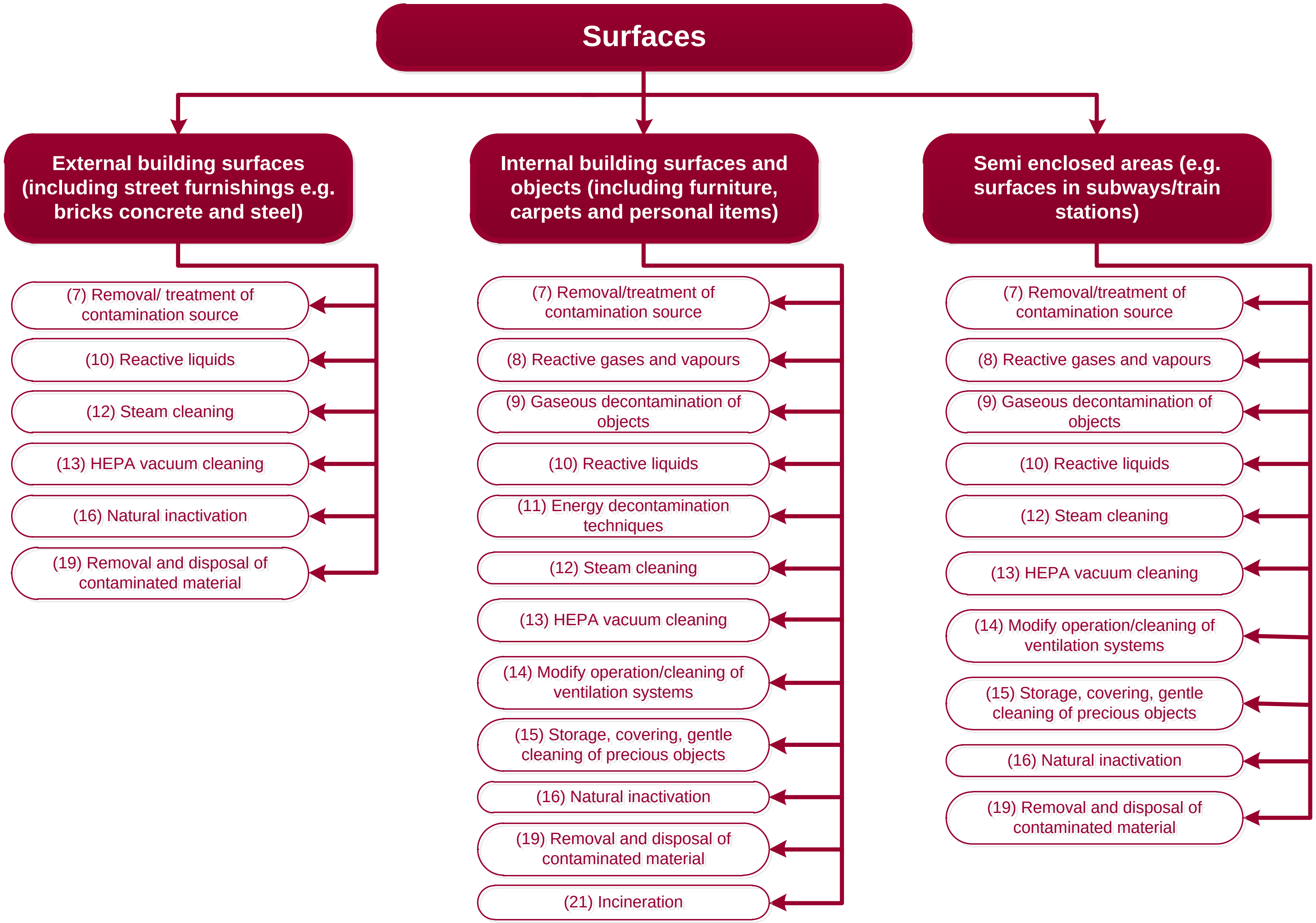

Figure 6.4: Surfaces in inhabited areas

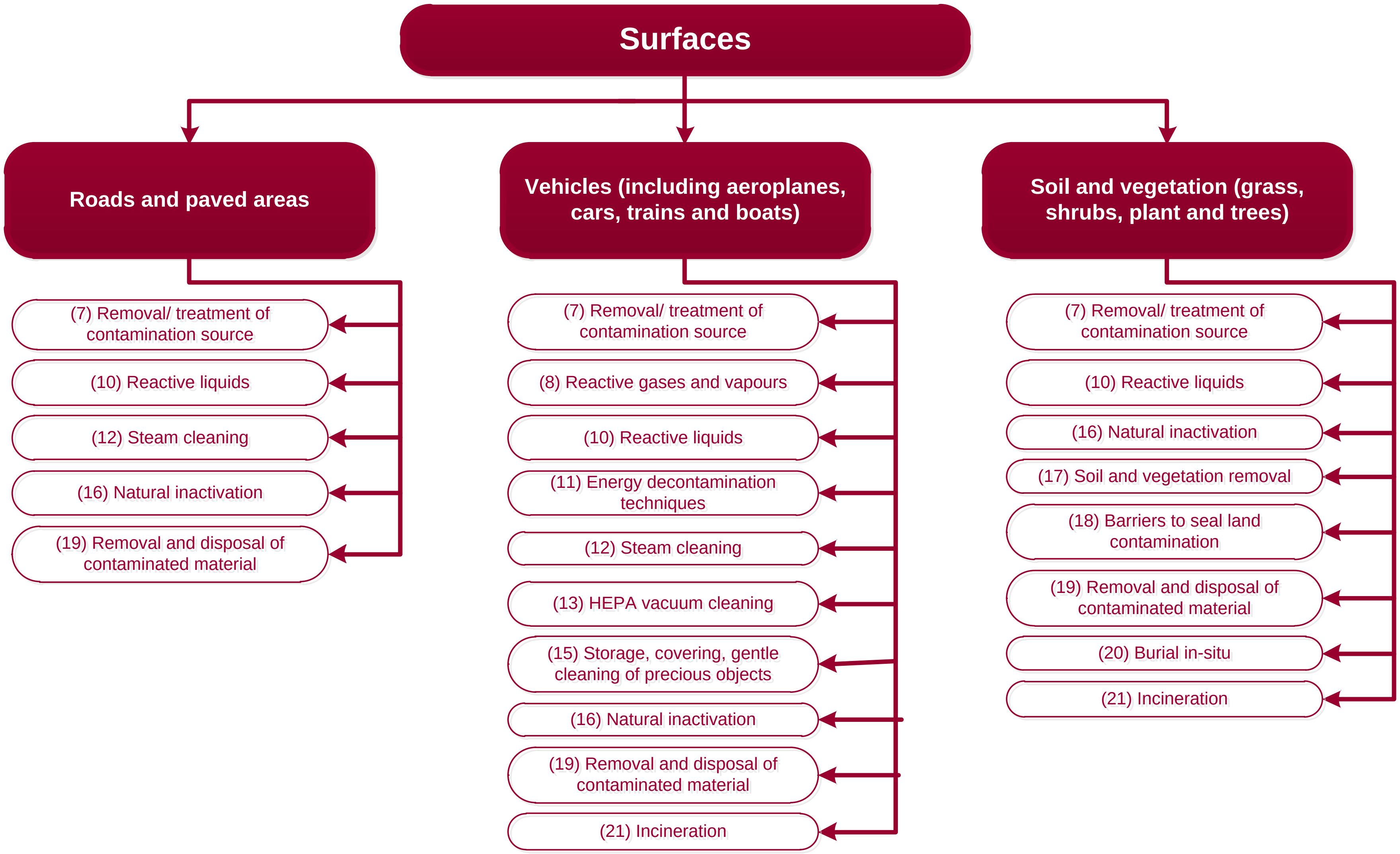

Figure 6.4 *(continued)*: Surfaces in inhabited areas

Step 3 Review effectiveness of recovery options

A Elimination of recovery options based on biological characteristics only

At this stage, expert advice should be sought to determine and interpret the biological characteristics of the agent(s), using data identified in Table 6.5 (Step 1) to assist in eliminating any of the recovery options identified in Step 2. For example, if information obtained in Table 6.5 indicates that there is no available medical treatment, vaccination or prophylaxis for an agent then the recovery option (5) Medical intervention can be eliminated at this stage. It should be noted that agent data will only be useful for elimination of certain recovery options and may not be applicable in all cases.

B Elimination of options based on recovery option effectiveness

Determining which recovery options may be further eliminated can be achieved by considering the surface type in more detail. The different surface/area categories can be further broken down into different types of material, eg soil, plastic, concrete, wood and glass (see also Table 6.3). The different types of surface material may affect how biological contaminants are effectively decontaminated. The types of contamination and surface can influence the effectiveness of a recovery option in removing biological contamination; these are summarised below (see also Table 6.7) and need to be considered.

Types of contamination

- free – biological contamination is free on a non-absorbent surface (eg powder or liquid lying on a steel or laminate flooring)
- absorbed – biological contamination is absorbed into a surface (eg into an absorbent material such as wood or fabric)
- inaccessible – biological contamination has occurred within an inaccessible surface (eg between a screw and bolt)

Type of surface material

- robust surface – can normally withstand potentially damaging decontamination techniques (eg steel and glass)
- sensitive surface – are less likely to withstand, or for which it is unacceptable to use, potentially damaging decontamination techniques (eg historical brick building, upholstered fabrics and electrical equipment)

Shading is used in Table 6.7 to give an indication of whether remediation options would be ‘up to 100% effective’, ‘potentially effective’ or have ‘limited effectiveness’. The classification used in the selection tables is intended to be a generic guide and is not agent specific. The grading used in Table 6.7 is based on evaluation of the current evidence (ie previous incidents), stakeholder experience, advice and ongoing decontamination research. Therefore Table 6.7 should be evaluated in conjunction with the biological characteristics of the agent under consideration (see Table 6.5) and with expert advice from relevant agencies (see Appendix E).

A recovery option should only be eliminated if it is deemed to have ‘limited effectiveness’ (dark shading) for contamination type ***OR*** surface type and there are other, more effective recovery options available. It should be noted that if a recovery option is deemed to have ‘limited effectiveness’ this does not mean that it is ineffective but that the option may only partially remove any residual contamination; it may still need to be used if it is the only option available. Similarly, if an option is deemed to have a ‘high’ increased exposure risk this may mean that a higher level of PPE is required for implementing this recovery option if it is the only option available. If it is not possible to readily eliminate a recovery option at this stage then it should be retained for consideration in Step 4.

Implementation of ‘protection’ recovery options (eg temporary relocation) is not influenced by the surface material or type of contamination so cannot be eliminated at this stage.

Therefore, options are considered to be applicable if:

- there is direct evidence that it would be effective for the agent (known applicability)
- the mechanism of action is such that it is highly likely to be effective for the agent (probable applicability)

An option is taken as not being applicable if one or more of the following criteria are met:

- there is direct evidence that the option would not be applicable to the agent
- the agent’s properties are such that the option would not be expected to have any effect
- the hazard posed by the agent would not be reduced
- the time taken to implement the recovery option would be longer than the agent’s persistence in the environment
- there is a risk that implementing the recovery option could make the hazard worse (eg aerosolisation)
- implementation of this option would place operatives at an unacceptable risk

Table 6.7: Overview of recovery option effectiveness

Key: Effectiveness	Up to 100% effective		Potentially effective		Limited effectiveness
	Efficacy for type of contamination and surface material				
	Surface type		Contamination type		
Recovery options	Robust	Sensitive	Free	Absorbed	Inaccessible
Protection options					
(1) Restrict public access	N/A	N/A			
(2) Controlled workforce access	N/A	N/A			
(3) Impose restrictions on transport	N/A	N/A			
(4) Temporary relocation from residential areas	N/A	N/A			
(5) Medical intervention	N/A	N/A			
(6) Pest control	N/A	N/A			
Remediation options					
(7) Removal/treatment of contamination source	N/A	N/A			
(8) Reactive gases and vapours					
(9) Gaseous decontamination of objects					
(10) Reactive liquids					
(11) Energy decontamination techniques					
(12) Steam cleaning					
(13) HEPA vacuum cleaning					
(14) Modify operation/cleaning of ventilation systems					
(15) Storage, covering, gentle cleaning of precious objects					
(16) Natural inactivation					
(17) Soil and vegetation removal	N/A	N/A			
(18) Barriers to seal land contamination					
Waste disposal options					
(19) Removal and disposal of contaminated material					
(20) Burial in-situ					
(21) Incineration					

An example of how to interpret Table 6.7 is given below (Table 6.7a) for an incident where biological contamination is absorbed on a sensitive surface.

Table 6.7a: Interpretation of recovery option effectiveness data

Recovery option	Efficacy for type of contamination and surface material					Interpretation
	Surface type		Contamination type			
	Robust	Sensitive	Free	Absorbed	Inaccessible	
A						Eliminate option – likely to damage surface
B						Eliminate option – not effective for absorbed contamination
C						Retain option but may only partially remove contamination
D						Retain option but may only partially remove contamination and potentially damage surface
E						Retain option but may potentially damage sensitive surfaces
F						Retain option

Step 4 Review key considerations and constraints

Each recovery option will have a number of considerations or constraints associated with its implementation. Table 6.8 describes some of the key issues (public health, waste, social, technical, cost and time) for each recovery option. More detailed descriptions of these considerations can be found in the recovery option sheets (Chapter 7). Tables 6.8, 6.9 and the recovery option sheets in Chapter 7 can be used to further eliminate recovery options based on their constraints and considerations.

Table 6.8 gives an overview of the major and moderate considerations for the recovery options. The classification used in the table is intended to be a generic guide and is not agent specific. The considerations used in this table are based on evaluation of the evidence (ie previous incidents), stakeholder experience and advice or ongoing decontamination research. Major considerations, while not applicable in all incidents, identify issues that might prohibit the use of the recovery option and should be considered in more detail to ensure they will not affect the remediation strategy. Moderate considerations highlight areas that can cause a recovery option to be limited in its effectiveness, such as having an effective media strategy to keep the public informed during that recovery option. Minor considerations have not been included in the table because they will depend more strongly on each individual incident compared to the major and moderate considerations, so can be thought of during the decision-making process by the recovery coordination group (RCG). Table 6.8 should be evaluated in conjunction with the biological characteristics of the agent under consideration (see Table 6.5) and with expert advice from the relevant agencies (eg PHE and GDS, see Appendix E).

If an important (key) constraint is identified, it does not indicate that the recovery option should necessarily be eliminated but that this constraint will need to be taken into consideration when evaluating the option as this may be the only option available.

Options can be eliminated based on their constraints:

- public health – implementation of the option would increase the risk to public health
- waste – would produce more waste than other available options
- social – would be socially unacceptable when other more acceptable options are available
- technical – would take longer to implement than the persistence of the agent or requires more technical expertise than other available options
- cost – would cost more than other available options
- time – would take longer to implement than other available options

Table 6.8: Overview of considerations for recovery options for inhabited areas

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Protection options		
(1) Restrict public access	**None**	**Social** – Effective communication is required to inform the public about the restriction and the potential health risks posed by the contaminant with the aim of ensuring compliance. Possible disruption and restricted access to an area may not be well received by members of the public, with pressure to reopen the area **Cost** – Travel implications and cost associated with redirecting people
(2) Controlled workforce access	**None**	**Waste** – Waste may be generated from used/contaminated PPE worn by recovery workers. This will have to be disposed of in an appropriate manner **Social** – There may be issues with compliance, guards may need to be appointed to prevent access **Technical** – For this measure to be successful, appropriate PPE will need to be distributed to the workforce that requires entry, eg in manned infrastructure, and to recovery workers **Cost** – This measure may prove expensive if guards are needed to prevent access and if large amounts of PPE for recovery workers are needed, eg respirators
(3) Impose restrictions on transport	**Social** – There may be issues with compliance. Disruptions to normal travel, disruptions to transport which may delay emergency vehicles and people requiring the urgent use of vehicles may not be perceived well by the public. Effective communication will therefore be required to deliver information on access to emergency services vehicles – ambulance etc – and possible alternative transport methods	**Technical** – For this measure to be implemented successfully road blocks need to be erected, combined with notices, signs and traffic cameras

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(4) Temporary relocation from residential areas	**Social** – Evacuation can be a disturbing exercise to the community. In some cases it can be difficult to ensure compliance, eg local business owners may resist leaving an area. Residents cannot be forced to leave their homes **Technical** – To minimise the social disruptions caused by relocation, certain measures should be taken to assist the process, eg leaflets containing important information for people being relocated need to be distributed (effective communication). Transport availability needs to be considered to aid the relocation process, especially if the affected area has an elderly population or people with disabilities (population profile). Additionally, an effective monitoring strategy needs to be implemented to determine the risk of adverse health effects to occupants upon return to the area **Cost** – This measure can prove to be expensive for local authorities responsible for relocating residents from an affected area. Cost is also influenced by the length of time for which residents will be temporarily relocated and the quality of the temporary housing offered (hotels versus hostels)	**Time** – This measure would need to remain in place as long as the contamination is being investigated/remediated, which could extend for months
(5) Medical intervention	**Technical** – It may be difficult to administer prophylaxis and/or vaccinations to everyone who needs it. Medical professionals will be needed to administer these treatments **Cost** – The cost of this measure will be influenced by the number of people needing treatment, the cost of the treatment itself and the number of medical professionals needed to administer the treatment	**Social** – Effective communication is required to inform the individuals at risk that treatment may be necessary and to avoid panic among the general public **Time** – This option could extend for large periods of time as those affected and/or 'at risk' will need to be identified and then brought in for treatment. These people will then need to be continually monitored over a set period of time, which could extend for months
(6) Pest control	**Technical** – This is likely to have to be sourced externally from specialist contractors **Cost** – This option could be quite costly depending on the extent of pest control needed	**Public health** – Large numbers of carcasses that are not cleared up immediately have the potential to spread further disease **Waste** – This option could result in large quantities of waste and the need to dispose of contaminated carcasses **Social** – It may be unacceptable to the public to see pest control measures being undertaken, especially if this results in a large number of carcasses being in view of the public. It would be necessary to remove any carcasses as soon as possible
Remediation options		
(7) Removal/treatment of contamination source	**Time** – This option will need to be undertaken prior to any other remediation option being carried out	**Technical** – There may be problems with accessibility as the contamination source might be in an inaccessible location **Cost** – This will be dependent on the incident in question due to the accessibility and type of contamination

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(8) Reactive gases and vapours	**Cost** – This option will require specialist equipment and trained personnel to carry out the procedure. This is likely to be sourced externally and could be quite costly	**Social** – This option has the possibility of damaging surfaces and personal objects and people may be anxious about possible damage to their belongings and homes **Technical** – This option will require specialist equipment which will need to be externally sourced from specialist companies. It is possible that multiple applications will be necessary to remove all of the contamination **Time** – The time taken for this option to be implemented has the potential to be lengthy, especially if multiple applications are needed
(9) Gaseous decontamination of objects	**Technical** – This option will require specialist equipment which will need to be externally sourced from specialist companies. It is possible that multiple applications will be necessary to remove all of the contamination **Cost** – This option may prove quite costly depending on the equipment needed and the number of objects to be decontaminated	**Time** – The time taken for this option to be implemented has the potential to be lengthy, especially if multiple applications are needed
(10) Reactive liquids	**None**	**Waste** – This option may produce contaminated waste and/or large volumes of liquid that need to be disposed of correctly or may require storage under a waste transfer licence
(11) Energy decontamination techniques	**Technical** – This option may require specialist equipment and suitably trained personnel. It is possible that multiple applications will be necessary to remove all contamination **Cost** – As this option requires specialist equipment, the cost may be quite high	**Time** – The time taken for this option to be implemented has the potential to be lengthy, especially if multiple applications are needed
(12) Steam cleaning	**None**	**Waste** – Produces water-based wash solutions that are likely to be contaminated, which may require disposal and/or storage under a waste transfer licence **Time** – Maximum effectiveness is achieved when carried out soon after a biological incident; this is when the maximum concentration of the contaminant is still on the surface, as with time weathering could disperse the contaminant into the surrounding environment if the contamination is outside
(13) HEPA vacuum cleaning	**None**	**Waste** – Potential for large amounts of dust-contaminated filters which may have high contamination levels being generated. This waste may require disposal and/or storage under a waste transfer licence **Technical** – The nature and condition of the surface in question can determine the effectiveness of this measure, eg vacuuming is not very effective on wet soot
(14) Modify operation/cleaning of ventilation systems	**None**	**Technical** – It may be difficult for workers to access ventilation systems to clean them effectively

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(15) Storage, covering, gentle cleaning of precious objects	**Time –** This option may prove lengthy if objects need to be stored for long periods of time prior to cleaning	**Public health** – Cleaning of objects can liberate the contaminant so precautions should be taken to avoid the spread of further contamination **Social** – People may be anxious about cleaning methods causing damage to their belongings **Technical** – If objects need to be stored prior to cleaning then storage facilities will be needed. Specialist cleaning chemicals may be required as to not damage precious objects **Cost** – This option can prove costly if storage facilities are needed for long periods of time. Consultation with experts depending on nature of items contaminated, eg valuable items
(16) Natural inactivation	**Technical** – Monitoring equipment and skilled personnel are needed to take samples. This method may take a prolonged period of time for the contaminant to be broken down in the environment. The length of time is partly dependent on the location of the area in question, eg allowing biological inactivation in a building would take a significantly longer period of time than in an outdoor area. Also this option may be more feasible for rural areas rarely used, in comparison to an commercial district which would need a more urgent remediation due to social pressures **Time** – This option may prove to be lengthy if the contaminant is quite persistent and could last for months	**Social** – This option may be perceived as doing 'nothing' by the public, which may have negative implications **Cost** – May be high, considering monitoring equipment, consumables, skilled personnel (including laboratory analysis) and time
(17) Soil and vegetation removal	**Social** – May cause damage to habitats and biodiversity. May also cause soil erosion **Cost –** Tools and/or vehicles needed to remove soil and vegetation can be quite costly. If it is decided to replace soil and vegetation with concrete or tarmac then this may also increase the cost	**Waste** – Large quantities of contaminated soil and vegetation likely to be produced, which will require appropriate disposal **Technical** – Effectiveness of this measure depends on the biological properties of the contaminant. An effective monitoring strategy also needs to be implemented **Time –** This option could prove to be lengthy if large areas of soil and vegetation need to be removed
(18) Barriers to seal land contamination	**Technical** – To determine the extent and depth of the barriers to be installed, site-specific assessments are required initially, which include geology, hydrology and local availability of possible materials for use in the vapour barriers. As an additional protection measure, houses built on top of vapour barriers need to have gas protection measures in place. An effective and long-term monitoring of the barriers is recommended as post-work strategy	**Social** – Residents living in a contaminated area may be anxious about the possibility of aerosols leaking into their homes. An effective communication strategy also needs to be implemented to address these health concerns **Cost** – Could prove to be expensive, due to machinery required, surveys conducted, labour costs, extra protection measures required and long-term monitoring **Time** – Barriers may be placed for long periods of time or remain indefinitely

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Waste disposal options		
(19) Removal and disposal of contaminated material	**Waste** – This option is likely to generate large amounts of contaminated material, which will require disposal and/or storage under a waste transfer licence **Social** – Entering homes to remove contaminated objects can be disruptive to residents. Compliance issues can arise if personal items such as clothes or home appliances are being removed and are not covered by compensation packages **Cost** – Likely to be high. Dismantling is a highly labour intensive process. Additionally, the large amount of waste generated will be costly to dispose of appropriately	**Technical** – Contaminated material needs to be packaged properly before removal from a contaminated environment to prevent the spread of contamination
(20) Burial in-situ	**Social** – Potentially significant resistance from residents in the area against burial of contamination in-situ as well as transporting the waste through/nearby the inhabited areas. Effective communication will be required to keep the public informed and address health concerns **Technical** – This method requires specialised engineering expertise and materials, which depend on the nature of the contaminant in question, eg water solubility, in order to construct an effective membrane to contain the biological agent. A suitable and robust monitoring programme will also need to be implemented to ensure the membrane remains intact	**Public health** – There is potential for future contamination of a site as the contamination may make its way to the surface **Cost** – Likely to be expensive due to transportation needs, specialised engineering expertise and the cost of the materials used to construct an effective membrane to line basins **Time** – This option may take a long time to complete and the site may still have restricted access until monitoring confirms that there is no more contamination
(21) Incineration	**Cost** – The cost of this option depends on the amount of contaminated material to be incinerated, certain incinerators can only burn waste of a small size	**Technical** – Incineration facilities need to be informed of the type and amount of waste that needs to be dealt with prior to transfer. If the facility is unable to take the waste straight away, it may need to be stored

Step 5 Consult recovery option sheets

Individual recovery option sheets (Chapter 7) can now be referred to for all remaining options that have been identified in the selection process. This step involves a detailed analysis of all remaining options by careful consideration of the information presented in the recovery option sheets. This step can only be completed on an incident-specific basis and in close consultation with local stakeholders to take into account local circumstances.

Step 6 Compare the remaining recovery options

The remaining recovery options now need to be compared and evaluated to eliminate any further options that may not be required. For example, if the remaining options include (8) Reactive gases and vapours and (10) Reactive liquids and it has been determined that these options are both effective and applicable for the contaminated area, then one of the options can be eliminated as both may not need to be used.

Once a recovery strategy has been implemented, the remaining steps are to monitor to determine if the recovery strategy has been effective and to report on the incident and subsequent response, including the effectiveness of the handbook (see Figure 6.2). These steps are outside the scope of the handbook and are not discussed further.

6.7 References

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7 Inhabited Areas Recovery Options

(1) Restrict public access

(2) Controlled workforce access

(3) Impose restrictions on transport

(4) Temporary relocation from residential areas

(5) Medical intervention

(6) Pest control

(7) Removal/treatment of contamination source

(8) Reactive gases and vapours

(9) Gaseous decontamination of objects

(10) Reactive liquids

(11) Energy decontamination techniques

(12) Steam cleaning

(13) HEPA vacuum cleaning

(14) Modify operation/cleaning of ventilation systems

(15) Storage, covering, gentle cleaning of precious objects

(16) Natural inactivation

(17) Soil and vegetation removal

(18) Barriers to seal land contamination

(19) Removal and disposal of contaminated material

(20) Burial in-situ

(21) Incineration

(1) Restrict public access

Objective	To reduce potential exposure of the public to biological contamination from within the contaminated area
Other benefits	Will prevent the spread of further contamination through human activity. Any necessary recovery options can be implemented more easily while the population is absent from the area
Recovery option description	This is a fixed recovery option. It should be used in the first instance for all biological incidents to prevent public exposure and the risk of disease while limiting the spread of contamination This option could be potentially implemented in the short, medium or long term Temporary restriction (prohibition) of access to non-residential areas: recreational areas are initially likely to be a lower priority for clean-up and so restricting access may be necessary prior to any clean-up being implemented Temporary restriction (prohibition) of access to residential/commercial areas: commercial districts of cities/towns and residential areas are likely to be a higher priority for clean-up and remediation, which will be facilitated by restricting access Temporary restriction (prohibition) of access in hospitals and health care facilities: remediation of an outbreak of infection will be a high priority but it probably will not to be possible to restrict access to everyone or over a long period of time. Likely actions taken under this recovery option include restricting access to the visiting public, closing wards to new admissions and cohorting affected patients into isolation rooms or wards Temporary restriction of access may be enforced while the clean-up and remediation is being implemented. Partial restrictions cannot be controlled and it will not be possible to control exposure received by members of the public Restriction of public access requires appropriate security measures (including signs, barriers and cordons) Land is only likely to be fenced off in the long term if it is deemed necessary. Public rights of way would be controlled with notices and barriers Public health legislation allows for the restriction of some land and building use
Key information requirements	What is the contaminant? What are the contaminant's characteristics? Magnitude of contaminated area What are the land use and demographics of the affected area (eg city centre)? Is access needed to commercial, industrial, educational or public facilities?
Linked recovery options	This is a protection option and should be linked to remediation options This option can be used in conjunction with (2) Controlled workforce access, (3) Impose restrictions on transport and (4) Temporary relocation from residential areas
Target environment	People living in, working in or visiting contaminated areas
Targeted organisms	This recovery option is applicable to ***ALL*** biological agents that pose a risk to public health. However, the properties of the biological agent will influence implementation of this option. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Inhalation, dermal (skin) and ingestion of biological agent
Time of application	This option should be implemented as soon as the risk is identified. There is maximum benefit if it is carried out soon after contamination. However, there are no time limits associated with this option; it can be applied at any time and for any duration

Considerations

Public health considerations	None
Legal implications and obligations	Seek specialist advice and guidance. This recovery option may require legislation to restrict access to land, depending on ownership
Social implications	There may be issues with acceptability of this option (and enforcement). Partial restrictions cannot be controlled and it will not be possible to control exposure received by members of the public This option may result in the loss of access to public amenities. There is a risk that there could be a change in public perception/acceptance of the affected area (eg recreational areas and city centres), which may affect public confidence There may be large amounts of pressure to re-open the affected area An effective public information strategy will be essential

(1) Restrict public access

Environmental considerations	Prohibition of access to the countryside may benefit fauna and flora
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	Exposure should be reduced significantly if implemented and enforced appropriately. The effectiveness of this recovery option increases the earlier it is implemented
Technical factors influencing effectiveness of recovery option	Small areas of residential accommodation are often found in largely commercial and industrial areas Suitable alternative provision Effective exclusion of people from an area may be difficult to demonstrate Success of barriers and fences and policing/monitoring of restrictions (if used)
Feasibility and intervention costs	
Specific equipment	Signs, barriers and fencing
Utilities and infrastructure	None
Consumables	Signs and barriers
Skills, personnel and operator time	Security may need to be posted in some circumstances Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of contaminated area that requires restriction of public access (eg recreational area and commercial districts)
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Costs may be influenced by: • size of area(s) where public access is to be restricted • possible need to regulate access to certain areas (eg access to a national critical infrastructure facility) • erecting and manufacturing signs and barriers • policing/monitoring restrictions • provision of suitable alternatives
Waste	
Amount and type	None
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Potential exposure of members of the public will be reduced by 100% if access is quickly and effectively restricted There may be issues with public acceptability and compliance (partial restrictions cannot be controlled and it will not be possible to control the exposure received by members of the public) Population habits: for example, if people do not spend significant quantities of time in areas where access is restricted, this option will not reduce the overall exposure Success of cordons (if used)

(1) Restrict public access

Potential increased worker exposure	None

Other considerations

Agricultural impact	This will depend on the nature of the affected area (eg farmland or urban). There may be animal welfare issues (eg provision of feed) that should be considered. Seek specialist advice and guidance Some pathogens are notifiable to Defra. A list of these pathogens can be found at https://www.gov.uk/government/collections/notifiable-diseases-in-animals
Compensation issues	There may be requests for compensation for costs associated with loss of trade and earnings (eg manufacturing processes or transport of goods) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

Additional information

Practical experience	The US Department of Justice Mail Facility at Landover, Maryland, was closed and all access was restricted after intentional contamination of mail with anthrax spores (Canter, 2005)
Key references	Canter DA, Gunning D, Rodgers P, O'Connor L, Traunero C, Kempter CJ. Remediation of Bacillus anthracis contamination in the US Department of Justice mail facility. Biosecur Bioterror. 2005 Jun;3(2): 119–27 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	This is a fixed recovery option and should be implemented in the first instance for all biological incidents to prevent public exposure and the risk of disease
Document history	

(2) Controlled workforce access

Objective	To enable the minimum number of workforce personnel necessary to remain in a contaminated area on a limited basis to keep essential services and infrastructure operating (such as power stations or hospitals). The workforce may be required to wear PPE and follow prescribed precautions
Other benefits	Any necessary recovery options may be implemented more easily while the (non-workforce) population is absent from the affected area Enables remediation workers and emergency services to safely access the contaminated area and also will allow for monitoring the exposure of individuals to the contamination
Recovery option description	This is a fixed recovery option. It should be used in the first instance for all biological incidents to prevent public exposure and the risk of disease Work environments can be controlled (in terms of the people who are allowed to enter a workplace, the time that workers spend there and the use of appropriate PPE). Employers have a duty of care towards their employees; therefore it will not generally be acceptable for employees to work in a contaminated area where access of the general population to the area has been or is likely to be prohibited For employees who are providing essential services, restricted access may be used with close monitoring of their potential exposure For emergency services and remediation workers, appropriate PPE and decontamination stations should be employed to reduce exposure and spread of contamination In smaller incidents, members of the public may be allowed to enter the contaminated area provided that they comply with safety and infection control procedures This recovery option would require an appropriate risk assessment depending on the biological agent and the level of contamination, and may be enforced while remediation options are being implemented. Vaccination and preventive prophylaxis may be offered to the workforce where appropriate
Key information requirements	What is the biological agent? What are the occupational health restrictions or relevant exposure limits/levels? What is the mode of acquisition of the biological agent? Are any of the workforce immunocompromised or otherwise predisposed to infection? What essential infrastructure requires operating?
Linked recovery options	This is a protection option and should be linked to remediation options This option is likely to be combined with (1) Restrict public access and (5) Medical intervention
Target environment	Individuals working in contaminated areas
Targeted organisms	This recovery option is applicable to ***ALL*** biological agents that pose a risk to public health. However, the properties of the biological agent will influence application of this option and whether or not it is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Inhalation, dermal (skin) and ingestion of biological agent
Time of application	This recovery option should be implemented as soon as the risk is apparent. There is no time limit on this recovery option

Considerations

Public health considerations	Potential for exposure of the public to biological contamination to continue (if protocols are not adhered to) Potential for exposure of workforce if correct PPE/decontamination is not used. Possible use of prophylaxis for workers
Legal implications and obligations	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace
Social implications	Compliance with restricted access times and correct use of PPE by workers Remediation workers may not be willing to enter or work in a contaminated environment Loss of public amenities

(2) Controlled workforce access

Environmental considerations	Buildings or outdoor areas may not be maintained. There may be animal welfare issues if the contaminated area includes animal facilities
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). Workers may not want to enter or work in a contaminated environment
Effectiveness	
Recovery option effectiveness	Variable, depending on the properties of the biological agent, level of contamination and time spent by workers in the workplace
Technical factors influencing effectiveness of recovery option	Amount and type of PPE required by the workforce
Feasibility and intervention costs	
Specific equipment	PPE for the workforce entering the affected area will depend on the type of contaminant and may range from overshoes and overalls, up to respirators
Utilities and infrastructure	System to control and monitor exposure of workforce System to control number of personnel in the affected area Air locks and decontamination stations might be necessary depending on the biological agent
Consumables	Gloves, face masks, overalls and overshoes
Skills, personnel and operator time	Seek specialist advice and guidance. Operator time and personnel requirements will vary depending on the size and scale of the biological incident where controlled workforce access is implemented as a recovery option
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance. Monitoring health and safety when there is only a skeleton workforce in an establishment may be required Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers will have to comply with Health and Safety at Work etc Act (HSWA) to ensure that workers entering the contaminated area use appropriate PPE Specialist PPE such as suited systems may require additional monitoring, including workers temperature and exposure to noise levels
Other limitations/ factors influencing costs	Size of area(s) where access is restricted Environmental monitoring, exposure assessment and biomonitoring of the workforce
Waste	
Amount and type	Disposal of PPE and other work-associated items which now may be considered contaminated waste. This should be the responsibility of the asset owner but the local authority may be approached for help Many types of waste that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Contaminated PPE may be considered as hazardous waste and may require treatment before disposal, eg autoclaving. Storage and/or transport may be necessary if there is no available on-site treatment or disposal facility. Seek specialist advice and guidance
Factors influencing waste issues (eg cost)	Waste disposal routes may be dependent on the hazard rating of the biological agent
Exposure	
Averted exposure	Exposure of workers who are required to work in contaminated areas will be closely monitored; they will receive additional exposure compared to members of the public Potential exposure may be reduced if there is compliance with controlled workforce access

(2) Controlled workforce access

Potential increased worker exposure	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that workers entering the contaminated area use appropriate PPE Monitoring of workers entering the affected area may be required to ensure that exposure limits are not exceeded. Due to the specific nature of the tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposures. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving controlled workforce access Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contaminant from workers' hands Exposure routes from transport and disposal of waste are not included

Other considerations

Agricultural impact	There may be animal welfare issues depending on the nature of the affected area
Compensation issues	There may be requests for compensation for costs associated with loss of trade and earnings (eg manufacturing processes) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

Additional information

Practical experience	Isolation of patients during a SARS outbreak in Taiwan required a medical team to remain in place to attend to affected patients (Jien-Wei Liu M, 2006)
Key references	Liu JW, Lu SN, Chen SS, Yang KD, Lin MC, Wu CC, et al. Epidemiologic study and containment of a nosocomial outbreak of severe acute respiratory syndrome in a medical center in Kaohsiung, Taiwan. Infect Control Hosp Epidemiol. 2006 May 1;27(5):466–72 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	This is a fixed recovery option and should be implemented in the first instance for all biological incidents to prevent exposure and risk of disease
Document history	

(3) Impose restrictions on transport

Objective	To prevent the re-aerosolisation of biological agents by all vehicle types To prevent the spread of biological contamination on vehicle surfaces
Other benefits	Any necessary recovery options related to cleaning or modification of surfaces on roads may be implemented more easily while transport is restricted through the affected area
Recovery option description	Prohibits members of the public from using their vehicles and/or imposes restrictions on bus and train networks in a contaminated area. Closure of roads by the use of barriers and/or signs. In extreme cases it could also include the prevention of flights to prevent the spread of infectious disease nationally or internationally Lesser restrictions may include imposing stricter speed limits to minimise the dispersal of contaminated material deposited on the ground. Advice could also be provided to limit car use to essential tasks. Another consideration would be to allow public transport (eg buses) but prevent private vehicle use (eg cars). Remediation vehicles would be covered by recovery option (2) Controlled workforce access This option may not be required if the option (1) Restrict public access has already been implemented. However, in some cases access may be prohibited in heavily contaminated areas, while transport may be restricted in less contaminated areas
Key information requirements	What is the traffic type (air, rail or road) in the affected area? What are the weather conditions? Are there alternative routes? Are there any current road works in the area or on alternative routes? How heavy is the traffic through the contaminated area? How long are the transport restrictions required and what groups will be affected, eg commuters (rush-hour), school children or holidaymakers (if on a bank holiday or weekend)? Will restrictions impact access to critical infrastructure sites (eg hospitals)?
Linked recovery options	This is a protection option and should be linked to remediation options This recovery option may be used in conjunction with (1) Restrict public access, (2) Controlled workforce access and (4) Temporary relocation from residential areas
Target environment	All transport vehicles and networks – emergency vehicles may still be granted access
Targeted organisms	This recovery option is applicable to ***ALL*** biological agents that pose a risk to public health, especially those that can be easily aerosolised. However, the properties of the biological agent will influence application of this option and whether or not it is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Will depend on the extent of contamination but will reduce exposure from inhalation of re-aerosolised biological contamination, including inhalation, dermal (skin) contact, eye contact and inadvertent ingestion
Time of application	Maximum benefits are associated with this option if implemented soon after the emergency phase to prevent further spread of contamination

Considerations

Public health considerations	None
Legal implications and obligations	Seek specialist advice and guidance, eg from the Department for Transport (DfT)
Social implications	Disruption in the affected communities may be extensive and members of the public may refuse to adhere to advice. Barriers and cordons may need to be used There may be problems for people requiring urgent use of vehicles (eg medical emergency and food supplies), and travel to/from home/work Access criteria for emergency vehicles will need to be established This option may cause heavy traffic in alternative routes
Environmental considerations	Strong winds and rain may negate the effectiveness of this option in reducing the spread of biological contamination Restrictions on transport could improve local air quality (due to the reduction in car exhaust emissions)

(3) Impose restrictions on transport

Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	This option will not reduce contamination levels but will be effective at reducing the spread of contamination in the restricted area as it may prevent vehicles from re-aerosolising certain biological agents, especially biologically contaminated dust-like particulates
Technical factors influencing effectiveness of recovery option	Level of contamination in area Properties of biological agent(s) involved Available alternative routes
Feasibility and intervention costs	
Specific equipment	Road blocks, notices, signs and traffic cameras Monitoring equipment
Utilities and infrastructure	Roads and transport networks
Consumables	Notices and signs among others
Skills, personnel and operator time	Operator time and personnel requirements will vary depending on the size and scale of the biological incident where restrictions on transport are required
Safety precautions	None
Other limitations/ factors influencing costs	Duration – restrictions may be progressively reduced as the clean-up and remediation are achieved
Waste	
Amount and type	None
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Exposure from re-aerosolised biological agents would be reduced for people living and working in the affected area. Averted exposure may be influenced by compliance with restrictions on transport; members of the public may need to drive through contaminated areas to obtain food and medical supplies
Factors influencing averted exposure	None
Potential increased worker exposure	None
Other considerations	
Agricultural impact	This will depend on the nature of the affected area (eg farmland or urban). There may be animal welfare issues (eg provision of feed) that should be considered. Seek specialist advice and guidance
Compensation issues	There are likely to be requests for compensation for loss of earnings from measures which restrict the movement of transport, eg goods, produce. Shops in the affected area (eg those in underground train stations or those surrounding affected train stations or bus stops) may also require compensation Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk

(3) Impose restrictions on transport

Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

Additional information

Practical experience	During remediation of a house in Connecticut after contamination with anthrax spores, the authorities closed the main thoroughfare to prevent exposure (Guh, 2010)
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Guh A, Heyman ML, Barden D, Fontana J, Hadler JL. Lessons learned from the investigation of a cluster of cutaneous anthrax cases in Connecticut. J Public Health Manag Pract. 2010 Jun;16(3): 201–10
Comments	
Document history	

(4) Temporary relocation from residential areas	
Objective	To reduce exposure to biological contamination within residential areas
Other benefits	Any necessary recovery options will be implemented more easily while the population are absent from the area
Recovery option description	This recovery option is essentially the relocation of individuals from a contaminated area on a temporary basis. It is likely that people would be moved to an area that is sufficiently outside the contaminated area to minimise exposure, but near enough to allow them to commute to their normal places of work or school
Key information requirements	Are alternative housing and associated resources (eg transport and access to retail, medical and social support services) available? What are the size and demographics of the affected population? What is the likely economic impact from implementing this option? What are the properties and infectious dose of the biological agent? Is relocation likely to result in a high risk of contaminant transfer?
Linked recovery options	This is a protection option and should be linked to remediation options Recovery options that may need to be considered with this option include (1) Restrict public access, (2) Controlled workforce access, (3) Impose restrictions on transport and (5) Medical intervention
Target environment	People living in contaminated areas, their key possessions and animals
Targeted organisms	This recovery option is applicable to ***ALL*** biological agents that pose a risk to public health. However, the properties of the biological agent will influence application of this option and whether or not it is a suitable adjunct to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Dependent on size of incident. Very large scale incidents, eg it would be impracticable to relocate a million people
Exposure pathway prevention	Inhalation, dermal (skin and ocular) contact and ingestion of biological contamination
Time of application	There is maximum benefit if people are moved out soon after contamination is reported or are evacuated during the emergency phase and do not return until after remediation is complete
Considerations	
Public health considerations	There will be psychological effects from temporarily relocating the affected population
Legal implications and obligations	Seek specialist advice and guidance. There may be a requirement to provide security for empty buildings to prevent theft and looting with the costs directed to the local authority relocating the residents. Residents may need to be forcibly removed if reluctant to leave and this may require legal enforcement/intervention by the police or military
Social implications	There may be issues with compliance and disruption in the affected communities (those moved and those in the receiving communities). This option could lead to fragmentation of communities Other social considerations include finding alternative accommodation, availability of infrastructure to support relocated populations, increased burden on schools, medical and recreational services in the receiving community, and preventing unauthorised access back into the affected area There may also be issues with people returning to their homes after remediation is complete. There may be a need to prove that contamination has been completely removed, otherwise public confidence may be affected
Environmental considerations	Increases in the size of the population in the receiving community (where people are temporarily relocated) may have impacts on the environment, eg amount of general waste generated and increased traffic. If temporary (mobile) housing is used for relocation sewage and water infrastructure may be challenged
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	This option should be up to 100% effective as residents will be temporarily removed from the affected area, and no longer be exposed to the contamination. Effectiveness is likely to be dependent on prevention of any contaminant transmission

(4) Temporary relocation from residential areas

Technical factors influencing effectiveness of recovery option	The effectiveness of this option is limited by compliance (people staying out of the contaminated area) and may require security to ensure access is restricted
Feasibility and intervention costs	
Specific equipment	Temporary housing, vehicles and transport to relocate affected populations and belongings
Utilities and infrastructure	Alternative accommodation/housing Infrastructure to support relocated populations: schools, medical and social services, etc Transport plans for the area will need review and decontamination centres for transport vehicles may need to be considered Security to protect services for the area that has been relocated
Consumables	Fuel and parts for vehicles and other transport Consumables needed for the alternative accommodation, eg blankets, beds and clothing Food and water during the transfer process
Skills, personnel and operator time	Personnel requirements will vary depending on the size and scale of the biological incident. Assuming people are moved about 1 hour away, it is estimated that one coach driver can relocate 60 people every 4 hours
Safety precautions	Seek specialist advice and guidance. There may be the need to decontaminate evacuees, animals and personal possessions before boarding transport out of the affected area
Other limitations/ factors influencing costs	Number of people requiring relocation? How far away are people being relocated? How much are they taking with them? Critical national infrastructure in the affected area whose workforce live locally (eg power station and medical personnel) Has the release of contamination already had a health impact on any of those earmarked for transfer, or their close relatives who they may need to leave behind
Waste	
Amount and type	None
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	If moved away from the affected area, the population should not be further exposed to biological contamination from the incident. Averted exposure may be influenced by compliance with relocation or willingness to give up contaminated possessions. There may also be issues with regard to people re-entering the contaminated area to obtain personal possessions or animals (ie pets) Level of exposure at new location
Factors influencing averted exposure	N/A
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving temporary relocation from residential areas

(4) Temporary relocation from residential areas

	Potential exposure pathways for workers are: • dermal (including ocular)/inhalation exposure from contamination in the environment and equipment • ingestion of contamination from workers' hands Exposure routes from transport and disposal of waste are not included

Other considerations

Agricultural impact	This will depend on the nature of the affected area (eg farmland or urban). There may be animal welfare issues (eg provision of feed) that should be considered and will need to be planned for. Seek specialist advice and guidance
Compensation issues	There are likely to be requests from compensation for loss of earnings as this recovery option may restrict the movement of transport, eg goods and produce Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Experience also confirms the need to ensure that other measures are put into place to keep the community informed of developments when regular briefings have been terminated. Previous incidents and exercises suggest weekly or monthly newsletter and site boards or banners around sites can be effective ways of achieving this
Other considerations	N/A

Additional information

Practical experience	A drum-maker and his family were temporarily relocated from the area when their house was found to be contaminated with anthrax spores. This reduced any further exposure and allowed for other remediation techniques to be carried out (Guh, 2010) During the Amoy gardens SARS outbreak, residents were relocated to a holiday camp while remediation activities were carried out (SARS: An Open Scar)
Key references	Guh A, Heyman ML, Barden D, Fontana J, Hadler JL. Lessons learned from the investigation of a cluster of cutaneous anthrax cases in Connecticut. J Public Health Manag Pract. 2010 Jun;16(3): 201–10 SARS: An Open Scar | Impact > Case Studies > Amoy Gardens. 2004. Available (September 2015) at http://www.openscar.com/amoygardens.html#contentoutline Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	Transmissibility of the biological agent will inform the nature, speed and risk assessments associated with any relocation exercise
Document history	

(5) Medical intervention

Objective	To reduce or prevent any ill-health in individuals who have been exposed to biological contamination or are considered to be 'at risk' of infection
Other benefits	Can prevent or reduce the transmission of infection
Recovery option description	Medical intervention can include a number of measures to reduce/prevent ill-health in individuals who have been exposed to contamination or are considered to be 'at risk' There are several different forms of treatment, including antibiotics, antivirals, antifungals and vaccination These treatments must be administered/prescribed by a registered medical practitioner/nurse Treated individuals will need to be monitored for infection and adverse treatment effects while undergoing treatment and may need to be quarantined/isolated (depending on the biological agent) from the general public The level of protection afforded by each medical intervention has to be balanced (as is normal medical practice) against the potential side effects of the intervention and the ability of the 'at risk' individuals to clinically respond to the intervention. This needs to be clearly communicated
Key information requirements	How many people have been exposed or are considered to be 'at risk'? What is the biological agent? Is there treatment available? Are the appropriate resources available?
Linked recovery options	This is a protection option and should be linked to remediation options This option is likely to be combined with (1) Restrict public access, (2) Controlled workforce access and (4) Temporary relocation from residential areas
Target environment	People living in or visiting the contaminated areas
Targeted organisms	This option is applicable to all biological organisms which pose a risk to public health and for which there are available medical treatments. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert clinical guidance should be sought on an incident- and site-specific basis
Scale of application	Any, although on larger scales, larger effective communication strategies and greater logistical support will be imperative and appropriate resources need to be available
Exposure pathway prevention	Transmission of infection from person to person
Time of application	There is maximum benefit if this option is carried out soon after contamination has occurred. People who may have been exposed or affected will need to undergo clinical assessment and be managed by medical professionals
Considerations	
Public health considerations	There may be some side effects associated with medical intervention (eg vomiting or diarrhoea). As a result, this recovery option can only be implemented by trained/qualified medical personnel
Legal implications and obligations	Seek specialist advice and guidance
Social implications	This option may cause panic among the community, which in turn may cause an increased burden on the community health services. Implementation and communication of this option will need to managed effectively to reduce alarm
Environmental considerations	None
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	Development of infection and the further transmission of infection should be reduced significantly if implemented quickly and efficiently
Technical factors influencing effectiveness of recovery option	Identifying all affected individuals Adequate stocks of medical supplies Appropriate infrastructure and personnel to support this option, eg health care clinics

(5) Medical intervention

Feasibility and intervention costs	
Specific equipment	Medical supplies, medicines and vaccines
Utilities and infrastructure	Hospitals, NHS walk-in centres and/or GP surgeries
Consumables	Medical consumables for delivering treatment
Skills, personnel and operator time	Registered medical practitioners
Safety precautions	All medical personal should take effective precautions when dealing with potentially exposed individuals, which includes the use of safe practices and PPE
Other limitations/ factors influencing costs	Costs may be influenced by the number of individuals needing prophylaxis and vaccination
Waste	
Amount and type	Medical waste will be generated (eg needles, syringes and gauze). The amount will depend on the number of individuals that need to be treated. Medical waste is classified as 'hazardous waste' and should be disposed of carefully, through appropriate routes (eg incineration)
Possible transport, treatment, disposal and storage routes	Medical waste should be disposed of through the correct disposal routes, which will be outlined by the facility dispensing treatment
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Person to person transmission of infection will be decreased
Factors influencing averted exposure	None
Potential increased worker exposure	Medical personnel would be subject to increased exposure. Appropriate PPE should be used to prevent exposure Monitoring of medical personnel dealing with affected individuals may be required
Other considerations	
Agricultural impact	None
Compensation issues	N/A
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international levels should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A
Additional information	
Practical experience	A drum-maker and his child who contracted cutaneous anthrax from a contaminated house were given antibiotics to treat the infection. The drum-maker was given antibiotics for 60 days (CDC, 2008)

(5) Medical intervention

Key references	CDC. Cutaneous anthrax associated with drum making using goat hides from West Africa-Connecticut, 2007. MMWR Morb Mortal Wkly Rep. 2008 Jun 13;57(23):628–31
Comments	
Document history	

(6) Pest control

Objective	To reduce the spread of contamination and infection from pests, eg rats and cockroaches
Other benefits	Reduction in the number of pests may make an area more acceptable to the general public and improve overall hygiene
Recovery option description	Pests can often be vectors of some infectious diseases and aid the spread of contamination. Common pests include rats, mice, cockroaches, ticks, mosquitos, fleas and pigeons Pests are humanely culled and disposed of using trained, specialist contractors. This may involve the use of traps, poison, pesticides and fogging
Key information requirements	What pests are in the affected area? What other animals are in the affected area?
Linked recovery options	This option is a protection option and should be linked to remediation options Recovery options that may need to be considered with this option include (1) Restrict public access, (4) Temporary relocation from residential areas and (5) Medical intervention
Target environment	Contaminated areas where pest levels are a problem
Targeted organisms	This recovery option is applicable to all organisms that pose a risk to public health and can easily be transmitted through animal vectors. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to remediation techniques. Expert guidance should be sought on an incident- and site-specific basis This option may be particularly relevant to the following biological agents that are known to be transmitted through animal vectors: *Toxoplasma gondii, Yersinia pestis, Plasmodium* spp. *and Borrelia* spp.
Scale of application	Dependent on size of the affected area where pests are involved
Exposure pathway prevention	Transmission from vector to human
Time of application	This recovery option has maximum benefit if implemented as soon as contamination is evident to prevent further spread of contamination
Considerations	
Public health considerations	The method of pest control used may be toxic to the human population. Any use of poisons or toxic gas must be monitored and, where appropriate, the human population should be removed from the area Ineffective removal of dead pests may later result in odour complaints (eg rats or mice may die under floorboards, which may make removing corpses difficult)
Legal implications and obligations	Seek specialist advice
Social implications	There may be concern from the public over the welfare of pets and other animals The method of pest control may cause public concern if it is considered to be inhumane
Environmental considerations	This is dependent on the environment of the affected area, the type of pest and the method of pest control used
Ethical considerations	There may be animal welfare considerations The most humane methods of pest control should be used where possible
Effectiveness	
Recovery option effectiveness	If implemented quickly, this recovery option should be effective at intercepting the exposure pathway of transmission from vector to human
Technical factors influencing effectiveness of recovery option	This recovery option will need to be carried out by trained exterminators
Feasibility and intervention costs	
Specific equipment	Equipment need for pest control method, eg poisons and traps
Utilities and infrastructure	N/A
Consumables	Protective equipment for specialist personnel, eg gloves
Skills, personnel and operator time	Will require specialist contractors to undertake this option, who are familiar with pest control and how to deal with the subsequent waste

(6) Pest control

Safety precautions	Will depend on the biological agent involved and the pests (vectors) that are to be removed. A risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers will have to comply with Health and Safety at Work etc Act (HSWA) to ensure that workers entering the contaminated area use appropriate PPE
Other limitations/ factors influencing costs	N/A
Waste	
Amount and type	There may be large volumes of pest carcasses that will need appropriate removal and disposal
Possible transport, treatment, disposal and storage routes	This will depend on the agent involved: landfill or incineration
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	This recovery option should be effective at intercepting the exposure pathway of transmission from vector to human
Factors influencing averted exposure	None
Potential increased worker exposure	There may be increased exposure of pest control operators while implementing this option. Appropriate PPE will need to be worn and care will need to be taken when disposing of contaminated carcasses
Other considerations	
Agricultural impact	Depends on the nature of the affected area, ie agricultural, rural or urban. There may be animal welfare issues that should be considered. Seek specialist advice and guidance
Compensation issues	Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Experience also confirms the need to ensure that other measures are put into place to keep the community informed of developments when regular briefings have been terminated. Previous incidents and exercises suggest weekly or monthly newsletters and site boards or banners around sites can be effective ways of achieving this
Other considerations	N/A
Additional information	
Practical experience	During an outbreak of SARS in the Amoy Gardens complex in Hong Kong there was evidence of cockroach infestation. Pest control methods were employed to reduce the cockroach level in the complex (SARS: An Open Scar) Anthrax epidemic, Sverdlovsk, USSR, 1979 (Meselson, 1994)
Key references	SARS: An Open Scar | Impact > Case Studies > Amoy Gardens. 2004. Available (September 2015) at http://www.openscar.com/amoygardens.html#contentoutline Meselson M, Guillemin J, Hugh-Jones M, Langmuir A, Popova I, Shelokov A, et al. The Sverdlovsk anthrax outbreak of 1979. Science. 1994 Nov 18;266(5188):1202–8
Comments	
Document history	

(7) Removal/treatment of contamination source	
Objective	To remove or treat the source of the contamination
Other benefits	This option can remove the need for extensive treatment programmes by reducing the contaminant loading and spread to surrounding areas
Recovery option description	This option requires the identification and then removal or inactivation of the contamination source After identification of the contamination source a decision will be made as to whether it can be removed or inactivated using appropriate techniques
Key information requirements	What is the source of the contaminant? Has the area of contamination been determined? What is the contaminating agent? What timescales are available for this option?
Linked recovery options	This is a remediation option and may be linked to protection options This recovery option should be considered with: (1) Restrict public access, (2) Controlled workforce access, (3) Impose restrictions on transport, (4) Temporary relocation from residential areas, (8) Reactive gases and vapours, (10) Reactive liquids, (12) Steam cleaning, (13) HEPA vacuum cleaning, (16) Natural inactivation, (17) Soil and vegetation removal, (18) Barriers to seal land contamination, (19) Removal and disposal of contaminated material and (21) Incineration
Target	Any inhabited area that has been contaminated with biological material
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate an inhabited area and pose a risk to public health. However, the characteristics (eg persistence and resistance to decontamination) of the agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Inhalation, dermal (skin) contact and ingestion of biological contamination
Time of application	This recovery option should be implemented as soon as contamination has been determined/reported
Considerations	
Public health considerations	The treatment or removal process may result in the spread of contamination into the environment
Legal implications and obligations	Seek specialist advice and guidance
Social implications	There may be issues with the public acceptability of this option (eg private residences, possessions or vehicles being removed or decontaminated) Public acceptability of waste production, treatment, storage and disposal routes
Environmental considerations	The disposal or storage of waste arising from the implementation of this option may have an environmental impact
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	If carried out effectively, this option should reduce contaminant levels and spread to surrounding areas
Technical factors influencing effectiveness of recovery option	Dependent on contamination source
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination operations across the UK. For more information see

(7) Removal/treatment of contamination source	
	http://www.fera.defra.go.uk/environment/governmentDecontaminationService/index.cfm/ Specific equipment may vary but the following may be required: • monitoring equipment • tools for dismantling/disposing of contaminated material or decontamination equipment • transport vehicles for equipment and waste • suitable containers which can be effectively sealed
Utilities and infrastructure	Dependent on contamination source, eg open or concealed Power/water supply Transport infrastructure to site
Consumables	Dependent on the removal/treatment process selected
Skills, personnel and operator time	Seek specialist advice and guidance, as skilled personnel are likely to be required to undertake this recovery option. Operator time and personnel requirements will vary depending on the type of contamination source
Safety precautions	A risk assessment will need to be undertaken Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Costs and equipment will vary according to the size of the contamination source
Waste	
Amount and type	Has the potential to generate large amounts of waste. Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Options for packaging and conveying waste (if applicable), including treating the waste on site or at an off-site facility and the possibility of interim storage if final disposal is not yet available Any waste to be transported must be sealed
Factors influencing waste issues (eg cost)	Waste disposal streams will be selected depending on the hazard category of the contaminating biological agent(s)
Exposure	
Averted exposure	Reduced contaminant level and spread to surrounding environments
Factors influencing averted exposure	N/A
Potential increased worker exposure	Worker exposure may be increased depending on the removal/treatment option selected. PPE must be worn to mitigate risk
Other considerations	
Agricultural impact	This is dependent on where the contamination is located and will be considered on a case-by-case basis
Compensation issues	There may be requests for compensation for loss or damage to property Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the

(7) Removal/treatment of contamination source

	public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Experience also confirms the need to ensure that other measures are put into place to keep the community informed of developments when regular briefings have been terminated. Previous incidents and exercises suggest that weekly or monthly newsletters and site boards or banners around sites can be effective ways of achieving this
Other considerations	N/A

Additional information

Practical experience	Investigations during the SARS outbreak at Amoy Gardens revealed that malfunctioning U-trap drains were a likely source of contamination in other apartments within the housing block (SARS: An Open Scar)
Key references	SARS: An Open Scar | Impact > Case Studies > Amoy Gardens. 2004. Available (September 2015) at http://www.openscar.com/amoygardens.html#contentoutline Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
Document history	

(8) Reactive gases and vapours

Objective	To reduce potential exposure to biological contamination by reducing concentrations of biological agent(s) in buildings and on surfaces using gaseous decontamination technologies such as hydrogen peroxide, chlorine dioxide *(see comment)* or formaldehyde
Other benefits	This recovery option may decrease the need to carry out more destructive recovery options such as (19) Removal and disposal of contaminated material
Recovery option description	The use of reactive gases and vapours is a specialised recovery option that will require expert advice, and can only be undertaken by specialist contractors Reactive gases and vapours include gaseous hydrogen peroxide, gaseous chlorine dioxide and formaldehyde. Different modes of generation and application may be used The reactive gas or vapour is allowed to circulate around a contaminated area and will inactivate the biological agent (depending on the biological agent's resistance properties). This recovery option may also be suitable for decontaminating sensitive electrical equipment Multiple applications of a reactive gas or vapour may be required to inactivate and reduce the biological contaminant to acceptable levels. Appropriate measures are required to ensure that when implemented inside a building, it is sealed effectively to prevent potentially toxic gas escaping into the surrounding environment, eg through doors, windows and ventilation systems During incident remediation this option may be carried out just to reduce the contamination load and risk of infection to personnel before more targeted remediation is carried out Waste may be produced, which could need further decontamination or treatment prior to disposal
Key information requirements	What surface (porous or non-porous) or type of building has been contaminated (eg multistorey, terraced or semi-detached)? What are the properties of the biological agent(s)? What is the availability of skilled personnel, contractors and specialist equipment? Seek specialist advice and guidance
Linked recovery options	This is a remediation option and should be linked to protection options This decontamination technique is usually undertaken in a closed and controlled environment as the reactive gases and vapours can be toxic. Residents would need to be removed/relocated from the contaminated area and access to the area should be restricted. Therefore this option would need to be carried out in conjunction with (1) Restrict public access and (4) Temporary relocation from residential areas
Target environment	Indoor and enclosed spaces. However, fogging technologies using droplet-based fumigant delivery methods may be effective for some semi-enclosed situations
Targeted organisms	This recovery option is applicable to ***ALL*** biological agents that pose a risk to public health, especially if persistent and difficult to decontaminate (eg in an inaccessible area) However, the properties of the biological agent(s) will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis, as different reactive gases and vapours may be more (or less) effective against different organisms
Scale of application	Medium (this option is only applicable for use in indoor environments or enclosed spaces). The scale of application will vary with different technologies
Exposure pathway prevention	Inhalation, dermal (skin) contact and inadvertent ingestion of biological contamination
Time of application	Maximum benefit is achieved if carried out as soon as contamination is evident, to prevent further spread of contamination. Multiple applications may be necessary to reduce contamination to acceptable levels

Considerations

Public health considerations	Seek specialist advice and guidance. There may be a potential risk that the reactive gases or vapours used for the remediation remain in the environment or on surfaces, which could pose a risk to public health. It is important that any enclosed space is completely sealed to prevent leakage of the vapour It is also important to ensure that harmful residues do not remain behind in the air or on surfaces after remediation activities are completed
Legal implications and obligations	Seek specialist advice and guidance. There may be liability issues with regard to possible damage to property and important artefacts. There may also be issues with ownership and access to property or the affected site, or cultural heritage protection of listed and other historically important buildings

(8) Reactive gases and vapours

	Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance. A summary of legislation is provided in Appendix A
Social implications	Potential for damage to sensitive surfaces and objects, buildings or infrastructure (eg corrosion, erosion or tarnishing of surfaces) Access to and sealing off residential properties or community facilities to carry out remediation
Environmental considerations	Extreme temperatures and humidity can influence the effectiveness of this option
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	The effectiveness of this technique depends on the type of system used, the biological agent involved and the material/surface on which the biological contaminant is found Gaseous hydrogen peroxide has reduced effectiveness against catalase positive bacteria and mycobacterial species
Technical factors influencing effectiveness of recovery option	There are several different commercially available systems for delivering the reactive gas or vapour, eg gaseous hydrogen peroxide can be delivered below the dew point or at the dew point, and may affect the effectiveness of this option This option may be less effective on inaccessible surfaces, eg under a screw or for hollow (lumened) items, where fumigant penetration may be limited or prevented
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination and waste removal operations across the UK. These framework providers are trained in the use of appropriate PPE and decontamination methods, allowing them to enter and work safely in suspected contaminated areas. For more information see https://www.gov.uk/government/groups/government-decontamination-service Monitoring equipment to determine efficacy of recovery option Appropriate containers for temporary storage of waste products
Utilities and infrastructure	Fuel and parts for transport vehicles, engines, water, electricity, etc
Consumables	Chemicals used in active decontamination (formaldehyde, chlorine dioxide and hydrogen peroxide)
Skills, personnel and operator time	Specialist personnel and suppliers are required to undertake this option. Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of contaminated surfaces (eg floor tiles, bricks and upholstery)
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Factors influencing the costs of this option include: • specialist personnel (as this is a specialist recovery technique) • biological agent(s) involved • type of reactive gas/vapour involved • building size and type • access to contaminated area • use of PPE *Note:* Costs will increase if decorating/repair of surfaces is required after application

(8) Reactive gases and vapours

Waste	
Amount and type	Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance. In addition, building materials and interiors may still require disposal after decontamination, albeit at a lower level to landfill
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Options for packaging and conveying the waste, including treating the waste on site or at an off-site facility and the possibility of interim storage if final disposal is not yet available, should be considered
Factors influencing waste issues (eg cost)	Contaminated waste must be transported in suitable tank-vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles Debris contaminated with material that would be classified as dangerous in transport (eg asbestos) is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Exposure	
Averted exposure	This technique will only reduce exposure to people while they are in a particular environment (eg indoors). Averted exposure will be dependent on specific situations and the types of surfaces cleaned. Averted exposure may be influenced by the consistency in implementing this option effectively over a large area
Factors influencing averted exposure	Efficacy of reactive gases/vapours used
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving the implementation of a reactive gas or vapour as a remediation technique
Other considerations	
Agricultural impact	N/A
Compensation issues	There may be requests for compensation for loss of homes, possessions and loss of earnings as this recovery option may restrict the movement of transport and the habitation of residential or workplace areas Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A
Additional information	
Practical experience	Gaseous hydrogen peroxide has been used to remediate a residential property after contamination with *Bacillus anthracis* spores from contaminated African drums (Riley, 2007) Gaseous chlorine dioxide was used to remediate a mail facility in Maryland after an intentional release of anthrax spores in mail (Canter, 2005)

(8) Reactive gases and vapours

Key references	Canter DA, Gunning D, Rodgers P, O'Connor L, Traunero C, Kempter CJ. Remediation of Bacillus anthracis contamination in the US Department of Justice mail facility. Biosecur Bioterror. 2005 Jun;3(2): 119–27 Guh A, Heyman ML, Barden D, Fontana J, Hadler JL. Lessons learned from the investigation of a cluster of cutaneous anthrax cases in Connecticut. J Public Health Manag Pract. 2010 Jun;16(3): 201–10 Riley A. Report on the management of an anthrax incident in the Scottish Borders. NHS Borders. 2007. Available (September 2015) at http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/13_12_07_anthrax.pdf Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	Chlorine dioxide is not routinely used in the UK outside the laboratory sector but has been known to be used in previous incidents to decontaminate *Bacillus anthracis*
Document history	

(9) Gaseous decontamination of objects

Objective	To reduce potential exposure to biological contamination by reducing levels of biological agent(s) on objects
Other benefits	This recovery option could potentially reduce the amount of hazardous waste for disposal and can reduce the amount of potential compensation
Recovery option description	Reactive gases and vapours can be used to decontaminate objects. It is a specialised recovery option that will require expert advice, and can only be undertaken by specialist contractors Contaminated items will need to be appropriately packaged and removed from the contaminated area and taken to a facility where gaseous decontamination can be carried out in a confined area, eg sealable safety cabinet, chamber or isolator Reactive gases and vapours that can be used include formaldehyde, ethylene oxide and ozone
Key information requirements	What type of objects (ie porous or non-porous) have been contaminated? What are the properties of the biological agent(s)? What is the availability of skilled personnel, contractors and specialist equipment? Seek specialist advice and guidance
Linked recovery options	This is a remediation option and should be linked to protection options This decontamination technique is usually carried out in a closed and controlled environment as formaldehyde, ethylene oxide and ozone gases are toxic. The contaminated objects would have to be removed from the original site of contamination and therefore this option would be linked to (19) Removal and disposal of contaminated material
Target environment	Small objects
Targeted organisms	This recovery option is applicable to ***ALL*** biological agents that pose a risk to public health, especially if persistent and difficult to decontaminate. However, the properties of the biological agent(s) will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and object-specific basis
Scale of application	Small (this option is only applicable for use on small objects)
Exposure pathway prevention	Inhalation, dermal (skin) contact and ingestion of biological contamination
Time of application	Can be carried out any time during the incident but there is maximum benefit if carried out as soon as contamination is evident to prevent further spread of contamination

Considerations

Public health considerations	Seek specialist advice and guidance. There may be a potential risk that the residues of reactive gases used in this option (formaldehyde, ethylene oxide and ozone) could remain on the surfaces of contaminated objects, which could pose a risk to public health Objects that are removed from the scene will need to be packaged and handled appropriately to prevent any further spread of contamination
Legal implications and obligations	Seek specialist advice and guidance. There may be liability issues with regard to possible damage to property. There may also be issues with ownership of the property or objects may have historical, cultural or personal value Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Social implications	Potential for damage to sensitive objects. There may also be concerns surrounding the residual risk and so owners of objects which have subsequently been decontaminated may need to be reassured regarding the decontamination process
Environmental considerations	N/A
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)

Effectiveness

Recovery option effectiveness	The effectiveness of this technique depends on the type of system used, the biological agent(s) involved and the object on which the biological contaminant is found

(9) Gaseous decontamination of objects

Technical factors influencing effectiveness of recovery option	Type and size of object This option is likely to be carried out within a sealable safety cabinet, chamber or isolator, therefore the size of the objects will be limited to the capacity of the cabinet or chamber
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination and waste removal operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service Monitoring equipment to determine efficacy of recovery option Appropriate containers for removal and transport of contaminated objects Sealable cabinets, chambers or isolators
Utilities and infrastructure	Fuel and parts for transport vehicles
Consumables	Chemicals used in active decontamination and packaging materials
Skills, personnel and operator time	Specialist personnel and suppliers are required to undertake this option. Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of contaminated objects (eg surgical instruments or tapestries)
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Factors influencing the costs of this option include: • specialist personnel (as this is a specialist recovery technique) • biological agent involved • use of PPE • type of reactive gas used • validation that the decontamination process has been successful
Waste	
Amount and type	Many types of waste that will be encountered during or after a biological incident may come under the classification of ‘hazardous waste’, which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance. In addition, building materials and interiors may still require disposal after decontamination, albeit at a lower level to landfill
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Options for packaging and conveying the waste, including treating the waste on site or at an off-site facility and the possibility of interim storage if final disposal is not yet available, should be considered
Factors influencing waste issues (eg cost)	Contaminated waste must be transported in suitable tank-vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles Debris contaminated with material that would be classified as dangerous in transport (eg asbestos) is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Exposure	
Averted exposure	This technique will only reduce exposure to people from a particular object that is being decontaminated. Averted exposure will be dependent on specific situations and the types of objects cleaned. Averted exposure may be influenced by the consistency in implementing this option effectively on a large scale
Factors influencing averted exposure	None

(9) Gaseous decontamination of objects

Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving the implementation of gaseous decontamination as a remediation technique

Other considerations

Agricultural impact	N/A
Compensation issues	There may be requests for compensation for loss of possessions and other valuable items Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

Additional information

Practical experience	During the 'Amerithrax' attacks, the Department of Justice mail facility in Maryland removed items that were considered 'valuable' and decontaminated them using ethylene oxide at an off-site facility (Canter, 2005)
Key references	Canter DA, Gunning D, Rodgers P, O'Connor L, Traunero C, Kempter CJ. Remediation of Bacillus anthracis contamination in the US Department of Justice mail facility. Biosecur Bioterror. 2005 Jun; 3(2):119–27 Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(10) Reactive liquids

Objective	To reduce potential exposure to biological contamination by reducing concentrations of biological agent(s) on a variety of surfaces
Other benefits	This recovery option may decrease the need to carry out more destructive recovery options, eg (19) Removal and disposal of contaminated material This is a self-help recovery option as specialist personnel and suppliers may not be required to undertake this option on a small scale. Some reactive liquids (eg sodium hypochlorite) are household cleaning products (eg bleach) and specialist skills are not required for small-scale disinfection and remediation
Recovery option description	This recovery option includes a number of techniques and methods for decontamination involving reactive liquids, all of which are effective disinfection techniques for killing biological agents This recovery option usually involves combining reactive liquids with water to form disinfectant solutions that can be applied to contaminated surfaces: • alcohols: eg ethanol and methanol • free available chlorine (FAC): eg sodium hypochlorite (household bleach) and chlorine dioxide • quaternary ammonium compounds (QACs): eg benzalkonium chloride and methylbenzethonium chloride • oxidising agents: eg hydrogen peroxide and peracetic acid This recovery option may also involve the use of pressure hosing to rinse off reactive liquids that are used in decontamination
Key information requirements	Before implementing this option it may be necessary to seek specialist advice and guidance Availability of trained personnel What surface or type of building has been contaminated (eg multistorey, terraced or semi-detached)? Are appropriate air-exchange or ventilation systems in place? How will the contaminated waste generated by this option be managed (eg can it go into public sewers or down the sink)? What are the properties of the biological agent(s)?
Linked recovery options	This is a remediation option and should be linked to protection options This decontamination technique is usually carried out in a closed and controlled environment, as the liquids may potentially be harmful to the environment (depending on the volume of waste water and concentration of solutions used). Residents may need to vacate the area while this technique is undertaken, therefore this option may need to be carried out in conjunction with (4) Temporary relocation from residential areas
Target environment	Indoor and outdoor surfaces and objects
Targeted organisms	This recovery option is applicable to biological agents that pose a risk to public health. However, the properties of the biological agents will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any (this option is only applicable for use in indoor environments or enclosed spaces)
Exposure pathway prevention	Inhalation, dermal (skin) contact and inadvertent ingestion of biological contamination
Time of application	Maximum benefit if carried out soon after a biological incident when maximum contamination is still on surfaces and before natural weathering can disperse contamination to the outdoor environment With indoor environments, if the room or area could be sealed-off, time is not such an issue

Considerations

Public health considerations	Some reactive liquids can be harmful. These liquids should be handled with care, using appropriate PPE and the manufacturer's instructions should be followed
Legal implications and obligations	Seek specialist advice and guidance. There may be liability issues with regard to possible damage to property. There may also be issues with ownership of the property or affected site, or cultural heritage protection of listed and other historically important buildings Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Social implications	Potential for damage to sensitive objects, surfaces, buildings or infrastructure (eg corrosion, erosion or

(10) Reactive liquids

	oxidation); however, this will depend on the volume and concentration of solutions applied Access to residential properties to carry out disinfection
Environmental considerations	The toxicity of degradation products would need to be considered Contaminated waste products from treatment (eg effluent) could run on to other surfaces (roads, soil, grass, etc) if not controlled effectively, resulting in a transfer of contamination which may require subsequent clean-up thus generating more waste
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	The effectiveness of this technique depends on: • reactive liquids used • physiological characteristics of the biological agent • surface requiring disinfection/decontamination (Is it easily accessible? Is it a robust or sensitive surface?) If the biological contaminant is decontaminated effectively, there should be a significant reduction in potential exposure Some reactive liquids may be more effective for decontamination than others: • alcohol-based disinfection solutions may not be as effective against bacterial spores as oxidising agents • some oxidising agents such as hydrogen peroxide will be less effective against catalase positive bacteria and mycobacterium • chlorine is very effective (>4 log kill) for disinfection and decontamination of *L. monocytogenes,* MRSA, norovirus and VHF • alcohol is very effective (>4 log kill) for disinfection and decontamination of norovirus and *Salmonella* spp. and has some effectiveness (2–4 log kill) for *M. tuberculosis* • QACs have limited effectiveness (<2 log kill) for disinfection and decontamination of *M. tuberculosis,* norovirus and *Salmonella* spp.
Technical factors influencing effectiveness of recovery option	The robustness of surfaces when exposed to reactive liquids should be considered. This option may be less effective where contamination has been absorbed into porous surfaces or penetrated inaccessible surfaces (eg under a screw) This option may need to be repeatedly several times to effectively decontaminate and disinfect the contaminated surface
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination and waste removal operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service Monitoring equipment to determine efficacy of recovery option Appropriate containers for removal and transport of contaminated objects
Utilities and infrastructure	N/A
Consumables	Reactive liquids and chemicals used in decontamination Paper towels, mops, buckets and general wiping materials
Skills, personnel and operator time	This is a self-help recovery option as specialist personnel and suppliers may not be required to undertake this option. Some reactive liquids (eg sodium hypochlorite) are household cleaning products (eg bleach) and specialist skills are not required for small-scale disinfection and remediation Specialist skills, operator time and personnel will vary depending on the size, nature and scale of biological incident and types of contaminated surfaces (eg floor tiles, bricks, upholstery and carpets)
Safety precautions	Specialist safety equipment may not be required if implemented on a small scale using household cleaning products. However, PHE would advise users to seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace.

(10) Reactive liquids

	Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Factors influencing the costs of this option include: • specialist personnel (if required) • biological agent involved • weather • building size • access to contaminated area • proximity of water supplies • use of PPE *Note:* Costs will increase is scaffolding is required, and if repair/redecorating of surfaces is required following application
Waste	
Amount and type	Waste is likely to be in liquid form, and may require abatement or treatment prior to be released into the environment, or transferred for disposal Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste', which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance. In addition, building materials and interiors may still require disposal after decontamination, albeit at a lower level to landfill
Possible transport, treatment, disposal and storage routes	In urban environments decontamination will mainly generate aqueous wastes or slurries which may contain high concentrations of the disinfectant. Products or solutions that may be hazardous to people or the environment must be neutralised before they can safely be discharged into the sewerage system. Contaminated waste effluent and liquids must be transported in suitable tank vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles Debris contaminated with material that would be classified as dangerous in transport (eg asbestos) is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Factors influencing waste issues (eg cost)	Will depend on the reactive liquids used, size and scale of the affected area and volume of contaminated waste produced
Exposure	
Averted exposure	This technique will only reduce exposure to people while they are in a particular environment (eg indoors). Averted exposure will be dependent on different situations and the types of surfaces cleaned. Averted exposure may be influenced by the consistency in implementing this option effectively over a large area
Factors influencing averted exposure	N/A
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving the implementation of formaldehyde as a remediation technique
Other considerations	
Agricultural impact	N/A
Compensation issues	There may be requests for compensation for loss of possessions and other valuable items Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk

(10) Reactive liquids

Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

Additional information

Practical experience	A number of chlorine-based disinfectants have been used during outbreaks of infection in hospital wards
Key references	Belliot G, Lavaux A, Souihel D, Agnello D, Pothier P. Use of murine norovirus as a surrogate to evaluate resistance of human norovirus to disinfectants. Appl Environ Microbiol. 2008 May;74(10): 3315–18 Fisher RG, Chain RL, Hair PS, Cunnion KM. Hypochlorite killing of community-associated methicillin-resistant Staphylococcus aureus. Pediatr Infect Dis J. 2008 Oct;27(10):934–5 Sagripanti JL, Eklund CA, Trost PA, Jinneman KC, Abeyta C Jr, Kaysner CA, et al. Comparative sensitivity of 13 species of pathogenic bacteria to seven chemical germicides. Am J Infect Control. 1997 Aug;25(4):335–9 Best M, Sattar SA, Springthorpe VS, Kennedy ME. Efficacies of selected disinfectants against Mycobacterium tuberculosis. J Clin Microbiol. 1990 Oct;28(10):2234–9 Magulski T, Paulmann D, Bischoff B, Becker B, Steinmann E, Steinmann J, et al. Inactivation of murine norovirus by chemical biocides on stainless steel. BMC Infect Dis. 2009 Jul 7;9:107 Kanerva M, Maunula L, Lappalainen M, Mannonen L, von Bonsdorff C-H, Anttila V-J. Prolonged norovirus outbreak in a Finnish tertiary care hospital caused by GII.4-2006b subvariants. J Hosp Infect. 2009 Mar;71(3):206–13 Lin W-R, Lu P-L, Siu L-K, Chen T-C, Lin C-Y, Hung C-T, et al. Rapid control of a hospital-wide outbreak caused by extensively drug-resistant OXA-72-producing Acinetobacter baumannii. Kaohsiung J Med Sci. 2011 Jun;27(6):207–14 Cherifi S, Delmee M, Van Broeck J, Beyer I, Byl B, Mascart G. Management of an outbreak of Clostridium difficile–associated disease among geriatric patients. Infect Control Hosp Epidemiol. 2006 Nov 1;27(11):1200–1205 Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(11) Energy decontamination techniques

Objective	To reduce potential exposure to biological contamination by reducing concentrations on a variety of surfaces
Other benefits	This recovery option may decrease the need to carry out more destructive recovery options, eg (19) Removal and disposal of contaminated material This recovery option can be used to treat waste prior to disposal
Recovery option description	Energy decontamination relates to a number of measures that remove a contaminant from the environment using radiation and/or heat: • radiation: this may include the use of gamma or ultraviolet (UV) radiation • heat: this may include boiling, dry heat (such as cooking in an oven) and moist heat (eg autoclaving) This option, specifically autoclaving, may also be used to decontaminate hazardous waste before disposal
Key information requirements	Seek specialist advice and guidance Availability of skilled personnel, contractors and specialist equipment (as some energy decontamination techniques may require specialist equipment) What surface or type of object has been contaminated?
Linked recovery options	This is a remediation option and should be linked to protection options This technique may be used in conjunction with other techniques such as (8) Reactive gases and vapours, (10) Reactive liquids and (13) HEPA vacuum cleaning to further remove contamination This option may also be considered as a waste disposal option and may be used in conjunction with (19) Removal and disposal of contaminated material and (21) Incineration
Target environment	Indoor surfaces and objects, contaminated waste
Targeted organisms	This recovery option is applicable to all biological agents that pose a risk to public health and can be inactivated by energy decontamination techniques. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	This may be dependent on the size of the affected area and/or the amount of biological waste to be decontaminated prior to disposal There may be a size limitation for this recovery option, especially when using heat as a decontamination technology
Exposure pathway prevention	Inhalation, dermal (skin) contact and inadvertent ingestion of biological contamination
Time of application	Maximum benefit if carried out soon after a biological incident when maximum concentration is still on the surfaces and before contamination can be dispersed throughout the environment. This option is effective at any time after contamination for persistent biological agents

Considerations

Public health considerations	Radiation presents a hazard and precautions should be taken while using this option to keep exposure as low as reasonably practicable
Legal implications and obligations	Seek specialist advice and guidance. There may be liability issues with regard to possible damage to property. There may also be issues with ownership and access to property or the affected site, or cultural heritage protection of listed and other historically important buildings or precious objects Many types of wastes that will be encountered during or after a biological incident may come under the classification of ‘hazardous waste’, which is subject to control under legislation. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Social implications	Access to residential properties to carry out remediation, and possible damage to building surfaces and objects Public acceptability of waste treatment and storage routes There may be a positive benefit from cleaning houses
Environmental considerations	Disposal of waste arising from the implementation of this option may have an environmental impact. However, this should be minimised through control of any disposal route and relevant authorisations
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)

(11) Energy decontamination techniques

Effectiveness	
Recovery option effectiveness	If applied correctly, reduction in overall exposure should be significant
Technical factors influencing effectiveness of recovery option	This option is unlikely to be applicable for sensitive surfaces (eg glass or heritage) due to the risk of damage Time of implementation, as natural weathering may reduce contamination over time so rapid implementation could improve the effectiveness of this option
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance as specialist suppliers may be required to implement the option The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service Transport vehicles required for removal of contaminated objects and/or contaminated waste Monitoring equipment to determine efficacy of recovery option Appropriate containers for temporary storage of waste products
Utilities and infrastructure	Fuels and parts for transport vehicles, engines, water and electricity
Consumables	Will be dependent on the decontamination techniques chosen
Skills, personnel and operator time	Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of contaminated surfaces (eg floor tiles, bricks, upholstery and carpets). Specialist personnel and suppliers may be required to undertake this option
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Factors influencing the cost of this option include: • type of energy decontamination technique used • specialist personnel (this option may require specialist suppliers to implement the option) • biological agent involved • building size • access to contaminated area (including tidiness of houses and amount of 'contents' that may require removal) • amount of dust/dirt on surfaces • use of PPE • amount of contaminated waste *Note:* The cost of equipment will vary depending on the size and scale of the contamination
Waste	
Amount and type	Dependent on amount of contaminated waste for disposal Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Options for packaging and conveying the waste and the possibility of interim storage if final disposal is not yet available
Factors influencing waste issues (eg cost)	The amount, type and processing of waste is dependent on whether this option is used to decontaminate waste before disposal or to decontaminate objects and surfaces prior to reuse

(11) Energy decontamination techniques

Exposure	
Averted exposure	There should be a significant reduction in potential exposures to members of the public living in the affected area. However, it should be noted that these techniques will only reduce exposure to people while they in particular environment. Averted exposure will be dependent on specific situations and the surfaces cleaned. Factors influencing averted exposure include: • consistency in effective implementation of option over a large area • time of implementation: the impact of decontaminating the surfaces on the overall exposure will be reduced with time on surfaces due to natural dispersion
Factors influencing averted exposure	N/A
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Recovery workers may be exposed to gamma and/or UV radiation and would require monitoring to ensure that exposure limits are not exceeded Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • ingestion of contamination from workers' hands (unlikely to be significant) Exposure routes from transport and disposal of waste are not included
Other considerations	
Agricultural impact	None
Compensation issues	There may be requests for compensation for loss of possessions and other valuable items Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A
Additional information	
Practical experience	US Amerithrax attacks, 2001 (Canter, 2009)
Key references	Canter DA, Sgroi TJ, O'Connor L and Kempter CJ. Source reduction in an anthrax-contaminated mail facility. Biosecur Bioterror. 2009 Dec;7(4):405–12 Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(12) Steam cleaning

Objective	To reduce exposure arising from contamination on surfaces and objects within inhabited areas
Other benefits	None
Recovery option description	Steam cleaning techniques use machines to spray hot detergent solution on to upholstered surfaces, carpets, tapestries etc, which is vacuumed off before the fabric becomes saturated Steam cleaning physically extracts contaminants from materials and equipment surfaces. The steam is applied by hand-held wands or automated systems, and the contaminated condensate waste is collected for treatment and disposal. Steam cleaners which use hot water are not suitable for silk, viscose or cotton velvet fabrics. Care should be taken to avoid spreading contamination through floating bubbles
Key information requirements	Seek specialist advice and guidance Availability of skilled personnel, contractors and specialist equipment What type of building has been contaminated (eg critical facility or domestic property)? What surfaces and objects are within the building? How will the contaminated waste generated by this option (eg contaminated condensate or waste water and run-off) be managed?
Linked recovery options	This is a remediation option and may need to be linked to protection options This technique may be used in conjunction with other techniques such as (11) Energy decontamination techniques and (13) HEPA vacuum cleaning to enhance the removal of contamination
Target environment	Surfaces of contaminated buildings and objects within it that are robust enough to be cleaned with water
Targeted organisms	This recovery option is applicable to all biological agents that pose a risk to public health and are susceptible to hot steam. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Surfaces in all types of buildings and potential objects within it
Exposure pathway prevention	Inhalation, dermal (skin) contact and ingestion of biological contamination
Time of application	Maximum benefit if carried out soon after incident when maximum contamination is on surfaces and before natural weathering can disperse contamination throughout the environment
Considerations	
Public health considerations	This option can potentially aerosolise biological contamination and increase the risk of spread and exposure. This risk is minimised if the population is absent from the area. Appropriate risk assessments will need to be carried out Risk to staff undertaking the steam cleaning
Legal implications and obligations	Liabilities for possible damage to property There may be issues with ownership and access to property There may be issues with using this option in listed or other historic buildings and on precious objects
Social implications	Public acceptability of waste treatment and storage routes of contaminated condensate and run-off Possible damage to building surfaces and objects Positive benefit of cleaning houses Maintenance of use of indoor spaces
Environmental considerations	The disposal or storage of waste arising from the implementation of this option may have an environmental impact. However, this should be minimised through the control of any disposal route and relevant authorisations Potential run-off
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	Would vary dependent on the surface and biological agent involved. If implemented successfully it is likely to remove nearly all contamination from a surface. However, steam cleaners, which use very hot water, are not suitable for all surfaces Depends on cleanliness of surface

(12) Steam cleaning

Technical factors influencing effectiveness of recovery option	Type of cleaning method used Time of operation (the longer the time between the incident occurring and implementation of the option the less effective it will be, as contamination may have migrated over time) Whether any cleaning has already been undertaken Efficiency of equipment Appropriate clean-up of other indoor surfaces and objects Ability to clean surfaces and objects thoroughly

Feasibility and intervention costs

Specific equipment	Seek specialist advice and guidance; specialist equipment may be required to undertake this option Steam cleaners Wet vacuum cleaners Transport vehicles for equipment and waste Sampling and monitoring equipment
Utilities and infrastructure	Electricity supply Water supply Roads for transport of equipment and waste Waste storage/holding utilities
Consumables	Fuel and parts for vehicles Water and detergent Decontamination reagents, eg bleach
Skills, personnel and operator time	Seek specialist advice and guidance as skilled personnel, contractors and specialist equipment may be required. Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of contaminated surfaces (eg floor tiles, bricks and upholstery)
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs) Appropriate PPE that may be required could include: • respiratory protection (may be required in highly contaminated areas) • gloves and overalls • waterproof clothing Normal safety procedures for handling biological agents Help and assistance may be required for storage areas, COSHH regulations etc Consider disposal of cleaning of contaminated PPE
Other limitations/ factors influencing costs	Removable items are easier and cheaper to dispose of Agent(s) involved Type of surface contaminated Building size Type of equipment used Access to the property Tidiness of houses and amount of 'contents' Amount of dust/dirt on surfaces Disposal route – if waste is not sampled first, it must be assumed that the same level of contamination remains so there will be limited disposal options

Waste

Amount and type	Water-based wash solutions Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance

(12) Steam cleaning	
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance
Factors influencing waste issues (eg cost)	Waste water contaminated with debris or material that in itself would be classified as dangerous in transport (eg asbestos) is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Exposure	
Averted exposure	There should be a significant reduction in potential exposures to members of the public living in affected areas. However, it should be noted that this technique will only reduce exposure to people while they are in particular environment. Averted exposure will be dependent on specific situations and the surfaces cleaned
Factors influencing averted exposure	Consistency in effective implementation of option over a large area; need to ensure edges and corners are cleaned properly Application of appropriate clean-up to other indoor surfaces and objects Time of implementation: the impact of cleaning surfaces on overall exposure will be reduced with time if clean-up is delayed (due to natural weathering) Care of application: need to wash contamination off surfaces and not just move it around the surface or on to another surface The amount of time spent inside contaminated buildings by recovery workers or members of the public if this is used as a self-help option should be considered. Restriction of the public will be most effective
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident where steam is used as a remediation technique Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands Exposure routes from transport and disposal of waste are not included
Other considerations	
Agricultural impact	Seek specialist advice and guidance. There may be a risk to agricultural land due to leaching of contaminated water
Compensation issues	There may be requests for compensation for loss of possessions and other valuable items Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A
Additional information	
Practical experience	

(12) Steam cleaning

Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
Document history	

(13) HEPA vacuum cleaning

Objective	To reduce exposure arising from contamination on internal surfaces of buildings and objects within inhabited areas HEPA filters will also allow reduction in cross contamination Vacuuming increases evaporation of liquids from surfaces besides physically removing solid residues
Other benefits	This recovery option may also remove contamination from indoor surfaces and objects in buildings. Implementing this option will make an area look clean, remove surface debris that might otherwise inhibit disinfection procedures, provide public reassurance and restore public confidence
Recovery option description	A variety of vacuum cleaning machines are available. Seek specialist advice and guidance, as the most appropriate method will be determined by the biological contaminant(s) and target surface material HEPA vacuum cleaning can achieve significant reductions in the gross levels of biological contaminants on surfaces. This approach is clean, does not damage materials and does not generate waste by-products other than those present in the filters themselves. HEPA vacuum cleaning also reduces the potential for re-aerosolisation of the biological contaminant. However, HEPA vacuum cleaning may give rise to dust (particularly in dusty environments). Using water to dampen the surface is unlikely to be practicable and so PPE must be provided for the workers to reduce the resuspension hazard
Key information requirements	Seek specialist advice and guidance Availability of specialist equipment and appropriately trained/skilled personnel What surface or type of building has been contaminated? Are other mechanical methods required first (eg move building debris)? How will the contaminated waste generated by this option (eg filters and collected debris) be managed?
Linked recovery options	This is a remediation option and should be linked to protection options This technique may be used in conjunction (11) Energy decontamination techniques and (12) Steam cleaning to enhance removal of contamination
Target environment	Internal surfaces and objects in buildings
Targeted organisms	This recovery option is applicable to all biological agents that pose a threat to public health and that may resuspend in the environment. This option is unlikely to be useful for liquids containing biological contaminants. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any: HEPA vacuum cleaning is suitable for indoor surfaces in all types of building. This option may be applicable to some external environments but expert advice should be sought on an incident- and site-specific basis
Exposure pathway prevention	Inhalation, dermal (skin/ocular) contact and ingestion of biological contamination
Time of application	Maximum benefit soon after an incident when maximum contamination is on surfaces and before natural weathering can disperse contamination throughout the environment. If there is a delay in implementing this option consider the possibility that contamination may have been transferred throughout buildings or homes, eg by touching surfaces. Therefore, a good sampling strategy and/or regular repeated applications may be required until contamination from the surrounding environment is effectively remediated

Considerations

Public health considerations	None
Legal implications and obligations	Liabilities for possible damage to property Ownership and access to property Use in listed or other historic buildings and on precious objects
Social implications	Public acceptability of waste treatment and storage routes Possible damage to indoor building surfaces and objects Positive benefit of cleaning houses Acceptability of active disposal of contaminated waste water into the public sewerage system Acceptability of disposal of filtered waste from contaminated water (eg incinerator or landfill)

(13) HEPA vacuum cleaning

Environmental considerations	Indoor vacuuming should have a limited environmental impact if waste is disposed of appropriately Outdoor vacuuming will be complicated by weather Wet conditions will create additional contaminated waste water, which may require filtering prior to disposal If waste water is not to be collected, and the hard surfaces are not equipped with drains, this option should not be considered
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	If the biological contaminant(s) is(are) effectively removed by vacuum cleaning, exposure reduction should be significant For outdoor areas, biological contaminant(s) will be removed rapidly from these surfaces through natural weathering; therefore the effectiveness of vacuum cleaning as a remediation method decreases over time
Technical factors influencing effectiveness of recovery option	This will vary depending on the vacuum cleaning technique used and the size and scale of contamination. Specific factors that should be considered include: • type and condition of surface • time of implementation (effectiveness as a remediation option decreases over time as contaminated dust may disperse from the affected area) • consistent application over the contaminated area; need to ensure edges and corners are cleaned • amount of dust/debris on surfaces at the time of contamination • ineffective removal of contamination around drains and in gutters • removal of loose debris from surface • amount of hard outdoor surfaces in the area • whether decontamination been carried out on adjacent surfaces, or any other cleaning has already been undertaken • efficiency of equipment (depends on aerosol size of contaminant) • amount of furniture and furnishings in the buildings and ventilation rates • relative humidity may also be a factor
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance as specialist equipment may be required The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service HEPA vacuum cleaner with brush attachment and upholstery cleaning attachment. Costs will be influenced by building size, type of equipment used, access, use of PPE, tidiness of buildings and amount of 'contents' and amount of dust/dirt on surfaces Transport vehicles for equipment and waste
Utilities and infrastructure	Electricity supply Roads for transport of equipment and waste
Consumables	Fuel and parts for equipment, generators and vehicles. Also, specialised filters
Skills, personnel and operator time	Seek specialist advice and guidance as specialist equipment may be required. Only a little instruction is likely to be required to operate the equipment. Vacuum cleaning could be implemented by the population as a self-help measure, after instruction from authorities and the provision of safety equipment (PPE) Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of contaminated surfaces (eg floor tiles, bricks and upholstery)
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)

(13) HEPA vacuum cleaning

	If this vacuum cleaning is implemented as a 'self-help' option, PPE, including respiratory protection, will be required due to potential dust production
Other limitations/ factors influencing costs	Outdoor surface, building and size of area to be cleaned will influence the cost of this option. The type of equipment required may also affect the cost of this option as a remediation technique Costs will be influenced by weather, topography, size of area to be treated and type of equipment
Waste	
Amount and type	The HEPA vacuum cleaning process will produce contaminated dust waste and potential contamination of the internal HEPA filters Some wastes can be classified as hazardous (eg asbestos). To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance
Factors influencing waste issues (eg cost)	This will vary depending on the size and scale of contamination Contaminated dust and debris or material that in itself would be classified as dangerous in transport (eg asbestos) is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Exposure	
Averted exposure	There should be a significant reduction in potential exposures for members of the public living in the affected areas. However, it should be noted that these techniques will only reduce exposure of people while they are in particular environment
Factors influencing averted exposure	Averted exposure will be dependent on specific situations and the surfaces cleaned Consistency in effective implementation of option over a large area; need to ensure edges and corners are vacuumed appropriately Population behaviour in the area (eg amount of time spent in buildings) Number of buildings in the area Weather at the time of the incident; less material is deposited indoors during wet conditions. Initial contamination is also influenced by the amount of furniture and ventilation rates Time of implementation: the impact of cleaning the surfaces on the overall exposure will be reduced with time as there will be less contamination on the surfaces due to natural weathering Application of appropriate clean-up to other indoor surfaces and objects
Potential increased worker exposure	None
Other considerations	
Agricultural impact	None
Compensation issues	There may be requests for compensation for loss of some property (eg jewellery or small valuables) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

(13) HEPA vacuum cleaning

Additional information

Practical experience	HEPA vacuum cleaning was used to remove contamination from soft furnishings and modular workstations during remediation of the 'Amerithrax' attacks (Canter, 2009)
Key references	Canter DA, Sgroi TJ, O'Connor L and Kempter CJ. Source reduction in an anthrax-contaminated mail facility. Biosecur Bioterror. 2009 Dec;7(4):405–12 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
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(14) Modify operation/cleaning of ventilation systems

Objective	To reduce exposure from contaminated ventilation systems in commercial and public buildings
Other benefits	Removal of contamination from the area and prevent redistribution of contamination in buildings
Recovery option description	*Reduce spread of contamination: interior release* – strategies for reducing the spread of contamination through building conditioning systems may include rapidly isolating all air handling unit (AHU) fans and closing all heating, ventilation and air conditioning (HVAC) dampers, including exhaust dampers. This could be implemented in the response (emergency) phase of a biological incident to reduce the spread of contamination if an incident occurred inside a building *Reduce spread of contamination: exterior release* – significant contamination of building interiors following an exterior airborne release may be relatively unlikely, except for large-scale events. HVAC systems can be shut down if an exterior release is identified, but some ingress can potentially occur through 'leaks' in the building envelope including the main and ancillary entrances *Underground transport networks* – disabling ventilation systems may need to be considered if contamination has occurred on an underground transport network (eg London underground). Once evacuation has taken place, shutting down ventilation systems may prevent the spread of contamination to the outdoor environment (eg streets) *Cleaning* – ventilation systems may become heavily contaminated and are not very easy to decontaminate or clean. Potential cleaning options will vary dependent on the biological agent involved. A significant quantity of biological contamination may be removed by exchanging the air filters from industrial buildings, mainly from ventilation systems and heaters
Key information requirements	Are the HVAC plans for the building available? What is the size and scale of the incident? Are skilled personnel and specialist equipment required?
Linked recovery options	This is a remediation option and should be linked to protection options This recovery option could be used in conjunction with (8) Reactive gases and vapours, (12) Steam cleaning and (13) HEPA vacuum cleaning to facilitate decontamination
Target environment	Contaminated AHU and HVAC units within buildings
Targeted organisms	This recovery option is applicable for all biological agents that pose a risk to public health and that could be dispersed through a buildings ventilation system. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Inhalation of biological agents
Time of application	Maximum benefit if carried out shortly after contamination
Considerations	
Public health considerations	Seek specialist advice and guidance, as there may be a need to consider biological contamination dispersal outside of the building
Legal implications and obligations	Liabilities for possible damage to property In some cases, small-scale demolition may be necessary as part of the process of making building modifications. Most demolition of non-residential properties does not need planning permission or prior approval
Social implications	It may be difficult for recovery workers to access ventilation systems to clean them effectively Reassurance of employees and users of the building that biological contamination has been removed, and maintaining continuity of work
Environmental considerations	Electronic parts may be damaged by water if not dismounted
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	The effectiveness of this option will depend on which strategy is employed, eg whether to use the ventilation system to induce fresh air into a building or to expel contaminated air out of a building. It will depend on the specification of the individual air ventilation system

(14) Modify operation/cleaning of ventilation systems

Technical factors influencing effectiveness of recovery option	HVAC systems can be shut down if an exterior release is identified, but some ingress is then likely to occur through 'leaks' in the building envelope including the main and ancillary entrances Operator skills/knowledge of specific ventilation system Technical difficulties in accessing and cleaning contaminated areas Pressure and amount of water for high pressure water treatment Water temperature: because the air outlet channels, in particular, may be greasy and contain dust, a high water temperature (>60°C) is required to ensure a high reduction in contamination levels. However, it should be noted that the inlet channels are usually the most contaminated Need to be aware of potential build-up of flammable natural gases (eg methane) in poorly ventilated underground spaces
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance, as skilled personnel are likely to be required to undertake this recovery option The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service Other equipment that is likely to be required includes: • monitoring equipment • brushes and vacuum device • appropriate containers for temporary storage of waste products • transport vehicles for equipment and waste • 'dust trap' filter and/or industrial type vacuum cleaner and/or high pressure water washer • grinding machines • other hand tools
Utilities and infrastructure	Transport vehicles for equipment Scaffolding or mobile lifts for tall buildings, where channels may be mounted under the ceiling
Consumables	Water supply Pressurised air supply
Skills, personnel and operator time	Seek specialist advice and guidance, as skilled personnel are likely to be required to undertake this recovery option. Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of contaminated buildings or ventilation systems that require remediation
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs) Appropriate safety equipment (eg hat, lifelines, waterproof safety clothing and boots) Respiratory protection would be important if there is a risk that dust and particulate matter would be generated dust. Appropriate safety measures and respiratory protection will be required if asbestos is present
Other limitations/ factors influencing costs	Need for scaffolds/mobile lifts and potential need for different types of treatment (dependent on, eg, channel sizes and other ventilation system characteristics) Cost of specialist labour
Waste	
Amount and type	Cleaning ventilation systems is likely to generate moderate amounts of contaminated waste material Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance Dry waste is collected in vacuuming filters that are relatively easy to dispose of

(14) Modify operation/cleaning of ventilation systems

	Liquid waste from pressure washing can mostly be collected and filtered with the industrial vacuum cleaner, so that the water is cleaned and sludge is left
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport Spent filters/absorbent material may be collected as solid waste and disposed of to landfill or incineration
Factors influencing waste issues (eg cost)	Contaminated waste must be transported in suitable tank-vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles Debris contaminated with material that would be classified as dangerous in transport (eg asbestos) is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Exposure	
Averted exposure	Inhalation of biological contaminants
Factors influencing averted exposure	Consistency in effective implementation of option throughout the affected ventilation system Appropriate decontamination of surrounding surfaces (eg walls, floors and ceilings)
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving the modification/cleaning of ventilation systems as a remediation technique Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant) Exposure routes from transport and disposal of waste are not included
Other considerations	
Agricultural impact	N/A
Compensation issues	There may be requests for compensation for loss or damage to property, or loss of earnings as this recovery option may restrict the movement of transport, eg goods, products and services Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	Public perception (and that of the workforce) may be a highly significant issue that is difficult to overcome. Ongoing health monitoring and surveillance may be required to ease the public's mind or the addition of extra carbon filters, etc
Additional information	
Practical experience	After remediation of a Lassa fever contaminated patient room, air filters were replaced in the ventilation systems (Otter, 2010)

(14) Modify operation/cleaning of ventilation systems

	During a SARS outbreak in a hospital in Taiwan, the ventilation in isolated patient rooms was modified to produce negative pressure as a means of containing the contamination (Liu JW, 2010)
Key references	Liu JW, Lu SN, Chen SS, Yang KD, Lin MC, Wu CC, et al. Epidemiologic study and containment of a nosocomial outbreak of severe acute respiratory syndrome in a medical center in Kaohsiung, Taiwan. Infect Control Hosp Epidemiol. 2006 May 1;27(5):466–72 Otter JA, Barnicoat M, Down J, Smyth D, Yezli S, Jeanes A. Hydrogen peroxide vapour decontamination of a critical care unit room used to treat a patient with Lassa fever. J Hosp Infect. 2010 Aug;75(4):335–7 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
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(15) Storage, covering, gentle cleaning of precious objects

Objective	To reduce exposure arising from contamination on personal items (eg mobile phones, credit cards and laptops) and precious objects within inhabited areas
Other benefits	Gentle cleaning will remove contamination from precious objects within buildings
Recovery option description	It may not be possible or appropriate to carry out decontamination of precious objects, such as museum artefacts, tapestries, jewellery and paintings, due to the risk of damaging the objects during the cleaning process. Important personal items such as mobile phones, car keys, credit cards, laptops and jewellery also need to be considered Several alternative options are available for such objects Some precious objects, which do not require handling, could be placed in protective casing or covered. For instance, museum artefacts could be placed behind glass or Perspex; the objects can then remain on display, but the public would be protected from the contamination. Specialist gentle cleaning techniques could be considered for other objects and personal items In some cases this option may be implemented for public reassurance purposes if the risk of adverse health effects arising from biological contamination of personal and precious objects is likely to be low
Key information requirements	None
Linked recovery options	This is a remediation option and may need to be linked to protection options In the case of extensive contamination that cannot be removed by gentle cleaning, appropriate disposal may need to be considered, see (19) Removal and disposal of contaminated material This recovery option could also be potentially be linked to (8) Reactive gases and vapours and (12) Steam cleaning
Target	Precious and personal objects within buildings
Targeted organisms and dispersion methods	This recovery option is applicable for all biological agents that pose a risk to public health and that are otherwise difficult to decontaminate. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small objects
Exposure pathway prevention	Inhalation, skin contact and inadvertent ingestion of biological contamination
Time of application	Maximum benefit if carried out soon after incident
Considerations	
Public health considerations	None
Legal implications and obligations	Liabilities for possible damage to objects Ownership and access to objects Use in listed or other historic buildings
Social implications	Potential damage to valuable items Decision to retain some objects and dispose of others could have social repercussions (eg credit cards, mobile phones or laptops) Possible damage of objects with particular heritage significance Lack of access to objects and buildings by the public
Environmental considerations	None
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	Will vary dependent on the biological agent involved, size of the object and type of material contaminated
Technical factors influencing	Type, condition and frailty of objects or personal items Value of object/item

(15) Storage, covering, gentle cleaning of precious objects

effectiveness of recovery option	Time of operation (contamination migrates elsewhere over time) Consistent application of cleaning over entire object Amount of dust on the surface of the object at the time of incident Whether any cleaning has already been undertaken
Feasibility and intervention costs	
Specific equipment	Specialist cleaning equipment for gentle cleaning
Utilities and infrastructure	Power and water supplies Storage facilities
Consumables	Protecting materials (eg glass, Perspex and zip lock bags) Cleaning materials (swabs and cotton buds) Cleaning solutions (mild detergents or soap)
Skills, personnel and operator time	This recovery option may require specialist cleaning and handling skills Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of personal items or precious objects that are contaminated
Safety precautions	Gloves and overalls
Other limitations/ factors influencing costs	None
Waste	
Amount and type	Waste water may be generated from cleaning; however, unlikely to be a large quantity Solid waste (eg cotton buds, swabs and cleaning clothes) Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Spent cleaning materials (eg cotton buds, swabs and clothes) may be collected as solid waste and disposed of to landfill or incineration
Factors influencing waste issues (eg cost)	Contaminated waste must be transported in suitable tank-vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles Debris contaminated with material that would be classified as dangerous in transport (eg asbestos) is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Exposure	
Averted exposure	Cleaning objects will only reduce exposure of people while they are indoors and will be very dependent on the specific situation and the objects and other surfaces cleaned
Factors influencing averted exposure	Weather at time of incident; less material from a biological aerosol would be deposited indoors during wet conditions Appropriate clean-up of other indoor surfaces and objects
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving the cleaning of personal items/precious objects as a remediation technique Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment

(15) Storage, covering, gentle cleaning of precious objects

	• inadvertent ingestion of contamination from workers' hands (unlikely to be significant) Exposure routes from transport and disposal of waste are not included

Other considerations

Agricultural impact	N/A
Compensation issues	There may be requests for compensation for loss or damage to personal property, or being displaced from home (eg credit cards, keys and laptops seized by the police) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	Storage, containment and cleaning may be expensive and take time. Also, the cost to replace the item should be evaluated, as the uniqueness of the item may influence the applicability of this option

Additional information

Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
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(16) Natural inactivation

Objective	This is a passive option to allow the natural degradation or dispersal of a biological agent naturally within the environment (eg internal building structure or external building surface) until it poses little or no hazard to the inhabitants
Other benefits	No active implementation required, therefore overall cost is likely to be lower than for many active remediation technologies. As this option involves monitoring, this can have a positive impact on the affected population
Recovery option description	Natural inactivation processes include a variety of physical, chemical or biological processes that, under favourable conditions, act without human intervention to reduce the level of contamination. These processes include: • destructive mechanisms: biodegradation, destruction, oxidation and hydrolysis • non-destructive mechanisms: dispersion and dilution Monitoring of the affected areas is required to confirm whether natural inactivation processes are acting at a sufficient rate to ensure that the wider environment is unaffected and that remedial objectives will be achieved within a reasonable timescale However, allowing biological contamination to inactivate within a building environment will be extremely limited. Opening windows and doors may accelerate the clearance of biological contamination but there would need to be consideration for the outdoor environment The environment into which a biological agent is released can also determine the feasibility of this recovery option. For instance, it may be more acceptable to let a biological agent inactivate in the environment in a rural area that is rarely used, whereas a commercial district or critical facility may require more urgent remediation strategy due to social and time pressures
Key information requirements	To properly evaluate this recovery option, it is necessary to know the location, concentration of the contaminant and properties of the biological agent Is there sufficient site data to support monitored natural inactivation as a viable recovery option? Do the site characterisation data and results of modelling demonstrate that natural inactivation is occurring and can achieve the risk management objectives? Is the monitoring programme sufficiently robust? Do the results of the monitoring demonstrate that remedial goals have been achieved and monitoring can cease?
Linked recovery options	This is a remediation option and may need to be linked to protection options This option can be used in conjunction with, or after, other remediation methods such as (14) Modify operation/cleaning of ventilation systems
Target	Potentially all surfaces, but may be more effective in environments that are not frequently used
Targeted organisms and dispersion methods	This recovery option should only be considered for biological agents with a short persistence or for environments that would be difficult to decontaminate but are not frequently used. For instance, this would not be a potential option for *Bacillus anthracis* in industrial buildings. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Inhalation, dermal (skin) contact and ingestion of biological contamination
Time of application	This recovery option can be implemented from the early to late phase (hours to years) of a biological incident. This recovery option may take several decades to arrive at a satisfactory outcome
Considerations	
Public health considerations	The natural attenuation process will expose any person who comes into contact with the area to the agent. Therefore it is imperative to restrict access to the area and (1) Restrict public access should be used as a protection option
Legal implications and obligations	There is legislation linked to the enforcement and control of natural inactivation as a remedial option. Depending on the nature of the contamination, consultation with the Environment Agency in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland or the Northern Ireland Environment Agency (NIEA) will be required. Some of the activities that are associated with monitored natural attenuation may themselves be subject to regulatory control
Social implications	Acceptance of monitored natural inactivation requires liaison and agreement with various stakeholders (landowners, insurers, financiers and prospective purchasers) and the relevant regulators. Regular

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	consultation is recommended throughout the screening, demonstration, assessment and implementation stages of this recovery option The public may perceive this option as 'doing nothing', which can have negative implications
Environmental considerations	Unsuitable weather conditions, eg lack of rain/wind or sun Potential for spread of contamination in the environment
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	Seek specialist advice and guidance. The effectiveness of this option is directly linked to the biological characteristics of the agent and behaviour in different environments and surfaces
Technical factors influencing effectiveness of recovery option	This recovery option may take from hours to several decades to arrive at a satisfactory outcome; therefore this potentially long-term time frame makes this recovery option susceptible to changes in various technical, economic and regulatory conditions, including land use and legislative changes. These factors need to be considered in the design and application if natural inactivation is selected as a long-term remediation strategy Weather conditions may influence the effectiveness of this option Also, if certain outdoor surfaces are protected from rainfall (eg bus shelter) contamination would potentially persist for longer. Similarly, agents may persist for different periods depending on the surface contaminated In addition, the level of perceived or actual risk will influence the appropriateness of implementing this recovery option, including: • sensitivity of the site (presence and proximity of vulnerable receptors) • hazardous properties of the biological contamination (mobility, persistence and pathogenicity) • level of uncertainty in the definition of the conceptual model and in assessment/monitoring data available
Feasibility and intervention costs	
Specific equipment	Screening and monitoring equipment
Utilities and infrastructure	Capacity to analyse samples (eg laboratory facilities)
Consumables	None
Skills, personnel and operator time	Seek specialist advice and guidance. Skilled personnel may be required to undertake monitoring and analysis
Safety precautions	Will depend on the agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance
Other limitations/ factors influencing costs	There is the potential for the long-term monitoring for many years (decades), which will require significant financial provision; other recovery options may provide a more favourable cost-to-benefit ratio; there is also a risk that data may confirm that active remediation is required after all. Finally, the cost of developing contingency plans may be prohibitive
Waste	
Amount and type	No waste is generated using this option. However, note that contaminated land may be classified as waste (but excluded from most waste controls)
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	If the agent does not persist in the environment, exposure may be reduced but maybe not as quickly in comparison to other decontamination options

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Factors influencing averted exposure	Weather conditions and season
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers (eg specialist personnel undertaking sampling and monitoring) who could be exposed to biological contaminant(s) may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving natural inactivation Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands Exposure routes from transport and disposal of waste are not included Incremental exposure to the public will be influenced by their knowledge, understanding and compliance of associated advisory notices and warnings about the incident

Other considerations

Agricultural impact	Potential for spread of contamination in the environment
Compensation issues	There may be requests for compensation loss of earnings as this recovery option may restrict the movement of transport and tourism into an area (eg land is perceived as blighted) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Acceptance of natural inactivation requires liaison and agreement with various stakeholders (landowners, insurers, financiers and prospective purchasers) and the relevant regulators. Regular consultation is recommended throughout the screening, demonstration, assessment and implementation stages of this recovery option Potential concerns could be raised due to the civil liabilities associated with migration of contamination between neighbouring properties; therefore communication of site monitoring is of key importance
Other considerations	N/A

Additional information

Practical experience	
Key references	Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(17) Soil and vegetation removal

Objective	To reduce exposure from contamination on outdoor grassed and soil areas within inhabited areas
Other benefits	Removal of contamination from grassed and soil areas. Removal of contaminant from grass areas in gardens may reduce subsequent contamination of soil used for growing food or in borders. This in turn may reduce uptake by food crops grown and potential splash contamination of flowers and other amenity plants
Recovery option description	There are a variety of techniques that could be used, dependent on the type of outdoor area involved and the level of contamination *Topsoil and/or turf/surface vegetation removal* – turf and the top 50 mm (may vary according to agent) of topsoil may be removed, eg using a spade (manual) or by mini-bulldozers (mechanical). Any plants and shrubs would need to be removed first and long grasses may need to be cut. Backfilling with clean topsoil may be beneficial to encourage clean plant growth and dilute residual contamination *Plant, tree and shrub removal* – a portable chainsaw, brush cutter or forage harvester (depending on the size of the area being remediated) is used to remove plant growth. Waste vegetation is removed by loading into trailers. If tree felling is conducted on a small scale, incineration of the waste in-situ is an option. Replanting is likely to be required. Any transport of waste will have to ensure that contaminated debris does not fall from vehicles while in motion *Collection of leaves* – collection of leaves (deciduous trees and shrubs), needles and pinecones (coniferous trees). Leaves that have fallen from trees are collected and disposed of or composted. Additional decontamination may also be necessary for surfaces under trees andshrubs
Key information requirements	Seek specialist advice and guidance Availability of skilled personnel and contractors, and specialist equipment that can be decontaminated What type of outdoor environment (eg parkland or farmlands) has been contaminated? How will the contaminated waste generated by this option be managed and disposed of? Will there be any environmental consequences (eg loss of habitats)? Has a cost–benefit analysis been completed?
Linked recovery options	This is a remediation option and should be linked to protection options such as (1) Restrict public access
Target	Soil and vegetation in inhabited areas
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that pose a risk to public health and those with low mobility in soil. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small to large scale dependent on technique used
Exposure pathway prevention	Inhalation, dermal (skin) and inadvertent ingestion of biological contamination
Time of application	Maximum effectiveness will be achieved soon after contamination and before natural weathering can occur. Can be applied later for biological agents that remain in the top layer of soil or on plant surfaces

Considerations

Public health considerations	Seek specialist advice and guidance. There is a likelihood of biological contaminated dust and particulate matter being produced using some of these methods May increase atmospheric levels of some allergens (pollen, etc) at some times of the year
Legal implications and obligations	Part 2A (Environment Protection Act 1990) Contaminated Land Liabilities for possible damage to property Ownership and access to property Appropriate recovery/disposal of collected waste Use on listed or conservation areas or sites of special scientific interest Restocking liabilities
Social implications	Access/acceptability for people's gardens/recreational areas Aesthetic issues Tourism may be affected
Environmental considerations	Soil texture: turf harvesting equipment is very sensitive to stones and rocks In extreme cases, the slope of the area may be a constraint

(17) Soil and vegetation removal

	This option may also pose a soil erosion risk and increase flooding risks This option may have a possible adverse impact on biodiversity and ecology in the affected area (may cause loss of plants, shrubs and soil fertility)
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	If the recovery option is implemented effectively, further exposure is likely to be reduced or eliminated
Technical factors influencing effectiveness of recovery option	Depth to which biological contamination has moved into soil and height of deposition (eg tops of trees) Weather conditions, particularly those at the time of contamination and the amount of rain following contamination Binding of agent to leaf surfaces, to bark and soil/rock Collection of leaves would be influenced significantly by the season Correct implementation of the option – all contaminated soil and vegetation should be collected to work effectively. For biological agents that have migrated below 50 mm in the soil, this option is less effective unless the depth of removal is increased Soil texture: dry, crumbly soils will be more difficult to remove Topography of the affected area (ie evenness of ground) Amount of the area with grass, soil and vegetation coverage Time of operation (contamination migrates into the soil over time)
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance, as specialist equipment may be required Specific equipment will depend on the size of the area being treated and the technique employed, and includes mower, brush cutter, tractor, rake, spade, motorised scraper, grader or bulldozer More specialist equipment includes seeding machine, chainsaw, axes/cutters, ropes and ladders (for tall trees) and shredder An incinerator may be used for waste from small areas Transport vehicles and containers for equipment and waste
Utilities and infrastructure	Roads (transport of equipment, materials and waste) Power supply
Consumables	Fuel and parts for vehicles and equipment Plants and turf or grass seed (if required)
Skills, personnel and operator time	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service For some of these techniques only a little instruction is likely to be required (eg grass cutting and plant and shrub removal). However, they may require hard physical work, which not all people would be capable of. They could, to some extent, be implemented by the inhabitants of the affected area as a self-help measure, after instruction from authorities and provision of safety and other required equipment Skilled personnel are required to operate brush cutters and forage harvesters and equipment for tree felling If it is necessary to wear additional PPE (including respiratory protective equipment) then heat stress will have to be managed
Safety precautions	Under very dusty conditions respiratory protection and protective clothes/gloves may be recommended to reduce the hazard from resuspended contamination (eg dust) PPE may be required dependent on the biological agent involved and level of contamination
Other limitations/ factors influencing costs	The appropriateness of this recovery option is influenced by the biological characteristics of the contaminant Requirement for skilled workforce (or not)

(17) Soil and vegetation removal

	Soil type, soil condition and depth removed Amount of soil and vegetation to be removed Weather Topography (ie evenness of the affected surface) Size of affected area requiring remediation Type of equipment used/required Decontamination capability Access to the contaminated area requiring remediation
Waste	
Amount and type	Most of these techniques are likely to generate large quantities of biologically contaminated soil and vegetation that will require appropriate disposal in accordance with permit controls In some cases incineration of trees or shrubbery could be considered on a relatively small scale, although this will depend on the biological agent involved In rural environments decontamination will mainly generate solid wastes, such as soils and foliage which may be treated by incineration processes or sent to landfill as hazardous waste. Smaller volumes of secondary wastes, such as bags of contaminated clothing, will also be generated which may be disposed at a clinical waste incinerator Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport. Solids should be transported in bulk transport units fitted with liners that can be closed for transport or in sift-proof receptacles Experience has shown that there may be a need to identify and establish an intermediate temporary storage site, or sites, between the site of the incident itself and the ultimate final destination(s) of debris. Such sites may be required to aid forensic investigation as well as sorting large amounts of contaminated waste
Factors influencing waste issues (eg cost)	Contaminated waste must be transported in suitable tank-vehicles or leak-proof receptacles. Debris contaminated with material that would be classified as dangerous in transport is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Exposure	
Averted exposure	Will vary dependent on the surfaces contaminated and the specific technique employed, although there should be significant exposure reduction if employed effectively
Factors influencing averted exposure	Effective implementation of option over a large area Reductions in exposure received by a member of public living in the area will depend on the amount of the area covered by grass and the time spent by individuals on or close to grassed areas Time of implementation: the impact of removing the contamination on the overall exposure will be reduced with time as there will be less contamination on the surfaces due to natural weathering
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving soil and vegetation removal Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment

(17) Soil and vegetation removal

	• inadvertent ingestion of contamination from workers' hands Exposure routes from transport and disposal of waste are not included

Other considerations

Agricultural impact	This is a risk of soil erosion, loss of plants, shrubs and biodiversity associated with the implementation of this recovery option
Compensation issues	There are likely to be requests for compensation for loss of agricultural foodstuffs Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

Additional information

Practical experience	
Key references	Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(18) Barriers to seal land contamination

Objective	Containment methods used to manage contaminated soil using established engineering approaches
Other benefits	Containment isolates the contaminated material or matrix, preventing exposure to the surrounding environment
Recovery option description	Barriers are used to prevent the migration of contaminants. Available techniques include: *Vertical barriers* – a physical wall constructed around a contaminant source to isolate contaminants, minimise the spreading of contaminants and restrict potential ground water contamination *Horizontal barriers* – injection or placement of a physical impermeable construction above or beneath a contaminated volume *Cover systems* – an engineered horizontal layer of 'uncontaminated' material placed on the surface or in the sub-surface. The cover may be a single layer or multi-layered and may be used for forming a barrier between contaminated material and surrounding environment (people, animals and plants) or for controlling the upwards migration of contaminated water or gas. Covers may be soil or soil-like material or synthetics
Key information requirements	What biological agent(s) are involved? What is the layout of the area requiring remediation? What are the requirements of the land user(s)?
Linked recovery options	This is a remediation option and should be linked to protection options This recovery options should be considered in conjunction with (17) Soil and vegetation removal and (20) Burial in-situ
Target	Contaminated land
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that are likely to pose an inhalational hazard. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small to medium
Exposure pathway prevention	Inhalation, dermal (skin) contact and ingestion of biological contamination
Time of application	Not important (can be implemented decades after contamination occurred)
Considerations	
Public health considerations	None
Legal implications and obligations	There may be waste permitting implications associated with this option
Social implications	There may be some social disruption due to noise complaints. Barriers may pose an aesthetic issue. The public may also be sceptical of contamination not actually being removed and just sealed off
Environmental considerations	Considerations of the geological and hydrogeological conditions at the affected site may influence whether or not this is a suitable remediation option
Ethical considerations	This recovery option has the potential to improve the affected environment, either by being less of an eye-sore or improving the ecology within the affected area Barriers are likely to significantly impact the chemical and/or biological state of the soil, eg pH and organic matter, which can in turn reduce soil biodiversity
Effectiveness	
Recovery option effectiveness	Potentially very effective at reducing exposure to contamination
Technical factors influencing effectiveness of recovery option	The barrier type will be dependent on soil and water characteristics Modelling data will be required to assess and validate the performance of this option Life span of barriers to seal contamination should also be considered

(18) Barriers to seal land contamination

Feasibility and intervention costs

Specific equipment	Considerable resources used for construction of barriers: heavy plant machinery, plant tools and transport; excavation for permeable reactive barriers and absorbent materials to prevent contamination leaching Monitoring equipment to determine contamination levels post-intervention
Utilities and infrastructure	None
Consumables	Barrier materials, fuel and parts for vehicles
Skills, personnel and operator time	Seek specialist advice and guidance, as skilled personnel and scientific support are likely to be required to monitor the effectiveness of this option at the remediated site The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service
Safety precautions	Appropriate PPE and general safety precautions are required
Other limitations/ factors influencing costs	Type of barriers to be installed and duration of treatment. This option can be quite expensive

Waste

Amount and type	Dependent on the volume of contaminated soil that requires treatment The barriers may require replacement and disposal (10+ years) and would need to be disposed of through approved (permitted) routes Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A

Exposure

Averted exposure	There should be a significant reduction in the risk of potential exposure to members of the public living in the affected area
Factors influencing averted exposure	N/A
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving barriers to seal land contamination Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant) Exposure routes from transport and disposal of waste are not included

(18) Barriers to seal land contamination

Other considerations

Agricultural impact	N/A
Compensation issues	Financial and legal advice relating to compensation can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

Additional information

Practical experience	
Key references	Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
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(19) Removal and disposal of contaminated material

Objective	To remove and dispose of contamination associated with buildings and other contaminated items ranging from cars, street furnishing and personal items
Other benefits	Will prevent removal of contaminated materials for use elsewhere
Recovery option description	Removal refers to the physical dismantling and removal of contaminated objects, structures and equipment. Dismantling could be the sole activity of decontamination efforts or removal of substructures prior to other clean-up techniques, or to expose inaccessible areas of decontamination. These objects and structures can be taken away for decontamination at specialist facilities and returned to the owner free from contamination Disposal refers to the complete destruction and or disposal of objects, equipment, parts of equipment or any other parts of the infrastructure by an appropriate disposal route if it is unnecessary to decontaminate or too difficult to decontaminate Significant preparation activities may be required, eg all surfaces may need to be washed or wiped down with reactive liquids and all objects will need to be packaged correctly before being removed from the site of contamination Selective/partial dismantling could take place where furniture or internal/external surfaces are contaminated and in removing components of the building the contamination is removed (doors, windows, wooden panels, soft furnishings, etc). In extreme cases roofs could be removed and replaced to remove contamination. Removal of street furnishings would include items such as street signs and bus shelters, mainly formed of plastic and painted metal. This option may be expensive and labour intensive and should only be considered if other options are inappropriate for the level of contamination Internal objects and furnishings that could be considered for disposal include: • small materials removed from the building (eg books, papers, pictures and wall hangings) • small equipment and office items (eg staplers, telephones and hand tools) • large durable materials removed from the building (eg furniture, computers, copiers, fax machines and printers) • building and decorating materials (eg carpeting, draperies, window blinds, window air conditioners, ceiling panels, wallboard and panelling) • mail suspected of contamination • refuse, food and other unwanted materials present at the site at the time of contamination Decontamination prior to disposal – if a decision is made to dispose of contaminated material/objects, the implementation of other recovery options to reduce the amount of contamination in the final waste generated should also be considered
Key information requirements	Seek specialist advice and guidance Availability of skilled personnel and contractors and specialist equipment What surface (eg vehicle or road) or type of building has been contaminated? How will the contaminated waste generated by this option be managed and disposed of?
Linked recovery options	This is a remediation option and should be linked to protection options such as (4) Temporary relocation from residential areas This technique may be used in conjunction with other decontamination options such as (10) Reactive liquids and (13) HEPA vacuum cleaning to reduce the amount of contamination prior to disposal This option can also be considered a waste disposal option and can be used in conjunction with (11) Energy decontamination techniques, (20) Burial in-situ and (21) Incineration
Target	Highly contaminated buildings or surfaces (including vehicles and internal objects) in an area where exposure concentrations are too high for people to live or work
Targeted organisms and dispersion methods	This recovery option is applicable for all biological agents that pose a risk to public health, especially if persistent or otherwise difficult to decontaminate in-situ. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Inhalation, dermal (skin) contact and inadvertent ingestion of biological contamination
Time of application	This recovery option is not time limited and can be implemented at any stage

(19) Removal and disposal of contaminated material

Considerations	
Public health considerations	Seek specialist advice and guidance. The dismantling process (eg demolishment of buildings in extreme cases) may result in release of contamination (including dust and particulate matter) into the environment
Legal implications and obligations	Before any dismantling or demolition of residential or non-residential buildings can be considered approval from the local planning authority will need to be sought Listed and other historically important buildings will need further permission due to their historical status Solid waste treatment and disposal legislation Responsibility for relocating residents or users where this is required
Social implications	There may be issues with regard to the public acceptability of this option (eg people's homes, items or vehicles being dismantled) Temporary relocation of residents in areas immediately surrounding the building in question may be essential Public acceptability of waste production, treatment, storage and disposal routes Effects on business – this recovery option could have large financial implications Damage to an inhabited area Distress caused by loss of homes or amenities Public acceptability to aesthetic changes to the area This option may not be appropriate for use on listed and other historically important buildings
Environmental considerations	The dismantling process (eg demolishment of buildings) can result in the release of contamination into the environment The disposal or storage of waste arising from the implementation of this option may have an environmental impact. However, this should be minimised through the control of any disposal route and relevant authorisations. If wet weather occurs the potential movement of biological contaminants into ground water should be considered
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	If carried out effectively this option should eliminate further exposure to contamination
Technical factors influencing effectiveness of recovery option	Biological agent involved
Feasibility and intervention costs	
Specific equipment	Seek specialist advice and guidance The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service Specific equipment may vary (dependent on the technique and surface involved) but the following may be required: • monitoring equipment • tools for dismantling/disposing of contaminated material • appropriate containers for temporary storage of waste products • transport vehicles for equipment and waste
Utilities and infrastructure	Roads for transport of equipment, materials and waste Power supply Water supply
Consumables	Water Fuel and parts for equipment and vehicles

(19) Removal and disposal of contaminated material

Skills, personnel and operator time	Seek specialist advice and guidance, as skilled personnel are likely to be required to undertake this recovery option. Operator time and personnel requirements will vary depending on the size and scale of the biological incident and types of contaminated surfaces (eg buildings, roads, paved areas and vehicles)
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs) Appropriate safety equipment (eg hats and boots) for large-scale dismantling Respiratory protection would be important if there is a risk that dust and particulate matter would be generated. Appropriate safety measures and respiratory protection will be required if asbestos is present
Other limitations/ factors influencing costs	Costs and equipment required will vary according to the scale of contamination and size of structure that requires dismantling or disposal. Other factors influencing costs include: • property type and use (eg residential or commercial) • compensation for damage to building/property • weather • size of structure that requires disposal • type of equipment used
Waste	
Amount and type	Likely to generate large amounts of contaminated material. Many types of wastes that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance Disposal of waste may be expensive as the assumption (in the absence of sampling and monitoring) will be that all associated waste is contaminated and will have to be disposed of as appropriate. This will have further implications on transport, treatment, disposal and storage
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Options for packaging and conveying the waste, including treating the waste on site or at an off-site facility, and the possibility of interim storage if a final disposal site is not yet available Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport Experience has shown that there may be a need to identify and establish an intermediate temporary site, or sites, between the site of the incident itself and the ultimate final destination(s) of debris. Such sites may be required to aid forensic investigation as well as sorting large amounts of contaminated waste
Factors influencing waste issues (eg cost)	Contaminated waste must be transported in suitable tank-vehicles or leak-proof receptacles. Solids should be transported in bulk transport units fitted with a liner that can be closed for transport or in sift-proof receptacles Debris contaminated with material that would be classified as dangerous in transport is subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Exposure	
Averted exposure	It is likely that individuals would not inhabit the area where dismantling or disposal is being implemented. If the option is carried out effectively and waste disposed of accordingly it should prevent further public exposure
Factors influencing averted exposure	None
Potential increased worker exposure	Consistency in effective implementation of the option over the entire area Appropriate decontamination of surrounding ground surfaces and vegetation

(19) Removal and disposal of contaminated material

Other considerations

Agricultural impact	None
Compensation issues	There may be requests for compensation for loss or damage to property or personal possessions Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A

Additional information

Practical experience	*C. difficile* outbreak in geriatric wards, Belgium, Brussels, 2003 (Cherifi, 2006) County Fair *E. coli* outbreak, Ohio, 2001 (Varma, 2003) Anthrax incident connected to contaminated drum skins, London, UK, 2008 (Anaraki, 2008) Gastroenteritis outbreak in a hospital ward, UK, 1996 (Fone, 1999) Death of a patient from Lassa Fever in an A&E department, London, UK, 2009 (Otter, 2010)
Key references	Cherifi S, Delmee M, Van Broeck J, Beyer I, Byl B, Mascart G. Management of an outbreak of Clostridium difficile-associated disease among geriatric patients. Infect Control Hosp Epidemiol. 2006 Nov 1;27(11):1200–1205 Varma JK, Greene KD, Reller ME, DeLong SM, Trottier J, Nowicki SF, et al. An outbreak of Escherichia coli O157 infection following exposure to a contaminated building. JAMA. 2003 Nov 26; 290(20):2709–12 Anaraki S, Addiman S, Nixon G, Krahe D, Ghosh R, Brooks T, et al. Investigations and control measures following a case of inhalation anthrax in East London in a drum maker and drummer, October 2008. Euro Surveill. 2008;13(51):pii:19076 Fone DL, Lane W, Salmon RL. Investigation of an outbreak of gastroenteritis at a hospital for patients with learning difficulties. Commun Dis Public Health. 1999;2(1):35–8 Otter JA, Barnicoat M, Down J, Smyth D, Yezli S, Jeanes A. Hydrogen peroxide vapour decontamination of a critical care unit room used to treat a patient with Lassa fever. J Hosp Infect. 2010 Aug; 75(4):335–7 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
Document history	

(20) Burial in-situ

Objective	To remediate the affected area by burying contaminated soil and vegetation in-situ
Other benefits	None
Recovery option description	In extreme cases following a large-scale incident large basins can be excavated to provide a waste disposal route for biological contamination and associated debris. Deep ploughing methods may also be used The waste may be encased in specific barriers such as a polyethylene sheet and concrete. Following burial the basin can be covered with topsoil
Key information requirements	Geology and hydrogeology of the area
Linked recovery options	This is a remediation option and may need to be linked to protection options This decontamination technique may be combined with (18) Barriers to seal land contamination
Target environment	Biologically contaminated soil, surface rocks and vegetation
Targeted organisms and dispersion methods	This recovery option is more applicable to biological agents that are persistent and difficult to decontaminate. However, the properties of the biological agent will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Inhalation, dermal (skin) and ingestion of biological contamination. Percutaneous
Time of application	There are no restrictions on time with this option, and it can be implemented at any stage after a biological incident
Considerations	
Public health considerations	None, provided the burial site is away from sensitive areas
Legal implications and obligations	Seek specialist advice and guidance. There may be legislation or legal implications relating to waste and the pollution of ground water. Legal issues over land ownership and future use/value may need to be addressed
Social implications	Potentially significant resistance from residents in the area against burial of contamination in-situ as well as transporting the waste through/nearby the inhabited area Aesthetic issues may be a social issue
Environmental considerations	Potential leaching of contamination to soil and/or ground water
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	There should be a significant reduction in potential exposure if burial in-situ if implemented properly and the area sealed appropriately to prevent leaching into ground water
Technical factors influencing effectiveness of recovery option	This method requires specialised engineering expertise and materials which depend on the nature of the contaminant in question, eg water solubility in order to construct an effective membrane to contain the biological agent. A suitable and robust monitoring programme will also need to be implemented to ensure the membrane remains intact
Feasibility and intervention costs	
Specific equipment	Large digging machinery Specialist membranes for sealing contamination
Utilities and infrastructure	Power and water supplies

(20) Burial in-situ

Consumables	Concrete and polyurethane for capping of the land after burial
Skills, personnel and operator time	Personnel and scientific support to undertake the monitoring programme Seek specialist advice and guidance. The Government Decontamination Service (GDS) maintains a framework of specialist suppliers able to offer a practical decontamination or wider remediation service, capable of carrying out decontamination operations across the UK. For more information see https://www.gov.uk/government/groups/government-decontamination-service
Safety precautions	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers and specialist contractors and suppliers will have to comply with Health and Safety at Work etc Act (HSWA) to ensure that recovery workers use appropriate PPE and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Depth of soil layer and/or presence of any bed rock may necessitate more effort (and cost) to construct burial area Geology, hydrology and land use of site
Waste	
Amount and type	None, soil may need to be disposed of elsewhere
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	There should be a significant reduction in the risk of potential exposure to members of the public living in the affected areas
Factors influencing averted exposure	None
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg transport personnel) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded, and to confirm that the remediation is having the desired effect. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not possible to estimate likely recovery worker exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident involving burial in-situ Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant) Exposure routes from transport and disposal of waste are not included
Other considerations	
Agricultural impact	Depends on use of land
Compensation issues	There may be requests for compensation for costs associated with loss or damage to property, or loss of trade and earnings (eg manufacturing processes) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the

(20) Burial in-situ

	public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	Likely to be expensive due to transportation needs, specialised engineering expertise and the cost of the materials used to construct an effective membrane to line basins

Additional information

Practical experience	
Key references	Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(21) Incineration

Objective	To destroy contaminated material in a controlled manner
Other benefits	This is normally a straightforward, routine and rapid process. In most cases, all of the technical, legal and socioeconomic considerations will already have been addressed; however, in view of the potential costs, other disposal options may turn out to be preferable
Recovery option description	Incineration is the controlled burning of waste at high temperatures, typically around 900°C. Organic components present in waste are released as exhaust gases, and mineral matter is left as a residual ash. The volume of the ash is about an order of magnitude less than the original waste; the corresponding reduction in terms of mass is about a factor of three. The ash is typically disposed of to landfill
Key information requirements	What is the biological contaminant? What is the capacity of incinerators under consideration? How far are the incinerators? Would mobile incinerators be suitable?
Linked recovery options	This is a waste disposal option and should be linked to protection and remediation options This recovery option should be considered in conjunction with (11) Energy decontamination techniques and (19) Removal and disposal of contaminated material, and is likely to be performed on waste from the incineration process
Target	Any contaminated waste from remediation processes where incineration is deemed necessary
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that pose a risk to public health and are persistent and difficult to decontaminate. However, the properties of the biological agents will influence whether or not this option is a suitable alternative to other remediation techniques. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any in principle. There may be limitations due to cost or capacity
Exposure pathway prevention	N/A – this is a fate of affected produce (waste disposal) option
Time of application	No restrictions on time. This recovery option is not time limited and can be implemented at any stage during a biological incident

Considerations

Public health considerations	Incineration is a normal waste disposal practice, therefore there should be no increased risk to public health
Legal implications and obligations	Environmental permitting controls need to be considered for incineration and co-incineration plants. The incinerator should already be regulated to ensure that it is compliant with the EC Waste Incineration Directive Exceptions to these controls include plants that only burn animal carcasses that are subject to the animal by-products regulations (eg animal carcass incinerators) For more information on legislation please see Appendix A
Social implications	The introduction of large quantities of additional waste for incineration may attract adverse local publicity. There may be objections to bringing a mobile incinerator into the area
Environmental considerations	Availability and capacity of suitable incinerators. Animal carcasses and crops must be incinerated and the ash disposed of without endangering human health or harming the environment Atmospheric emissions from incineration include: • gases: CO, CO_2, NO_X, SO_2, etc • mineral dust: fly ash (PM_{10}) • heavy metals: Pb, Cu, Hg, Cd, etc • organic molecules: dioxins, furans, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) All of these are damaging to human and animal health and the environment. However, the amounts discharged have been significantly reduced (and continue to be) due to advances in incinerator and flue gas treatment technologies. Chemicals released during incineration may be taken up into the food chain by animals grazing on grass nearby. Possible risk of pollution to soil, surface waters and ground waters from ash-associated contaminants

(21) Incineration

	However, all of these issues will be managed if the incineration activity is properly run There may be a requirement to monitor air and water quality
Ethical considerations	None
Effectiveness	
Recovery option effectiveness	100% for a correctly-run process
Technical factors influencing effectiveness of recovery option	None
Feasibility and intervention costs	
Specific equipment	Commercial high temperature incinerators, on-farm incinerators and mobile air-curtain incinerators capable of disposing of crops and/or mammalian carcasses Vehicles for transporting materials, crops or carcasses to the incineration site and ash to the landfill site
Utilities and infrastructure	Disposal route for ash if it is not handled as part of a routine commercial operation. There are a number of beneficial reuse options for incinerator bottom ash, although fly ash must normally be disposed of to landfill as hazardous waste
Consumables	Fuel for transporting crops or carcasses to the incineration site and to run the incinerator. Mobile air-curtain incinerators only work effectively when fed with dry seasoned timber
Skills, personnel and operator time	Trained personnel will be available at incineration facilities Time to transport food products. Incineration plant operatives for processing additional material
Safety precautions	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (eg rendering operators) use appropriate PPE (if required) and follow standard operating procedures (SOPs) Consider protective clothing. Respiratory protection is recommended whenever materials are handled or moved
Other limitations/ factors influencing costs	Availability of the correct type of incinerator
Waste	
Amount and type	Ash. The volume of ash produced is usually 10% of the original material and the mass is reduced to 25–30% of the original material
Possible transport, treatment, disposal and storage routes	Ash from commercial incinerators must be disposed of to landfill. Ash from air-curtain and on-farm incinerators can be buried on site providing there is no possibility of contamination of ground and surface waters. Otherwise it must be collected, stored and sent to landfill
Factors influencing waste issues (eg cost)	Biological concentration of waste product. Quantity of ash produced and space available for landfill. If land filling is not possible then the ash should be safely stored Transportation of ash to disposal site. Cost of landfill – charges or tax if appropriate
Exposure	
Averted exposure	N/A
Factors influencing averted exposure	None
Potential increased worker exposure	Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that recovery workers (eg incinerator operatives and drivers) use appropriate PPE (if required) and follow SOPs Monitoring of recovery workers may be required to ensure that exposure limits are not exceeded. Due to the specific nature of tasks and the wide variety of possible biological agents involved, it is not

(21) Incineration

	possible to estimate likely recovery worker (eg incinerator operatives and drivers) exposure. They would, however, need to be assessed on a case-by-case basis in the event of any incident processing or treatment of food products as a remediation technique Potential exposure pathways for workers are: • dermal/inhalation exposure from contamination in the environment and equipment • inadvertent ingestion of contamination from workers' hands (unlikely to be significant)
Other considerations	
Agricultural impact	Ash has high concentrations of micronutrients and macronutrients that may be used to fertilise soil
Compensation issues	There should be none Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Other considerations	N/A
Additional information	
Practical experience	This option has been used in a number of incidents as an effective way to deal with contaminated waste both during the 'Amerithrax' attacks and during outbreaks of infection in hospital wards to deal with clinical waste (Canter, 2005)
Key references	Canter DA, Gunning D, Rodgers P, O'Connor L, Traunero C, Kempter CJ. Remediation of Bacillus anthracis contamination in the US Department of Justice mail facility. Biosecur Bioterror. 2005 Jun;3(2): 119–27 Otter JA, Barnicoat M, Down J, Smyth D, Yezli S, Jeanes A. Hydrogen peroxide vapour decontamination of a critical care unit room used to treat a patient with Lassa fever. J Hosp Infect. 2010 Aug;75(4):335–7 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	This is an acceptable option for small quantities of waste as incinerators are already licensed to accept food wastes. There could be local opposition near to an incineration plant due to public perception that contamination will be released to the atmosphere A valuable option when landfill space is scarce or biological contamination cannot be decontaminated effectively
Document history	

8 Water Environments

What is a 'water environment'?

Water environments include a variety of water sources such as drinking water supplies (ie public, private and industrial water supplies), water used in food and beverage production and controlled waters (ie surface waters, ground waters, recreational waters and coastal waters).

The types of water environments considered within the scope of the handbook are described in Tables 8.1–8.3.

In terms of biological contamination, public water supplies are highly regulated to minimise the level of microorganisms within drinking water and prevent the occurrence of water-borne infections. Within water treatment facilities, there are critical control points which water companies must ensure are operating effectively to maintain the quality of the water they supply to the consumer. Quality control systems ensure that if water does not reach the required standard, protective measures are immediately put into place. In the event of an outbreak of infection, this is likely to be due to a failure in a critical control point or a treatment system. These failures are usually picked up and dealt with quickly and with minimal fuss. If an incident does occur within a public water system, the response and recovery phase often overlap, with many protective measures being put in place before a recovery coordination group is formed. It is worth noting that, in public drinking water systems, above-normal levels of microorganisms are often transient and usually only require protective measures to be put in place until the incident has abated.

However, other drinking water supplies can become contaminated which are not as highly regulated as a public water supply system. There are over one-million private water supplies in the UK which are not controlled by water companies and are, in fact, the responsibility of the landowner and regulated by the local authority. Currently there is variable compliance with private water supply regulations, leaving many individuals exposed to potential contamination.

Other water environments such as rivers, lakes and coastal waters can become contaminated with biological agents such as *Cryptosporidium* sp. or norovirus, which can be harmful to the public who may use these water environments for recreational activities. These water environments are not regulated and are the responsibility of the Environment Agency.

Following biological contamination, decision makers require a framework which allows them to select appropriate recovery options to produce a remediation strategy for recovering a water environment. This handbook is a tool to help users evaluate potential recovery options by providing a decision-making framework and the relevant information needed to support decisions enabling implementation of timely and effective remediation strategies[1].

For small-scale biological incidents the recovery strategy may comprise one or two recovery options that could be applied over the first few days or weeks. For example, a low level outbreak of cryptosporidiosis in a drinking water supply may only require protective options such as (2) Restrict water use (DND/DNU notices) and (4) Boil notices until the outbreak attenuates[2]. However, for a widescale biological release involving persistent agents the recovery strategy is likely to be more complex, comprising multiple recovery options which include both protection and remediation options[3].

Some aspects of recovery can be considered in advance of an incident as part of contingency planning. A series of checklists is provided in Chapter 3 to highlight the type of information that can be gathered under non-crisis conditions to help manage the pre-release and early phases of an incident. Decision makers will need input and guidance from the relevant experts to supplement the information, particularly to provide advice on the suitability of recovery options for the biological agent in question and the practicability of their implementation[1].

Table 8.1: Types of sub-area in water environments

Area	Description
Drinking water supplies	Water supplied under statutory legislation as being wholesome to drink Public water supply – those delivered by statutorily appointed water companies Private water supplies – those not provided by a statutorily appointed water company
Food production	Water used in beverages Water used for irrigation Water for animals
Controlled waters	Surface waters – lakes, lochs, canals, rivers, streams, reservoirs, etc Groundwater – this is all water contained underground and includes groundwater as well as water above the saturated zone (ie the bottom of aquifers) Recreational waters – outdoor areas accessed by the public for recreation, eg water sports or leisure Marine waters – coastal waters, harbours, estuaries, sea, etc

8.1 Drinking water

Drinking water can come from one of three main types of water supply; these are defined in Table 8.2.

As mentioned previously, drinking water that is supplied by public water companies is heavily regulated and must conform to legal standards as a minimum. Water companies undergo continuous and routine monitoring but if drinking water supplies are determined to be contaminated at an unsafe level, it is possible that some of the contaminated water will be consumed due to the nature of biological testing not providing instant results. Effective communication strategies between water companies and consumers need to be put in place to inform consumers of the risks of drinking contaminated water and any self-help options that may be available. Public perception may also drive the need to provide 'clean' drinking water.

This also applies to private water supplies, which are unlikely to undergo as frequent testing so there may be a greater risk of contaminated water being consumed, although the number of users is generally much smaller. Effective communication strategies will be imperative in the event of a biological incident to prevent panic and anxiety for consumers.

Table 8.2: Definition of drinking water supply categories in the handbook

Water supply	Description
Public	Public water supplies are those delivered by statutorily appointed water companies to the majority of properties, including private houses, commercial and public buildings, industrial premises and other properties* Public water supplies come from both surface water and groundwater sources. Surface water sources include reservoirs, lakes and rivers, while ground water sources are from aquifers, which are natural underground geological formations that store rainwater. The ground water is drawn through wells or boreholes drilled into the aquifers by the water companies. Ground water can also supply impounding reservoirs Water supplies delivered by water companies are subject to strict regulation regarding their quality. To comply with water quality regulations, the water is treated at water treatment works prior to being delivered. Water companies take regular samples of the water throughout the treatment process and distribution systems to ensure the provision of high quality water that meets the required standard
Private	Private water supplies are defined as any regular supply of water that is not provided by a statutorily appointed water company and where the responsibility for its maintenance and repair lies with the owner or person who uses it[4]. Private water supplies only account for a small percentage of water usage. Less than 1% of the population of the UK obtain their water from an entirely private supply, either on an individual or on a multiple property basis. However, the number of private water supplies can be significant Private water supplies can come from a variety of sources, including wells, boreholes, springs, rivers, lakes and ponds. The majority of private supplies are likely to be for dwellings and farms situated in remote or rural areas. However, there may be some private supplies in urban areas, particularly those used for industrial purposes such as brewing. Private water supplies may also be found supplying places such as hospitals, hotels, schools or campsites In contrast to public supplies, some private water supplies may not be treated to remove impurities that affect the quality of the water. Additionally, the treatment method may vary – for example, chlorine only or filtering only. They are, however, regulated by the local authority under private water supplies regulations and should meet the levels which are defined for microbiological concentration
Unregulated	Unregulated water supplies are defined as those drinking water supplies that are not maintained as public or private water supplies. The use of these water supplies will generally be confined to people using water from springs or collected rainwater and greywater systems
Inset appointments	In some circumstances, a water company can replace the incumbent as the appointed water and/or sewerage company for a specified area. As such, the replacement appointed water company takes on the same duties and responsibilities as the previous statutory water company for the specified area

* Water companies may have a number of minor water supplies, typically in rural areas that may have simple water treatment (eg disinfection)

8.2 Water used in food production

Water is used in food production systems for animals, to irrigate crops and in food processing plants. This water may come from a number of sources, including both public and private drinking water supplies, unregulated water such as collected rainwater and springs, and from other water environment such as rivers, lakes and streams.

If the water supply that is used in the food production system has become contaminated then this section of the handbook should be used to deal with the contaminated water only. If contaminated water has been used in a food production system and the food products have become contaminated please see the food production systems section (Chapter 4) for remediation options.

8.3 Controlled water

Controlled water encompasses all fresh and saline natural waters up to the UK offshore territorial limit. As such, by definition, it includes all surface water, ground water, recreational waters and coastal waters within the UK. The definition of controlled waters is presented in Table 8.3.

Table 8.3: Definition of controlled water categories in the handbook

Water supply	Description
Controlled waters	All fresh and saline natural waters up to the UK offshore territorial limit, including rivers, streams, lochs, estuaries, reservoirs, coastal waters and ground water. The statutory definition of controlled waters is given in the Water Resources Act 1991 s104(1) and the Control of Pollution Act 1974 s30A(d) The Water Resources Act defines the Environment Agency's role in water pollution, water resource management, flood defence, fisheries and navigation. It covers discharges to surface and groundwaters, estuaries and coastal waters, and controls abstracting and impounding water. The Act affects all businesses in England and Wales that discharge substances to controlled waters. It states that a person must not cause or knowingly permit poisonous, noxious or polluting material or solid waste to enter controlled water unless they have consent from the Environment Agency Industrial operators have to pay the cost of repairing damage caused by their polluting discharges, largely by reimbursing the Environment Agency for the anti-pollution works it has carried out

For ease of reference, controlled waters have been divided into four sub-areas, described in Table 8.4.

8.4 Other water sources (unregulated)

The collection of rainwater or greywater for use in the home and garden has become more popular in recent years as a way to reduce the pressure on mains water supply, improve water sustainability, to save money and as a way to reduce the risk of flooding. However, there are currently no regulations on the water quality of collected rainwater and not all rainwater harvesting systems will use adequate treatment process to remove the risk of contamination.

Greywater recycling and rain water harvesting poses a risk (in terms of biological contamination) as the storage of warm, nutrient rich water in an open-ended system may provide an ideal habitat for microorganisms to grow and colonise, and as many of the uses of recycled water produce aerosols it can present a risk of inhalational exposure. These water recycling systems need to be maintained on a regular basis and any fitting of these systems should comply with the water fitting regulations. Greywater systems should be unconnected from other water systems and not used for the provision of drinking water.

If these systems become contaminated they will need to be thoroughly cleaned and disinfected. Many of the recovery options listed for water environments will be suitable for the remediation of contaminated water recycling systems.

Table 8.4: Definition of sub-areas of controlled water categories in the handbook

Water supply	Description
Surface waters	Water present above ground, associated with freshwater resources, eg rivers, streams, springs, reservoirs and lakes Discharge of clean surface water run-off (rain run-off from roofs, yards and roads) may be made to surface waters or ground waters without consent If there is any risk of run-off being contaminated, eg by oil drips from cars or roofs contaminated by chimney emissions, then persons must have a discharge consent or groundwater regulations permit (England and Wales) or a groundwater authorisation (Northern Ireland) In Scotland, an offence would be committed if an activity was carried out that was likely to cause water pollution without SEPA's authorisation. If there is a risk of run-off being contaminated an authorisation must be obtained under the Water Environment (Controlled Activities) (Scotland) Regulations 2011
Groundwater	Groundwater is all water that is found underground in the cracks and spaces in soil, sand and rock. Groundwater is stored in and moves slowly through layers of soil, sand and rocks (aquifers). Aquifers typically consist of gravel, sand, sandstone, or fractured rock, such as limestone, which are permeable due to the large connected spaces that allow the flow of water
Recreational waters	Coastal and freshwater recreational water environments are defined, for the purposes of this guidance, as any coastal, estuarine or freshwater area where any type of recreational usage of the water is made by a significant number of users. While uses may be diverse and the guidance is intended to be applicable to all types of use, most concern relates to uses entailing water contact and, in the case of water quality, significant risk of water ingestion
Marine waters	These consist of natural maritime saline waters up to the UK offshore territorial limit. The Merchant Shipping Act 1995 covers at-sea activities but also covers estuarial pollution in certain cases. The Maritime and Coastguard Agency (MCA) exercises central government's statutory responsibilities for taking action when hazardous substances emanating from any at-sea activity threaten the UK or its surrounding waters (https://www.gov.uk/government/organisations/maritime-and-coastguard-agency), but little is mentioned about biological contamination release. The appointed regulatory body for each piece of legislation has a general duty to carry out enforcement activities when necessary. They have statutory powers to serve notices and take prosecutions (National contingency plan for maritime pollution) from shipping and offshore installations Local authorities (Environment and Heritage Service in Northern Ireland) have accepted the non-statutory responsibility for shoreline clean-up

8.5 Health protection criteria for water environments

It is important that any measures taken to protect public health and reduce the risk of infection, eg PPE or infection control measures, are appropriate to the level of risk of the biological contaminant in question. They, therefore, must also take into account all the wider consequences of the proposed protective measure; for example, costs and disruption to implement the measure must be balanced against the pathogenicity of the agent and expected benefits of implementation including public reassurance. This balance must take into account the specific circumstances of the event, which are likely to vary between incidents[1,3]. At present there are no national regulations outlining remediation criteria following an incident involving a biological release in the UK; however, in some specific areas there are localised guidance notes on how to deal with biological incidents. Most public drinking water companies have established procedures in the event of potential biological contamination and should carry out appropriate risk assessments to evaluate the risks and consequences of protective measures, including the risk to vulnerable groups of people.

It is recognised that, through published advice for radiation and chemical incidents, some clean-up techniques are considerably more resource intensive and disruptive than others[1,3]. This can also be applied to the remediation from biological contamination. It is difficult to specify clean-up goals in advance of an incident as background levels of biological contaminants are often not known and should be considered alongside other aspects of planning for a response (see Chapter 3). Following an incident, it is recommended that assessments of the remediation strategy should be completed, examining both the risk and the consequences. These consequences should include cost, timescales, public acceptability and the availability of the necessary resources. Any information relevant to these assessments (ie potential efficacy, resource requirements, identification and preparation of appropriate equipment and contractor's costs) would enable the completion of such assessments quickly and efficiently in the event of an incident. Potential strategies that involve high levels of cost and disruption should only be undertaken if the risk to public health is also high, thereby maintaining a balance between the expected harms and benefits of the strategy[1,3].

8.6 Estimating exposure in water environments

The exposure of an individual from a biological agent following an incident can vary widely. There are many factors which govern the estimated exposure of an individual in such a situation, including the properties of the biological agent in question, the extent of the contamination in the affected area, the time spent by the individual living/working in the contaminated environment and the activities carried out by the individual in the affected environment.

Any individual should be protected from exposure to biological contamination at home, during recreational time and in the workplace. When considering recovery options, the potential exposure or increase in exposure of an individual should be considered and all necessary precautions taken to protect the affected individual. If there are very good reasons as to why individuals may need to be in areas where the likelihood of their exposure is high, eg those maintaining critical facilities and infrastructure, there should be an appropriate monitoring programme in place to limit any potential exposure by determining the level of biological agent in the water and allowing appropriate action to be taken.

Under the Water Act 2003, drinking water companies are required to give special assistance to those people recognised as vulnerable due to disability, age or illness, especially in times of a disrupted water supply. These people are likely to be at greater risk and therefore they should be considered when estimating exposure and developing a recovery strategy.

8.7 Constructing a recovery strategy for water environments

Constructing a remediation strategy and selecting appropriate recovery options involves multiple steps. An overview of the decision-making framework for developing a recovery strategy is given in Figure 8.1. It is important to note that this framework should not be considered as a substitute for expert specialist advice, but provides a framework for requesting, recording and evaluating the advice (Steps 1–3). The decision-making framework (Figure 8.1) comprises six steps which involve the elimination of inappropriate recovery options through the use of a decision tree, selection diagrams, tables and checklists.

Step 1 of the framework describes the identification of the biological agent (if possible) and the gathering of information relevant to the incident. Step 2 then leads the user to the decision trees in Figures 8.2 and 8.3. The decision tree guides the user through the initial decision-making process and the range of considerations that need to be taken into account, as well as allowing the user to select all the available appropriate recovery options for the incident in question. Steps 3–5 then provide a methodology for eliminating options that are unsuitable or ineffective by evaluating their efficacy and characteristics. From the remaining options, a recovery strategy can then be developed (Step 6). A template table is provided (Table 8.6) that can be used to help record the decisions made during the recovery option elimination process. Once the recovery strategy has been developed, it can be executed and monitoring can be performed to confirm whether acceptable levels have been reached and the area can be returned to normality. If acceptable levels have not been reached then the user can return to the decision tree in Step 2.

The final step is to document the incident and evaluate the recovery response with the formation of a report, including the effectiveness of the handbook. This report can then be used to determine any lessons that should be learnt from the response. It would also be helpful to forward the report on to the handbook project team (biological.recovery@phe.gov.uk) as the information can then be incorporated into the databases which support the document.

Further details of the steps are given in the following sections. The water environments decision framework does not include a strategy for performing a risk assessment or for designing or implementing a monitoring strategy following a biological incident, this falls outside the scope of the handbook.

To view an example of how this process works, please see Chapter 10: Worked Examples.

Step 1: Obtain relevant information regarding the incident

Identify affected water environment(s) and, if applicable, determine the agent's characteristics
Obtain expert advice

↓

Step 2: Consult flow chart and decision tree for water environments

Identify potentially applicable recovery options
Consult food production systems and inhabited areas sections of the handbook (if applicable)

↓

Step 3: Determine the effectiveness of recovery options

A: Eliminate options based on the agent's characteristics
B: Eliminate options based on effectiveness

↓

Step 4: Review key considerations and constraints

Eliminate further options according to other considerations (public health, waste social, technical, cost and time)

↓

Step 5: Consult recovery option sheets

Eliminate further options following a detailed analysis of options on a site and incident specific basis

↓

Step 6: Compare remaining recovery options

Based on steps 1 – 5, select and combine options for managing each phase

↓

Implement recovery strategy/report and evaluate

↓

Yes
Return to normality and report

Was recovery strategy effective?

No
Return to Step 2/review recovery options

Figure 8.1: Key considerations for recovery

Step 1 Obtain relevant information regarding the incident

When a biological incident occurs, the initial steps are to identify the biological agent(s) involved and seek technical (biological) expertise. It may not always be possible to identify the biological agent and there may be cases where there are multiple agents in a contaminated area (eg flooding). There may also be delays before the laboratory identification of the agent. However, by consulting the appropriate experts it may be still possible to gather information on the likely contaminants that may be found. An example of this can be found in Chapter 10.

Having identified the biological agent (if possible), information should then be collected on the agent's biological characteristics, eg persistence and mode of transmission. The handbook has identified a subset of biological characteristics and properties that need to be considered – see Table 8.5. These properties will then be used to eliminate options in Step 3 of the decision-making process. Only when this information is available can an appropriate recovery strategy be developed.

Table 8.5: Important physiological characteristics of biological agents

<table>
<tr><th rowspan="2">Agent characteristics</th><th rowspan="2">Description</th><th rowspan="2">Interpretation</th><th colspan="2">Biological agent</th></tr>
<tr><th>Characteristic</th><th>Interpretation</th></tr>
<tr><td>Agent’s species</td><td>Agent’s taxonomy</td><td>Further details about the agent can be determined from literature searches and consultation with experts.
For example, Clostridium difficile
<table>
<tr><td>Genus</td><td>Clostridium</td></tr>
<tr><td>Species</td><td>difficile</td></tr>
</table>
The persistence of and efficacy of disinfection techniques can be determined by agent species, genus or family</td><td>
<table>
<tr><td>Genus</td><td></td></tr>
<tr><td>Species</td><td></td></tr>
</table>
</td><td></td></tr>
<tr><td>Organism form</td><td>Bacteria, bacterial spore, virus, fungi, parasite, oocyte</td><td>The form of the organism will help to determine the persistence of the agent and types of disinfection methods that are most effective for decontamination. It is possible that more than one form may be present, in which case the method of disinfection should consider the more resistant form
For example, alcohol-based solutions are very effective for disinfection of some vegetative bacteria; however, they are ineffective against bacterial spores</td><td></td><td></td></tr>
<tr><td>Persistence</td><td>How long will the agent survive in the environment?</td><td>How long a biological agent can persist in the environment will influence which recovery options should be considered for the remediation strategy (consult the persistence database)
An additional factor that should be considered is ‘What is the environment used for?’ This may also influence which recovery options are selected
For example, protective options (restrict public access) could be used if an agent has limited persistence (1–2 days) as natural inactivation (natural weathering) would eliminate the agent from the environment. However, this would not be appropriate for persistent agents, more active decontamination or removal options need to be considered</td><td></td><td></td></tr>
<tr><td>Resistance</td><td>Is the agent known to be resistant to disinfection processes or methods?</td><td>If the biological agent exhibits increased resistance to a disinfection method (eg vapour hydrogen peroxide) then alternative recovery options should be considered (consult the disinfection database)
Repeating disinfection with more effective disinfection techniques may result in delays and increase costs for remediation</td><td></td><td></td></tr>
</table>

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	**Interpretation**
Person to person spread/route of transmission	Can the agent be spread from person to person or animal to human? How is the agent infectious? (gastrointestinal/inhalation) Is the agent zoonotic?	Further recovery options might be necessary to stop the spread of the agent from person to person The route of transmission will affect the prioritisation of recovery from the agent *For example, a scenario where an agent causes gastrointestinal upset but is not infectious through the aerosol route may lend more time to develop a recovery strategy than a scenario with highly infectious or contagious agents that would need to be dealt with as a priority*		
Prophylaxis, vaccination and treatment	Is there medical intervention available with activity against the agent?	The risk to the public and workers will be increased if there is no prophylaxis or treatment available		
Hazard group	What is the ACDP hazard group of the agent?	Agents with a hazard group of 3 or 4 are more likely to cause serious infection and pose a significant risk to public health The recovery from incidents involving hazard group 3 or 4 agents could have increased cost implications, may take longer to remediate, require appropriate levels of worker PPE, and may involve specialist techniques		
Production of toxins	Does the agent produce a toxin? What is the stability of the toxin?	Toxins might persist in the environment after the destruction of the parent agent. Therefore consideration should be given to potential release of harmful toxins from the parent agent. Additionally, they may also be volatile and therefore difficult to contain Recovery options will need to be effective against the parent agent and subsequent toxins (eg mycotoxin). Seek expert advice and guidance for information on toxicology of toxic compounds Some toxins are heat resistant and may not be inactivated by processes used to inactivate microbial agents		
Background level of agent	Are the levels of the agent within the environment before the incident known?	This level will determine the extent of the contamination and the levels that need to be achieved during decontamination. The recovery phase must return the agent's level to at least the background amount.		
Will the agent multiply in the environment?	Is the agent able to replicate in the environment in which it is found?	If the agent has the ability to replicate in the environment in which it is found then the level and spread of contamination could increase. If the agent can replicate in the environment then the decontamination recovery options will need to be employed earlier to limit the growth and spread of the agent. This will be further dependent on the environmental conditions at the time, including the availability of water and nutrients, the relative humidity and the ambient temperature		

Step 2 Consult decision tree/diagrams for water environments

The decision tree should be consulted (Figures 8.2 and 8.3), which guides the user through a number of questions investigating the affected water environment. The decision tree also highlights any immediate protection options that should be considered. The protection recovery options shown in the yellow boxes are there to identify options that should have been implemented during the response phase. If they are deemed appropriate to the incident but have yet to the implemented they can be put in place during the recovery phase. Examples on how the decision steps should be used are located in Chapter 10 of this handbook; further help can be sought by contacting PHE.

This step is essentially an 'inclusive' step, identifying all potentially applicable recovery options prior to the elimination of options which will be carried out in Steps 3–5. Table 8.6 has been produced to allow the user to record the recovery options that have been identified as potentially applicable for use in remediation of the incident. As the user works through Steps 3–5 then this table can be used to identify if the option is still applicable and whether it should be removed from consideration. The reasons for removal should be recorded in the spaces provided; these can be used later in the review of the recovery of the incident and during the production of the report. This will allow anyone auditing the choices made during the remediation to ascertain why recovery options were not used and allows for a clear and open decision-making process.

In some instances, there may be cross-over between sections of the handbook – food production systems (Chapter 4) and inhabited areas (Chapter 6) – if other environments have been contaminated. This is highlighted in Figures 8.2 and 8.3 where applicable.

Table 8.6: Recording and analysis of identified recovery options

Recovery option name	**Step 1** Obtain information regarding the incident	**Step 2** Identify preliminary options for affected water environment (refer to Figures 8.2 and 8.3)	**Step 3** Determine applicability of recovery options, eliminate options on:		**Step 4** Review key considerations and constraints (refer to Table 8.8)	**Step 5** Consult recovery option sheets (Chapter 9)	**Option applicable?**	**Reason for elimination?**
			3A Agent characteristics (refer to Table 8.5)	**3B** Effectiveness of option (refer to Table 8.7)				

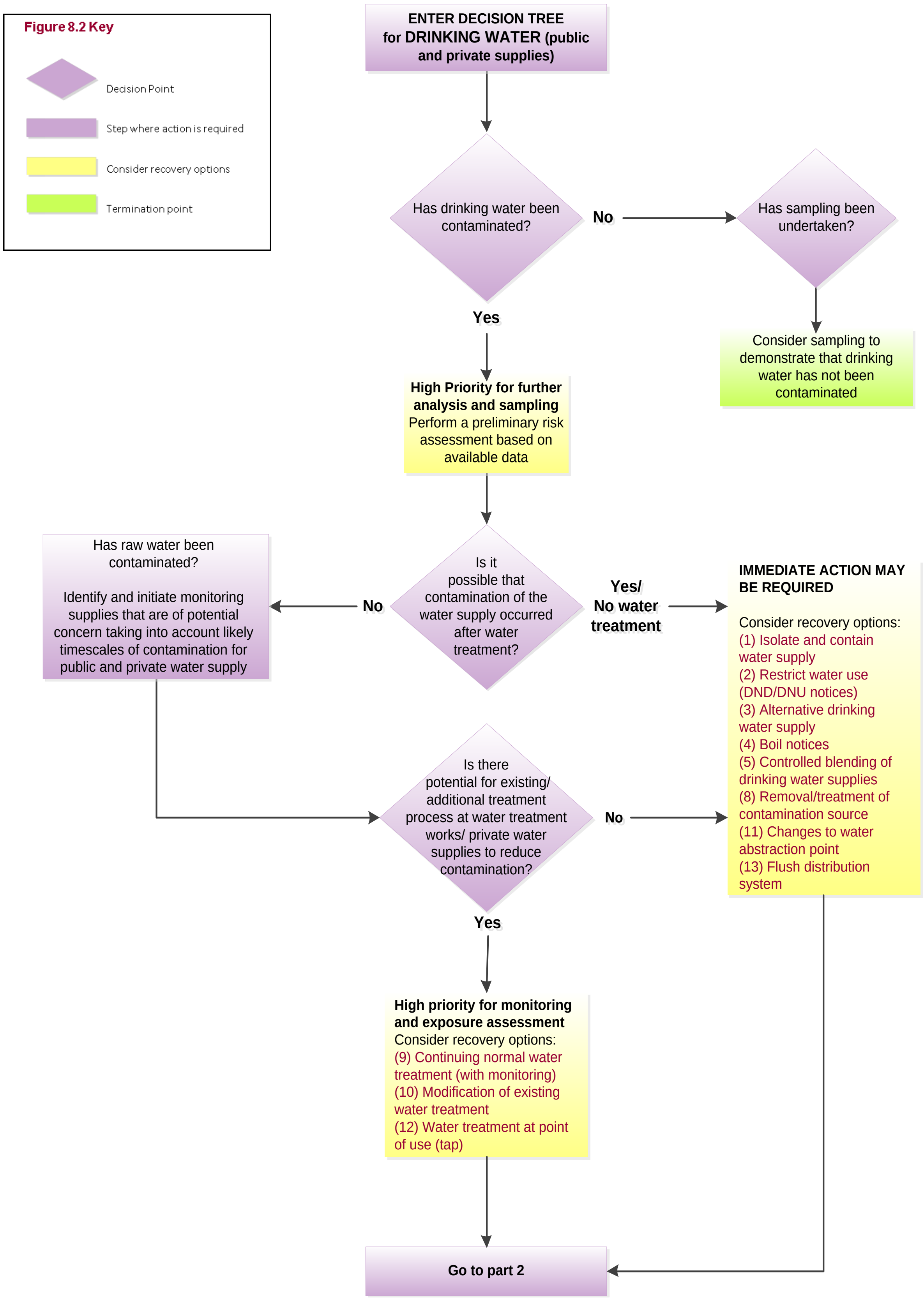

Figure 8.2: Drinking water decision tree (part 1)

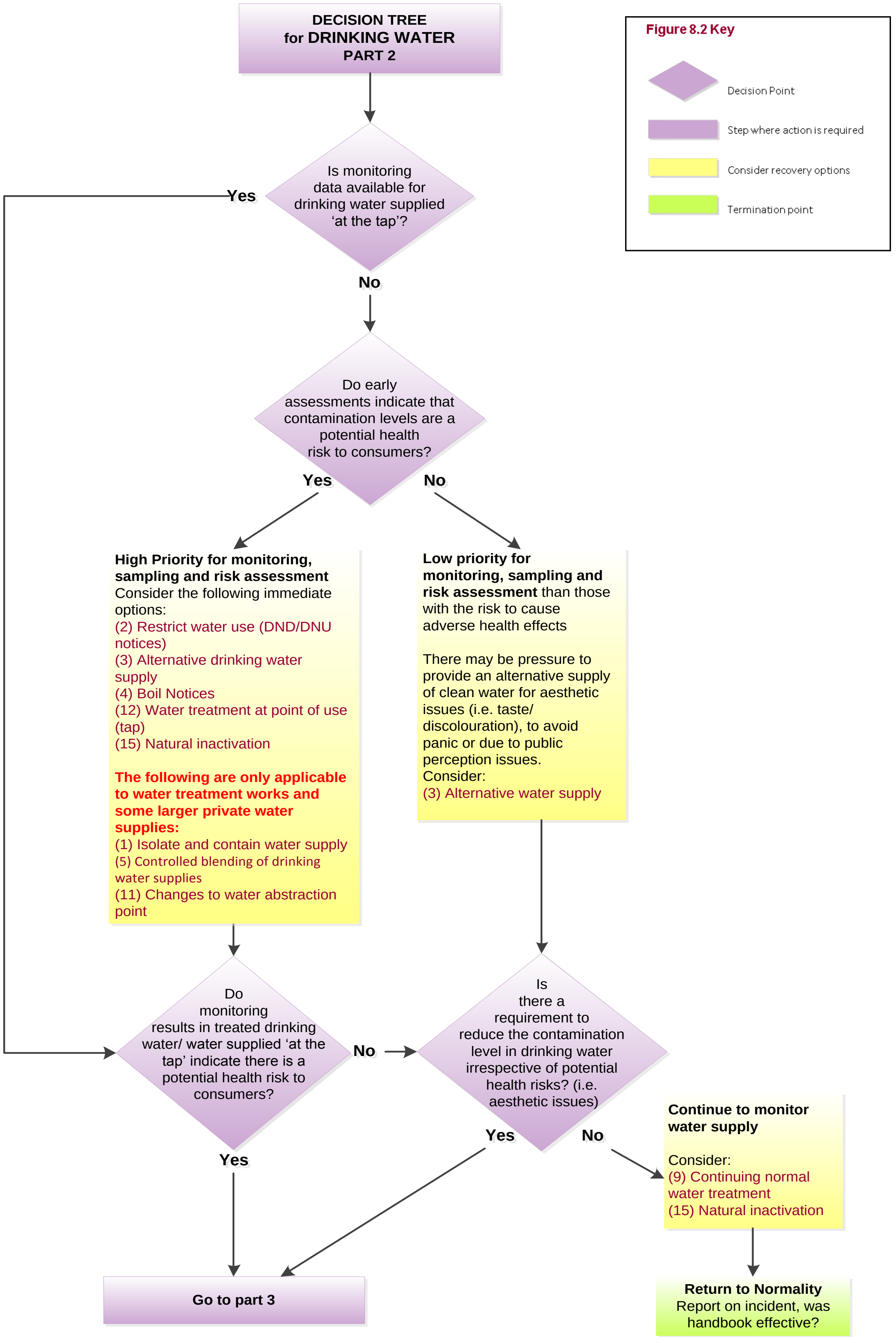

Figure 8.2 *(continued)*: Drinking water decision tree (part 2)

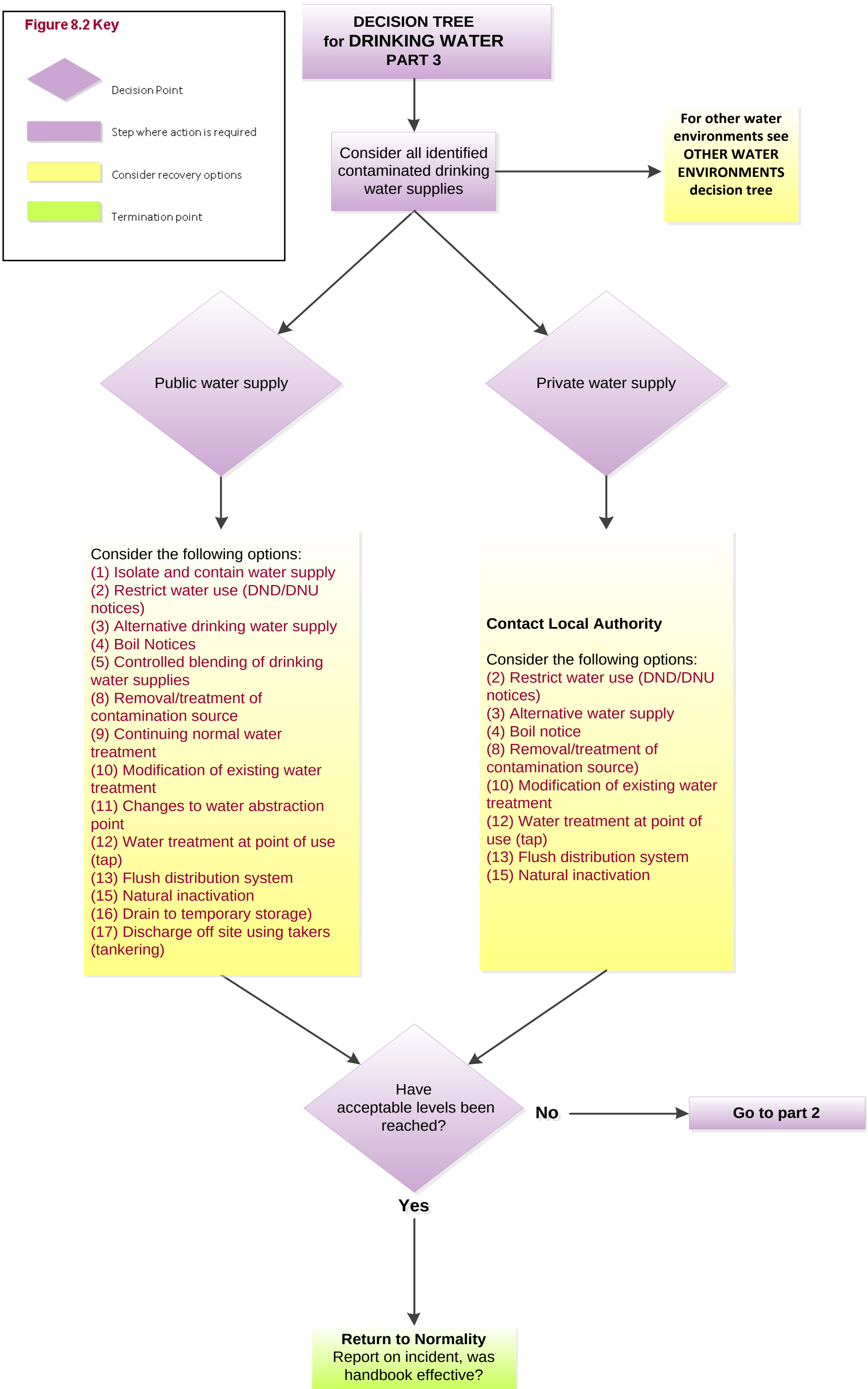

Figure 8.2 *(continued)*: Drinking water decision tree (part 3)

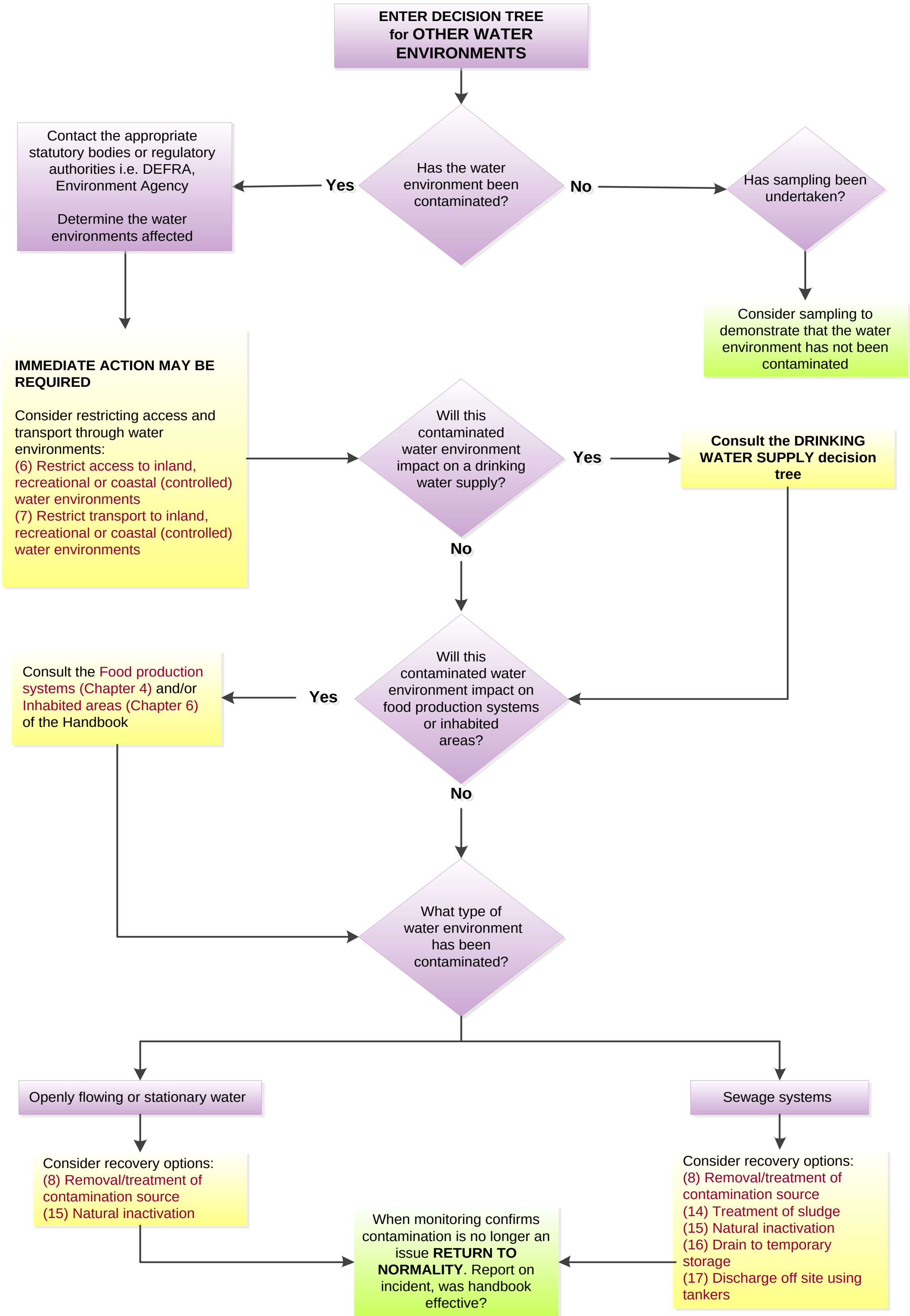

Figure 8.3: Other water environments decision tree

Step 3 Review effectiveness of recovery options

A Elimination of recovery options based on biological characteristics only

At this stage expert advice should be sought to determine and interpret the biological characteristics of the agent(s), using data identified in Table 8.5 (Step 1) to assist in eliminating any of the recovery options identified in Step 2. It should be noted that agent data will only be useful for elimination of certain recovery options and may not be applicable in all cases.

B Elimination of options based on recovery option effectiveness

Determining which recovery options may be further eliminated can be achieved by considering the type of water environment in more detail. The different water environments can be further broken down into sub-categories. The type of water environment will impact the efficacy of potential recovery options and the efficacy of each option is summarised in Table 8.7.

Shading is used in Table 8.7 to give an indication of whether remediation options would be 'up to 100% effective', 'potentially effective' or have 'limited effectiveness'. The grading used in Table 8.7 is based on evaluation of the current evidence (ie previous incidents), stakeholder experience, advice and ongoing decontamination research. Therefore, Table 8.7 should be evaluated in conjunction with the biological characteristics of the agent under consideration (see Table 8.5) and with expert advice from relevant agencies (see Appendix E).

A recovery option should only be eliminated if it is deemed to have 'limited effectiveness' (dark shading) for the water environment under consideration and there are other more effective recovery options available. It should be noted that if a recovery option is deemed to have 'limited effectiveness' this does not mean that it is ineffective but that the option may only partially remove any residual contamination; it may still need to be used if it is the only option available. Similarly, if an option is deemed to have a 'high' increased exposure risk this may mean that a higher level of PPE is required for implementing this recovery option if it is the only option available. If it is not possible to readily eliminate a recovery option at this stage then it should be retained for consideration in Step 4.

Therefore, options are considered to be applicable if:

- there is direct evidence that it would be effective for the agent (known applicability)
- the mechanism of action is such that it is highly likely to be effective for the agent (probable applicability)

An option is taken as not being applicable if one or more of the following criteria are met:

- there is direct evidence that the option would not be applicable to the agent
- the agent's properties are such that the option would not be expected to have any effect
- the hazard posed by the agent would not be reduced
- the time taken to implement the recovery option would be longer than the agent's persistence in the environment
- there is a risk that implementing the recovery option could make the hazard worse (eg aerosolisation)
- implementation of this option would place operatives at an unacceptable risk

Table 8.7: Overview of recovery option effectiveness

Key: Effectiveness	Up to 100% effective	Potentially effective	Limited effectiveness

Recovery options	Effectiveness				
	Drinking water		Other water environments		
	Public	Private	Sewage treatment	Inland and underground waters	Marine and coastal water
Protection options					
(1) Isolate and contain water supply			N/A	N/A	N/A
(2) Restrict water use (DND/DNU notices)			N/A	N/A	N/A
(3) Alternative drinking water supply			N/A	N/A	N/A
(4) Boil notices			N/A	N/A	N/A
(5) Controlled blending of drinking water supplies			N/A	N/A	N/A
(6) Restrict access to inland, recreational or coastal (controlled) water environments	N/A	N/A	N/A		
(7) Restrict transport to inland, recreational or coastal (controlled) water environments	N/A	N/A	N/A		
Remediation options					
(8) Removal/treatment of contamination source					
(9) Continuing normal water treatment (with monitoring)				N/A	N/A
(10) Modification of existing water treatment				N/A	N/A
(11) Changes to water abstraction point or location of water source			N/A	N/A	N/A
(12) Water treatment at point of use (tap)			N/A	N/A	N/A
(13) Flush distribution system				N/A	N/A
(14) Treatment of sludge		N/A			
(15) Natural inactivation					
Waste disposal options					
(16) Drain to temporary storage		N/A	N/A	N/A	N/A
(17) Discharge off site using tankers (tankering)		N/A		N/A	N/A

Step 4 Review key considerations and constraints

Each recovery option will have a number of considerations or constraints associated with its implementation. Table 8.8 describes some of the key issues (public health, waste, social, technical, cost and time) for each recovery option. More detailed descriptions of these considerations can be found in the recovery option sheets (Chapter 9). Tables 8.7, 8.8 and the recovery option sheets in Chapter 9 can be used to further eliminate recovery options based on their constraints and considerations.

Table 8.8 gives an overview of the major and moderate considerations for the recovery options. The classification used in the table is intended to be a generic guide and is not agent specific. The grading scheme used in this table is based on evaluation of the evidence (ie previous incidents), stakeholder experience and advice or ongoing decontamination research. Major considerations, while not applicable in all incidents, identify issues that might prohibit the use of the recovery option and should be considered in more detail to ensure they will not affect the remediation strategy. Moderate considerations highlight areas that can cause a recovery option to be limited in its effectiveness, such as having an effective media strategy to keep the public informed during that recovery option. Minor considerations have not been included in the table because they will depend more strongly on each individual incident compared to the major and moderate considerations, so can be thought of during the decision-making process by the recovery coordination group (RCG). Table 8.8 should be evaluated in conjunction with the biological characteristics of the agent under consideration (see Table 8.5) and with expert advice from the relevant agencies (eg PHE and GDS, see Appendix E).

If an important (key) constraint is identified, it does not indicate that the recovery option should necessarily be eliminated but that this constraint will need to be taken into consideration when evaluating the option as this may be the only option available.

Options can be eliminated based on their constraints:

- public health – implementation of the option would increase the risk to public health
- waste – would produce more waste than other available options
- social – would be socially unacceptable when other more acceptable options are available
- technical – would take longer to implement than the persistence of the agent or requires more technical expertise than other available options
- cost – would cost more than other available options
- time – would take longer to implement than other available options

Table 8.8: Overview of considerations for recovery options for water environments

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Protection options		
(1) Isolate and contain drinking water	**Public health** – An alternative drinking water supply would have to be available. There are depressurisation risks for the network if rezoning cannot be carried out	**Waste** – There may be significant amounts of contaminated water, which may require disposal and/or storage under a waste transfer licence. The Environment Agency should be consulted **Social** – Disruption is likely to be upsetting to members of the public. People will also need information on where restrictions are in place, where alternative water distribution points are and how long the situation will last **Technical** – The considerations associated with this option will vary depending on what other options are implemented with it. If the water supply is isolated but the area which is served by the supply is rezoned, impacts will be fairly minimal; however, if alternative temporary supplies are required (ie tankers/bowsers) then the technical, social and cost aspects will be increased **Cost** – The costs associated with other options which would need to be implemented alongside this
(2) Restrict water use (DND/DNU notices)	**Public health** – This recovery option should only be implemented if alternative water supplies are available/provided. Although existing water supplies may be suitable for sanitation purposes, convincing people that water is safe to bathe in, but not safe to drink or cook with, may be difficult, ie compliance. A clear communication plan is required to ensure the water advice reaches the customers it needs to in a timely manner **Social** – Reluctance of affected population to comply with and adhere to the restriction being imposed. Additionally, the social implications of providing an alternative water supply would also need to be considered for this option (see above) **Cost –** May be high considering options that will need to be implemented alongside this. For example, for alternative water supplies the following cost factors would need to be considered: vehicle hire (tankers and bowsers), consumables (fuel, bottles or containers for transporting water) and personnel (eg travelling time for drivers and, possibly, unsociable hours)	**Waste** – Providing bottled water would produce bottle plastics waste **Technical** – Ensuring the affected population are aware that restrictions are in place and that an alternative supply is available. Shortages of alternative supplies could lead to people drinking contaminated water and, if the area affected involves large numbers of people, the supplies might not meet demand. The technical implications of providing an alternative water supply during restriction of water use also need to be considered (see above)

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(3) Alternative drinking water supply	**Social –** People will not want to travel too far to water distribution points. Older people and people with disabilities may require assistance in getting water to their homes. It should be noted that water companies do keep records of vulnerable customers and key users in their region, and would therefore deliver water directly to these people. However, the customer list is voluntary (ie depends on people registering themselves with their water companies) therefore these companies may need to work with local authorities to identify other vulnerable customers. Bulk buying at shops is likely to lead to shortages of bottled water supplies **Technical** – Separate individual supplies would need to be provided for hospitals, schools, office buildings and any other large premises containing large numbers of people. If bowsers are used, there is a requirement to sample the water in them every 48 hours and analyse for a full suite of contaminants or to refresh the water on a regular basis. This would involve a number of personnel and significant resources in the laboratory depending on the number of bowsers/tanks required and tankering requirements **Cost –** May be high, considering vehicle hire (tankers and bowsers), consumables (fuel, bottles or containers for transporting water) and personnel (eg travelling time for drivers and, possibly, unsociable hours)	**Public health –** Although existing water supplies may be suitable for sanitation purposes, convincing people that water is safe to bath in, but not safe to drink or cook with may be difficult, ie compliance. This can also have implications for lack of hygiene practices such as hand washing (as people are concerned about using the water, and they may reduce hand washing or stop altogether). The same applies to food hygiene and preparation. Clear public health messages should be given alongside any instructions about the water supply **Waste** – Providing bottled water would produce bottled plastics waste
(4) Boil notices	**Public health** – This recovery options relies on people boiling their water effectively to inactivate the biological agent in question. There is a potential compliance issue and convincing people that water will be safe after boiling may be difficult. A clear communication plan is required to ensure water advice reaches the customers in a timely manner **Social –** Reluctance of affected population to comply with and adhere to the notice being imposed	**Technical** – Ensuring the affected population are aware that a boil notice is in place
(5) Controlled blending of drinking water supplies	**None**	**Public health** – Controlled blending of drinking water supplies or changes in treatment processes may give increased exposure to water treatment operatives, either from direct exposure to contaminated water or through the accumulation and storage of contaminated waste from treatment **Social –** Public perception would be an issue when implementing this recovery option, even if water companies blended water to an acceptable standard, customers may still be concerned. Additionally, rezoning may be applied here which carries a risk of discolouration of supplies if not carried out carefully – this is caused by the disturbance of iron and manganese deposits in water mains caused by a change in flow

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(6) Restrict access to inland, recreational or coastal (controlled) water environments	**None**	**Social –** Possible disruption and restricted access may not be well received by members of the public **Technical –** There may be difficulties in enforcing cordons depending on the size and nature of the affected water environment
(7) Restrict transport to inland, recreational or coastal (controlled) water environments	**Technical** – It may be difficult to implement this option and control access and transport within the affected water environment	**Social –** There may be issues with compliance and pressure to allow access to the affected water environment
Remediation options		
(8) Removal/treatment of contamination source	**Technical** – The source of contamination might be difficult to find and access	**Waste** – The process of the removal of the contamination might generate a large volume of waste. The source of contamination might be in an isolated area making waste removal difficult **Cost** – The production of waste in an isolated area where the contamination source could occur will increase the cost of the option **Time** – The production of waste in an isolated area where the contamination source could occur will increase the time that the option will take
(9) Continuing normal water treatment (with monitoring)	**Technical** – Continuing normal water treatment may require enhanced surveillance to evaluate the effectiveness of this option	**Public health** – Continuing normal water treatment may give rise to increased exposure to water treatment operatives, either from direct exposure to contaminated water or through the accumulation and storage of contaminated waste from treatment **Waste** – Although the works might remove the contamination, contamination may be concentrated in certain processes or in waste streams/sludge. Disposal of these wastes would also carry costs and may require disposal and/or storage under a waste transfer licence **Social** – There may be problems regarding the acceptability of any remaining contamination in water supplies; this is also likely to be related to the availability of alternative supplies such as bottled water

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(10) Modification of existing water treatment	**Technical** – Infrastructure needs to be in place to support the expansion of or changes to water treatment works if additional treatments are required (increased frequency of operations, 'new build', space requirements for new equipment, etc) **Cost** – May be high, considering infrastructure (adaption of current treatment plant or installation of a 'new build'), equipment, technology and personnel (builders and specialist engineers), timescale (could take months to years to install or build), and disposal of contaminated water (availability of suitable disposal route)	**Public health** – Changes to water treatment processes may give rise to increased exposure to water treatment operatives, either from direct exposure to contaminated water or through the accumulation and storage of contaminated waste from treatment **Waste –** There may be significant amounts of contaminated water, which may require disposal and/or storage under a waste transfer licence **Social** – Public acceptability and trust in water treatment processes to remove or reduce biological contamination. There are also issues around the acceptability of residual levels of contamination by the public and the availability of alternative supplies (ie bottled water). Additionally, there is an aspect of disruption if modifications to existing water treatment require construction (ie 'new build')
(11) Changes to water abstraction point	**Cost** – May be high, considering infrastructure (adaption of current treatment plant or installation of a 'new build'), equipment, technology and personnel (builders and specialist engineers), timescale (could take months to years to install or build), and disposal of contaminated water (availability of suitable disposal route)	**Social** – There may be problems regarding the acceptability of any remaining contamination in water supplies; there may also be concerns over the availability of alternative supplies. Where rezoning is used, or an alternative raw water source, acceptability may be an issue as customers may not like, or be used to, the alternative supply (eg upland water versus lowland or hard ground water versus soft water). Additionally, rezoning carries a risk of discolouration of supplies if not carried out carefully – this is caused by the disturbance of iron and manganese deposits in water mains caused by a change in flow **Technical** – Priorities also need to be decided depending on the vulnerability of water supplies to the biological emergency. Surface water supplies, such as rivers and reservoirs, are likely to be of higher priority than boreholes in the short term and this should be taken into account when formulating a monitoring strategy and identifying drinking water supplies of potential concern. In the longer term, monitoring and the implementation of this option may need to focus more on ground water sources, such as boreholes. The effectiveness of this measure depends on a programme of testing new abstraction points. Testing apparatus must be accurate

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(12) Water treatment at point of use (tap)	**Technical –** The practicality of this option will be influenced by the availability of and installation of appropriate equipment	**Social** – This option relies upon individuals purchasing units, or arranging installation, as well as using them in an appropriate manner (eg not removing parts or bypassing them) **Technical** – Reverse osmosis units require specialist engineers to install them and maintain/service them – if these activities are not carried out frequently, there are water quality risks **Cost** – Depends on the size of the area affected, and may be high, considering equipment (jug filters are relatively inexpensive <£40, whereas reverse osmosis units are more expensive >£300), installation and maintenance (specialist engineers) and consumables (additional filters or pumps, if needed) **Time** – This option may take some time to implement considering the components required
(13) Flush distribution system	**Public health –** An alternative drinking water supply (and appropriate water notifications) would have to be available while the system is being flushed **Waste –**There may be significant amounts of contaminated water to be flushed through the water distribution system, which could potentially lead to the spread of low levels of contamination in the environment	**Time** – This option could take some time to implement depending on the size of the distribution system
(14) Treatment of sludge	**Waste –** There may be significant amounts of contaminated water and material generated from treatment of sludge. Contaminated waste will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence. Disposal routes for waste water and solid wastes could lead to the spread of low levels of contamination in the environment **Cost –** May be high, considering volume of contaminated sludge requiring treatment, monitoring equipment, consumables, skilled personnel (including laboratory analysis, loading and driving)	**Public health –** There may be increased exposure of water treatment operatives, either from direct exposure to contaminated water or sludge or through the accumulation, storage or discharge of contaminated waste water from treatment **Technical –** Monitoring in the treatment works and of operatives may be required to ensure that operator exposure limits are not exceeded, and to confirm that treatment of sludge is effective in removing the biological contamination
(15) Natural inactivation	**None**	**Social –** This option may be perceived as doing 'nothing' by the public, which has negative implications. However, some may argue that continuing with normal water treatment is a positive message to the public **Technical –** Monitoring equipment and skilled personnel to take samples. May take prolonged period of time for contamination to reduce **Cost –** May be high, considering monitoring equipment, consumables, skilled personnel (including laboratory analysis) and time **Time** – This option can take a very long time (months to years) for some biological agents

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Waste disposal options		
(16) Drain to temporary storage	**Waste** – There may be significant amounts of contaminated material generated from water treatment (eg sand from filter beds and sludge) that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence. Disposal routes for waste water and solid wastes could lead to the spread of low levels of contamination in the environment **Cost** – May be high, considering equipment, skilled personnel to undertake the recovery measure and volume of waste requiring disposal	**Public health –** There may be increased exposure of water treatment operatives, either from direct exposure to contaminated water or through the accumulation and storage of contaminated waste from treatment **Technical –** The volume/capacity of contaminated material generated from water treatment that the water treatment facility can store is a technical consideration. It could also take days to weeks to drain (and then clean if required) the affected area **Time –** There might be a delay in notifying the relevant agencies. The draining process may take some time depending on the amount of contaminated water
(17) Discharge off site using tankers (tankering)	**Waste –** There may be significant amounts of contaminated water that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence. Disposal routes for waste water and solid wastes could lead to the spread of low levels of contamination in the environment **Technical –** Equipment and skilled personnel to undertake the recovery measure (ie transport of raw materials and waste to and from treatment works) **Costs –** May be high, considering equipment, personnel and volume of waste requiring disposal	**Public health –** There may be increased exposure of water treatment operatives, either from direct exposure to contaminated water or through the accumulation and storage of contaminated waste from treatment

Step 5 Consult recovery option sheets

Individual recovery option sheets (Chapter 9) can now be referred to for all remaining options that have been identified in the selection process. This step involves a detailed analysis of all remaining options by careful consideration of the information presented in the recovery option sheets. This step can only be completed on an incident-specific basis and in close consultation with local stakeholders to take into account local circumstances.

Step 6 Compare the remaining recovery options

The remaining recovery options now need to be compared and evaluated to eliminate any further options that may not be required. For example, if the remaining options include two that contradict one another and it has been determined that these options are both effective and applicable for the contaminated water environment, then one of the options can be eliminated as both cannot to be used together.

Once a recovery strategy has been implemented, the remaining steps are to monitor to determine if the recovery strategy has been effective and to report on the incident and subsequent response, including the effectiveness of the handbook (see Figure 8.1). These steps are outside the scope of the handbook and are not discussed further.

8.8 References

1 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. UK Recovery Handbook for Chemical Incidents. Health Protection Agency. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications

2 Lim LS, Varkey P, Giesen P, Edmonson L. Cryptosporidiosis outbreak in a recreational swimming pool in Minnesota. J Environ Health. 2004 Aug;67(1)):16–20.

3 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). Public Health England. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015

4 Drinking Water Inspectorate. Types of private water supplies and the implications to you. 2014. Available (September 2015) at http://dwi.defra.gov.uk/private-water-supply/Owner/TypesPWS.pdf

9 Water Environments Recovery Options

(1) Isolate and contain water supply

(2) Restrict water use (DND/DNU notices)

(3) Alternative drinking water supply

(4) Boil notices

(5) Controlled blending of drinking water supplies

(6) Restrict access to inland, recreational or coastal (controlled) water environments

(7) Restrict transport to inland, recreational or coastal (controlled) water environments

(8) Removal/treatment of contamination source

(9) Continuing normal water treatment (with monitoring)

(10) Introduction/modification of existing water treatment

(11) Changes to water abstraction point or location of water source

(12) Water treatment at point of use (tap)

(13) Flush distribution system

(14) Treatment of sludge

(15) Natural inactivation

(16) Drain to temporary storage

(17) Discharge off site using tankers (tankering)

(1) Isolate and contain water supply

Objective	To prevent and reduce exposure to a contaminated drinking water supply
Other benefits	None
Recovery option description	Water supplies would be isolated (turned off) in only the most extreme circumstances. Ideally, this option should only be considered for a very short time (hours) to allow an initial flush of contamination to pass through the water supply system or to allow for biological agents with a short persistence to degrade. It may also result in a large quantity of contaminated water requiring disposal
Key information requirements	What is the source of contamination? What are the population demographics and size of the affected area? Will sensitive groups or populations be affected (eg hospitals and schools)? Are alternative drinking water supplies available? How difficult is it to isolate the supply?
Linked recovery options	This is a protection option and may need to be linked to remediation options This recovery option should be considered in conjunction with (2) Restrict water use (DND/DNU notices), (3) Alternative drinking water supply, (4) Boil notices, (11) Changes to water abstraction point or location of water source and (13) Flush distribution system Storage/treatment of contaminated water (post-treatment) would also need to be considered: options include (16) Drain to temporary storage and (17) Discharge off site using tankers (tankering)
Target	Water supply and subsequent water use (eg drinking, food preparation and washing)
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate water supplies and pose a risk to public health. However, the characteristics of the biological agents will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option would need to be implemented as soon as contamination becomes apparent. The recovery option will need to be in place for the duration of the contamination, or until contamination is within water quality standards
Considerations	
Public health considerations	This option should only be considered for a very short time (hours). If this option is likely to be required for some time (ie days) then an alternative source of potable water would need to be made available
Legal implications and obligations	Drinking water standards are regulated by the Drinking Water Inspectorate. Biological contamination would have to be within regulated limits before the isolated supply could be turned back on and comply with relevant regulations. Refer to Appendix A for more information
Social implications	Disruption likely to be upsetting to members of the public. There may also be issues with regard to disruption and access to people's homes and residential areas
Environmental considerations	None
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) An alternative supply of potable drinking water would have to be provided
Effectiveness	
Recovery option effectiveness	Up to 100% effective in reducing exposure (ie ingestion, inhalation and dermal contact) of contaminated water
Technical factors influencing effectiveness of recovery option	Access to water source to isolate the supply may be difficult Depressurisation of system could lead to leaching of residual contamination from pipes when supply is turned back on

(1) Isolate and contain water supply

Feasibility and intervention costs	
Specific equipment	None
Utilities and infrastructure	Water companies will need to be consulted if they control the access to the water supply
Consumables	None
Skills, personnel and operator time	Communication with individuals who will be affected by the isolation
Safety precautions	Ensure any individuals affected will have access to enough water during the isolation period
Other limitations/ factors influencing costs	None
Waste	
Amount and type	None unless contaminated water requires treatment and disposal
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion, inhalation or dermal contact with contaminated water (eg drinking, food preparation and washing)
Potential increased worker exposure	None
Other considerations	
Agricultural impact	There may be an agricultural impact if water was diverted from agricultural use, which could lead to a shortage of water for irrigation and animal welfare, particularly in conditions of limited water resources. Licences to abstract water for agricultural use may be withdrawn temporarily
Compensation issues	There may be requests for compensation for costs associated with loss of normal water supplies provided by water companies and suppliers (eg manufacturing, production or farming practices) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments People will need information on: where restrictions are in place and that alternative water is available; location of alternative water distribution points; times when water will be distributed; how long the situation will last
Additional information	
Practical experience	Cryptosporidium outbreak in high-rise apartment in Seoul, 2012 Cryptosporidium outbreak in North Thames area, 1997 *E. coli* contamination, Northumberland, 2009 Hepatitis A outbreak in a middle school in China, 2012

(1) Isolate and contain water supply

	E. coli incident in Hurlfield service reservoir, 2012 Killiganoon service reservoir contamination, 2010 Sowerby service reservoir contamination, 2012
Key references	Cho EJ, Yang JY, Lee ES, Kim SC, Cha SY, Kim ST, et al. A waterborne outbreak and detection of Cryptosporidium oocysts in drinking water of an older high-rise apartment complex in Seoul. Korean J Parasitol. 2013;51(4):461–6 Willocks L, Crampin A, Milne L, Seng C, Susman M, Gair R, et al. A large outbreak of cryptosporidiosis associated with a public water supply from a deep chalk borehole. Commun Dis Public Health. 1998;1(4):239–43 Drinking Water Inspectorate. The Chief Inspector's Report. 2009. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Ye-Qing X, Fu-Qing C, Jia-Tong Z, Guo-Ming Z, Jin-Fa D, Qu-Yun D, Hui-Min L. An outbreak of hepatitis A associated with a contaminated well in a middle school, Guangxi, China. Western Pac Surveill Response J. 2012;3(4):44–7 Yorkshire Water Services Ltd. Annual Report and Financial Statements. 2014. Available (September 2015) at https://www.yorkshirewater.com/sites/default/files/Yorkshire%20Water%20Annual%20Report%202014.pdf Drinking Water Inspectorate. The Chief Inspector's Report. 2010. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Drinking Water Inspectorate. Significant drinking water quality events in 2012. 2013. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/2012/significant-events.pdf Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
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(2) Restrict water use (DND/DNU notices)

Objective	To prevent potential adverse health effects from exposure to contaminated water
Other benefits	This recovery option also avoids exposing the affected population to risks in the initial and possibly later stages of a biological incident where water supplies have been contaminated
Recovery option description	DND – Do Not Drink or DNU – Do Not Use notices These two notices differ but both have important outcomes. There might be cases in which water may not be potable as it may cause adverse health effects but the same water might be acceptable for washing items or bathing
Key information requirements	What are the population demographics and size of the affected area? Will sensitive groups of populations be affected (ie hospitals or schools)? Are alternative drinking water supplies available?
Linked recovery options	This is a protection option and may need to be linked to remediation options This recovery option should be considered in conjunction with (1) Isolate and contain water supply, (3) Alternative drinking water supply, (4) Boil notices and (11) Changes to water abstraction point or location of water source Storage/treatment of contaminated water (post-treatment) would also need to be considered; options include (13) Flush distribution system, (16) Drain to temporary storage and (17) Discharge off site using tankers (tankering)
Target	Water supply and subsequent water use (eg drinking, food preparation and washing)
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	It is recommended that DNU notices are reserved for use only in those circumstances where there is unequivocal evidence of persistent contamination of the water supply with a biological agent at a level where short-term exposure is known to give rise to adverse health effects in the otherwise healthy population, and measures to restore the water supply to normal are likely to be protracted (weeks, rather than hours or days) Another relevant scenario would be where the contaminant cannot be detected by a change in appearance of the water (meaning consumers would not be alerted to the problem and thus unlikely to take avoiding action without being warned) Additionally, it may be that users are advised to restrict use of water for irrigation of crops, especially for foodstuffs which are not cooked prior to eating
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option would need to be implemented as soon as contamination becomes apparent. The recovery option will need to be in place for the duration of the contamination, or until contamination is within water quality standards
Considerations	
Public health considerations	This recovery option should only be implemented if alternative water is available/provided Although existing water supplies may be suitable for sanitation purposes, convincing people that water is safe to bathe in, but not safe to drink or cook with, may be difficult, ie compliance issue
Legal implications and obligations	Ability of the authorities to ensure compliance with instructions and advice; people cannot be forced to comply, may not understand the instructions or be able or willing to follow them. Refer to Appendix A for more information
Social implications	Reluctance of community to adhere to the restriction being imposed Generally, the type of circumstances when a DNU notice might be considered are those where there is a major biological incident which cannot be contained by the water supplier through stopping abstraction at the treatment works and/or the contamination has entered the treated water distribution system and the extent of the contaminated water cannot quickly be identified and contained/removed Local authorities have the responsibility for making decisions about the continued operation of premises manufacturing or serving food and drink, and for public buildings such as schools and leisure centres PHE is responsible for initiating contingency arrangements for hospitals and other health services

(2) Restrict water use (DND/DNU notices)

Environmental considerations	Inclement weather could lead to disruption in the provision of alternative supplies. Remote areas may not receive alternative supplies. Widespread contamination could mean alternative supplies are limited. Drought conditions may mean alternative supplies are limited
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) It must be clear that issuing DND/DNU notices are a sufficient response to the incident
Effectiveness	
Recovery option effectiveness	This recovery option may be up to 100% effective in preventing exposure, although it is possible that some members of the community will not adhere to the notice or understand the instructions. The efficacy of the recovery option depends on efficiency of the communication medium and compliance of the community to adhere to the warning notice
Technical factors influencing effectiveness of recovery option	Implementing this option will depend on the nature of the incident. In a large-scale event, the hazards posed by issuing a widescale warning notice need to be balanced carefully against the nature of the water supply. Experience has shown that it is often preferable to implement enhanced health surveillance of the affected community instead of issuing a warning notice. Each situation has to be judged on its merits, taking into account local knowledge and whether or not water supplies can be returned to normal quickly or an alternative piped supply provided (by rezoning). If a decision is taken to issue DND or DNU advice or notices, the basis for lifting the advice must be agreed at the same time. Experience has shown that significant problems can arise if the criteria for lifting the notice have not been decided when it is first issued The public may ignore restrictions and continue to drink the contaminated water. The public may also not be aware that restrictions are in place and that an alternative supply is available. Shortages of alternative supplies could lead to the public drinking contaminated water. If the area affected involved large numbers of people, the supplies might not meet demand The key issues associated with this recovery option are compliance of individuals and length of time for which this notice would be enforced DND/DNU notices pose a significant challenge to a water supplier due to the need to make 100% provision of alternative water supplies for drinking and food preparation (ie cooking). These logistical problems are magnified and further compounded in the case of a DNU notice because of the hygiene issues implicit in restricting the public's access to piped water for showering and bathing
Feasibility and intervention costs	
Specific equipment	Mechanism of communication, leaflets, loud hailer, local radio and television
Utilities and infrastructure	See linked recovery option (3) Alternative drinking water supply
Consumables	Possibly bottled water/bowsers. See linked recovery option (3) Alternative drinking water supply
Skills, personnel and operator time	Operators disseminating warning notification, enforcing the message. Operator time and personnel requirements will vary depending on the size and scale of the biological incident
Safety precautions	Appropriate educative/informative material for the affected community
Other limitations/ factors influencing costs	Compliance by the public Costs will be influenced by the length of time for which the restriction will remain in place
Waste	
Amount and type	None
Possible transport, treatment, disposal and storage routes	None
Factors influencing waste issues (eg cost)	None

(2) Restrict water use (DND/DNU notices)

Exposure	
Averted exposure	Ingestion, inhalation or dermal contact with contaminated water (eg drinking, food preparation, washing or bathing). Averted exposure will be influenced by public compliance with this recovery option
Potential increased worker exposure	N/A
Other considerations	
Agricultural impact	There may be an agricultural impact that could lead to a shortage of water for irrigation or an impact on other farming practices, particularly in conditions of limited water resources. Licences to abstract water for agricultural use may be withdrawn temporarily
Compensation issues	There may be requests for compensation for costs associated with loss of normal water supplies provided by water companies and suppliers (ie manufacturing, production or farming practices) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Implementing this recovery option would require a clear communication strategy to ensure the public are kept informed, address health concerns and ensure compliance. All responding agencies should ensure that public advice is provided in an agreed and common format such as frequently asked questions (FAQ) and provided to their staff in call centres or placed on their websites
Additional information	
Practical experience	Gastroenteritis outbreak from a private borehole, 1995 Private water supply contamination, 2011
Key references	Reacher M, Ludlam H, Irish N, Buttery R, Murray V. Outbreak of gastroenteritis associated with contamination of a private borehole water supply. Commun Dis Public Health. 1999;2(1):27–31 Rundblad G. The semantics and pragmatics of water notices and the impact on public health. J Water Health. 2008;6:77–86 Drinking Water Inspectorate. The Chief Inspector's Report. 2011. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
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(3) Alternative drinking water supply

Objective	To reduce exposure to consumers by providing an alternative supply of potable drinking water in the event of biological concentrations in supplied (treated) water exceeding UK water quality standards
Other benefits	Reduce dermal exposure from washing and impact on gardens from watering
Recovery option description	If restrictions were placed on the use of drinking water supplies due to biological agent concentrations exceeding UK water quality standards, alternative sources of water would need to be provided for drinking water and water used for food preparation This recovery option sheet considers the use of: • alternative mains water supply • reservoir/aquifer rezoning • bottled water • water provided by water companies by tankers and bowsers at distribution points from other drinking water sources Advice is likely to be given that continued use of the water supply for sanitation is expected – see (12) Water treatment at point of use (tap) – and this will not give rise to any significant hazard If the level of contamination was sufficiently high, then, in extreme cases, the water supplies could be isolated completely – (1) Isolate and contain water supply Although water may not be acceptable for use as drinking water, it may still be suitable for sanitation. However, water supplies could be turned off completely in the most extreme circumstances. Ideally, this recovery option should only be considered for a very short time (hours) to allow an initial flush of contamination to pass through the water supply system or to allow for biological agents with a short persistence to inactivate
Key information requirements	What are the population demographics and size of the affected area? Will sensitive groups or populations be affected (ie hospitals or schools)? Details of responsibilities for providing alternative water to private supply users Monitoring/sampling analysis to confirm water is fit for consumption Seek specialist advice and guidance (ie from the Drinking Water Inspectorate (DWI) and water suppliers) as this recovery option may require bowsers, tankers and transport vehicles
Linked recovery options	This is a protection option and may need to be linked to remediation options This recovery option should be considered in conjunction with (1) Isolate and contain water supply, (2) Restrict water use (DND/DNU notices), (4) Boil notices and (11) Changes to water abstraction point or location of water source
Target	Water supply and subsequent water use (eg drinking, food preparation and washing)
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small to medium scale – sufficient drinking water would need to be provided to sustain the population affected by any restrictions to their normal drinking water supply. Also sufficient drinking water would need to be provided to meet any legal obligations placed on the supplier and comply with UK drinking water standards In general, the supply of alternative water could only be maintained for a short period (days) and then only to relatively small numbers of people in local or regional communities. Distribution of bottled water or water by tankers and bowsers is likely to take at least eight hours to plan and arrange. It is important, therefore to encourage use of existing water supplies for sanitation purposes to avoid other public health issues
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option would need to be implemented as soon as contamination becomes apparent. The recovery option will need to be in place for the duration of the contamination, or until contamination is within water quality standards

Considerations

Public health considerations	None expected if water supplied is of sufficient quality. However, some mineral waters on sale in the high street have a high concentration of sodium that can cause adverse health effects if used in baby feed. Although existing water supplies may be suitable for sanitation purposes, convincing people that

(3) Alternative drinking water supply	
	water is safe to bathe in, but not safe to drink or cook with, may be difficult The season (summer or winter) will affect the amount of drinking water required due to human physiology
Legal implications and obligations	Alternative drinking water supplies would need to meet the quality standards for normal drinking water supplies. Sufficient water would need to be provided to meet any legal obligations placed on the water supplier. In the UK, the Security and Emergency Measures Direction (SEMD) requires that 10 L/d per person should be provided if piped water supplies fail Water companies in the UK have contingency plans to provide an alternative supply of drinking water during emergency situations (SEMD). These plans specify a daily amount of 10 L/d of drinking water per person must be supplied for the first five days, then 20 L/d after this period, and a time limit in which this alternative supply is provided. Refer to Appendix A for more information
Social implications	There would be a short-term social impact as people would have to make provisions for collecting alternative drinking water supplies. Rationing may be needed to extend available supplies. Social unrest (due to real or perceived shortages in supplies) could lead to problems at distribution points. There is evidence to suggest that people are more likely to move out of their homes due to loss of water supply than electricity Loss of confidence in the quality of water provided by water companies to the public (and other parties for private supplies) People will not want to travel far to distribution points. Older people and people with disabilities will require assistance in getting water to their homes. Bulk buying at shops is likely to lead to shortages of bottled water supplies. Separate individual supplies would need to be provided for hospitals, schools, office buildings and any other large premises containing large numbers of people There is the potential issue of bottled water theft (water is an important commodity), and vandalism of bowsers, therefore security may be required The public may decide to boil water provided by an alternative supply regardless of the public health message sent out Generally, members of the public prefer bottled water to water from bowsers or tankers
Environmental considerations	Inclement weather could lead to disruption in the provision of alternative supplies. Remote areas may not receive alternative supplies. Widespread contamination could mean alternative supplies are limited. Drought conditions may mean alternative supplies are limited If undue pressure was put on a particular source of water such as rivers or reservoirs, then there could be an environmental impact. This would be exacerbated during the summer when water levels are generally at their lowest Potential impact from requirement to dispose of large quantities of plastic bottles
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	If the alternative supply was free from contamination, and the restricted water not used, then this recovery option will be up to 100% effective An alternative supply may be less contaminated but still acceptable for use as drinking water; in this case the reduction in contaminated concentrations will be lower Bottled water from shops should be free from contamination, as the source is generally not local and it could have been bottled for some time prior to any incident. In addition, bottled water has already gone through screening to meet quality control requirements
Technical factors influencing effectiveness of recovery option	Some people may ignore restrictions and continue to drink the contaminated water. Some people may not be aware that restrictions are in place and that an alternative supply is available Shortages of alternative supplies could lead to people drinking the contaminated water. If the affected area involved large numbers of people, the supplies might not meet demand Suitable storage is required for the storage of large quantities of water Sufficient staff to hand out large quantities of bottled water In some circumstances narrow roads may affect the distribution of water by tankers and bowsers Separate individual supplies would need to be provided for hospitals, schools, office buildings and any other large premises containing large numbers of people. Instructions on DND notices could be supplied with bottled water

(3) Alternative drinking water supply

Feasibility and intervention costs

Specific equipment	Equipment used for the transport of water (lorries, tankers and bowsers). Large storage facilities for the stockpiling of water. Containers for the transport of water from the distribution point to homes. Pallets for appropriate storage of bottled water
Utilities and infrastructure	Coordination of distribution of supplies. Forward planning to determine how long capacity can be maintained
Consumables	Fuel for vehicles and bottles or containers for transporting water. Bottled water from shops/warehouses
Skills, personnel and operator time	Sufficient number of drivers to transport the water. Travelling time for drivers and, possibly, unsociable hours (weekends or outside normal working) If bowsers are used, there is a requirement to sample the water in them every 48 hours and analyse for a full suite of contaminants. This would involve a number of personnel and significant resources in the laboratory depending on the number of bowers/tanks required In extreme circumstances, a police presence (or security) may be required at water distribution points
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water company workers use appropriate PPE (if required) and follow standard operating procedures (SOPs) Possible crowd control may be required at water distribution points. The water distributor (eg tanker or bowser) may require protection (from vandalism), and there may be the need for security at water storage areas
Other limitations/ factors influencing costs	Availability of tankers and bowsers. Some water companies may have their own tankers or bowsers or may have service level agreements with companies to provide such equipment in the event of an emergency. In both cases the equipment will be available locally, although may be not on the required timescales if large numbers are required. In large-scale incidents, resources beyond those available to individual or groups of water companies may be needed. Mutual aid agreements may be necessary

Waste

Amount and type	Many types of waste that will be encountered during or after a biological incident may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion – the Environment Agency in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland and the Northern Ireland Environment Agency (NIEA) – and consult available national guidance No direct waste is generated unless a contaminated water supply is isolated and requires treatment prior to disposal. If contaminated water has already been treated, wastes arising from water treatment may also be contaminated Indirect waste may also be generated, eg the disposal of large quantities of empty plastic bottles following the supply of an alternative source of water
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance as contaminated water may require disposal and/or storage under authorisation by a suitable disposal route (EA, SEPA and NIEA) For any contaminated water, the following recovery options may apply: (16) Drain to temporary storage and (17) Discharge offsite using tankers (tankering) Contaminated waste water may be classified as dangerous in transport and will be subject to the transport of dangerous goods legislation whatever the mode of transport used. Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport Experience has shown that there may be a need to identify and establish an intermediate temporary site, or sites, between the site of the incident itself and the ultimate final destination(s) for disposal
Factors influencing waste issues (eg cost)	Contaminated waste must be transported in suitable tank-vehicles or leak proof receptacles EA, SEPA and NIEA have special powers to respond to waste issues during major incidents and should be consulted to determine an appropriate disposal route for contaminated waste, although they are not responsible for removing the waste

(3)	Alternative drinking water supply
	Costs will be influenced by the volume of water requiring disposal and contaminant concentrations in the water
Exposure	
Averted exposure	Ingestion, inhalation or dermal contact with contaminated water (eg drinking, food preparation and washing)
Potential increased worker exposure	N/A
Other considerations	
Agricultural impact	There may be an agricultural impact if water was diverted from agricultural use, which could lead to a shortage of water for irrigation and animal welfare, particularly in conditions of limited water resources. Licences to abstract water for agricultural use may be withdrawn temporarily
Compensation issues	There may be requests for compensation for costs associated with loss of normal water supplies provided by water companies and suppliers (eg manufacturing, production or farming practices) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Additional information	
Practical experience	Cryptosporidium outbreak in high-rise apartment in Seoul, 2012 E. coli contamination, Northumberland, 2009 Gastroenteritis outbreak from a private borehole, 1995 King Sutton water contamination following a burst main, 2010 Private water supply contamination, 2011
Key references	Cho EJ, Yang JY, Lee ES, Kim SC, Cha SY, Kim ST, et al. A waterborne outbreak and detection of Cryptosporidium oocysts in drinking water of an older high-rise apartment complex in Seoul. Korean J Parasitol. 2013;51(4):461–6 Reacher M, Ludlam H, Irish N, Buttery R, Murray V. Outbreak of gastroenteritis associated with contamination of a private borehole water supply. Commun Dis Public Health. 1999;2(1):27–31 Drinking Water Inspectorate. The Chief Inspector's Report. 2009. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Drinking Water Inspectorate. The Chief Inspector's Report. 2010. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Drinking Water Inspectorate. The Chief Inspector's Report. 2011. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Rundblad G. The semantics and pragmatics of water notices and the impact on public health. J Water Health. 2008; 6:77–86. Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
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(4) Boil notices

Objective	To reduce ingestion exposure to consumers by advising the public to boil water before use
Other benefits	This is a 'self-help' option
Recovery option description	Boiling of water at the point of use can inactivate biological contamination within drinking water supplies
Key information requirements	What are the population demographics and size of the affected area? Will sensitive groups of populations be affected (eg hospitals or schools?) Are alternative drinking water supplies available?
Linked recovery options	This is a protection option and may need to be linked to remediation options This recovery option should be considered with (2) Restrict water use (DND/DNU notices), (11) Changes to water abstraction point or location of water source and (13) Flush distribution system
Target	Public and private drinking water supplies
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion of contaminated drinking water
Time of application	This recovery option should be implemented as soon as contamination is apparent. The recovery option will need to be in place for the duration of the contamination, or until contamination is within water quality standards
Considerations	
Public health considerations	Potential for burns and scalds if individuals use water which has not sufficiently cooled to wash with or bathe in Although existing water supplies may be suitable for sanitation purposes, convincing people that water is safe to bathe in, but not safe to drink or cook with, may be difficult Water may still be perceived to be contaminated as boiling will not remove any particles/cloudiness if present in the supply Bottled water may be a better alternative if accessible as this will limit the impact of the above-mentioned issues, and may be more practical for large-scale premises and businesses
Legal implications and obligations	Section 70 of the Water Industry Act 1991 legislates that it is an offence for a water company to supply water that is unfit for human consumption If a boil notice has been enforced, then this implies that the water is safe for sanitary purposes, but is not suitable for ingestion. Properties are therefore not without water but will have to put in additional measure before consumption of the water supplied. It would need to be demonstrated that boiling of the water would be sufficient to bring the level of contamination below the threshold level Alternatively, water could be supplied by the water company to all those affected – (2) Restrict water use (DND/DNU notices)
Social implications	Loss of confidence in the quality of water provided by water companies to the public (and other parties for private supplies) Increased electricity requirements to boil water. Time factor in boiling and cooling of water to safe temperature levels
Environmental considerations	None
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)
Effectiveness	
Recovery option effectiveness	This may be limited as it relies on individuals observing the boil water notice and is difficult to enforce. It also assumes that individuals are following the boil water notice correctly and not, eg, using tap water to brush teeth

(4) Boil notices

Technical factors influencing effectiveness of recovery option	Some people may ignore boil notice and continue to drink the contaminated water. Some people may not be aware that a boil notice is in place and therefore continue to drink contaminated water There may be a delay in detection of the biological contamination and implementation of a boil water notice which will result in individuals consuming contaminated water during that time period
Feasibility and intervention costs	
Specific equipment	Equipment required to boil water: at domestic premises this will most likely be a standard kettle, although at larger premises alternatives may be available
Utilities and infrastructure	Increase demand on electricity/gas supply to boil water Communication to inform affected premises that a boil water notice is in place. This may include email, phone call, leaflets and advertising through local news and radio
Consumables	None
Skills, personnel and operator time	Generally, boiling of water is a task that most individuals would be able to complete. However, it is important that water is sufficiently cooled prior to use and therefore this will need to be controlled. People with disabilities and the young and elderly may struggle to boil water in the quantities required The water supplier will be tasked with notification of affected premises that the boil water notice is in place
Safety precautions	Potential for burns or scalds if water not sufficiently cooled for its usage purpose
Other limitations/ factors influencing costs	Resources required to inform individuals that a boil notice is in place. This may be difficult to apply to large-scale premises such as schools or hospitals and therefore other alternatives may be sought
Waste	
Amount and type	No direct waste is generated unless a contaminated water supply is isolated and requires treatment prior to disposal. If contaminated water has already been treated, wastes arising from water treatment may also be contaminated
Possible transport, treatment, disposal and storage routes	None
Factors influencing waste issues (eg cost)	None
Exposure	
Averted exposure	Ingestion, inhalation or dermal contact with contaminated water (eg drinking, food preparation, washing or bathing). Averted exposure will be influenced by public compliance with this recovery option
Potential increased worker exposure	None
Other considerations	
Agricultural impact	None
Compensation issues	None
Public information	Information concerning the boil notice would have to be successfully distributed to all those affected. The public must be kept informed and instructed as to when the boil notice is no longer enforced
Additional information	
Practical experience	Members of the public are familiar with boil water advisory notices. While these notices cause inconvenience in the home and can be disruptive to certain businesses (food and drink retailers and manufacturers) and public buildings (health care premises), the water industry has substantial experience of the practical aspects which are manageable, and the public is familiar with the concept
Key references	Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf

(4) Boil notices

Rundblad G. The semantics and pragmatics of water notices and the impact on public health. J Water Health. 2008;6:77–86

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Comments

Document history

(5) Controlled blending of drinking water supplies

Objective	To reduce exposure to consumers by diluting biological contamination in drinking water in the event of activity concentrations in the supplied (treated) water exceeding UK water quality standards
Other benefits	None
Recovery option description	Contaminated water could be mixed with uncontaminated or less contaminated water if more than one supply is available at the point of water treatment or post-treatment. This is an effective method of reducing biological concentrations in water to below UK water quality standards and is done when required for other contaminants
Key information requirements	Access to other water distribution networks Capacity of water supplies from other water supplies (eg service reservoirs)
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (9) Continuing normal water treatment (with monitoring), (11) Changes to water abstraction point or location of water source, (12) Water treatment at point of use (tap) and (15) Natural inactivation
Target environment	Public drinking water supplies This recovery option is generally inappropriate for private drinking water supplies
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate drinking water supplies. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Medium to large scale This recovery option could be used on a medium to large scale depending on the options for blending different water sources either before or after water treatment, and the size of water distribution networks in place Blending should not reduce the amount of drinking water produced or supplied to homes
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option should be implemented in the early to medium phase (hours to weeks) of a biological incident. Blending could be used as soon as contamination of a water source had been confirmed and would need to be implemented quickly. Blending would be required for the duration of time that a contaminated water source was above the UK water quality standards
Considerations	
Public health considerations	None, if implemented correctly
Legal implications and obligations	Blended drinking water supplies would need to meet the quality standards for normal drinking water supplies and comply with UK drinking water standards. Refer to Appendix A for more information
Social implications	There may be problems regarding the acceptability of residual levels of contamination in water supplies by the public, which may lead to loss of confidence in drinking (tap) water supplies. This could result in the demand for bottled water to increase sharply. Blending contaminated water with uncontaminated water means that biological contamination is diluted. This will need to be carefully explained to the public, who might find this practice unacceptable, particularly if people who would have had a 'clean' supply now receive water contaminated with low levels (albeit within acceptable limits) of biological contamination
Environmental considerations	Widespread contamination or water shortages during periods of drought could result in fewer opportunities for blending. If undue pressure was put on a particular source of water such as a river or a reservoir this may lead to an environmental impact. This would be exacerbated during the summer months when water levels are generally at their lowest
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) This option may possibly result in water shortages in other areas. The public may also be inadvertently exposed to biological contamination from blended drinking water that otherwise they would not have encountered. Any increase in exposure to the affected population would need to be balanced against the need to supply drinking water for the larger population

(5) Controlled blending of drinking water supplies

Effectiveness

Recovery option effectiveness	The effectiveness of this option in reducing contamination levels in water depends on the extent of contamination, the nature of the biological agent and level to which the contamination has been diluted The effectiveness of this option relies on a programme of testing and monitoring water after the point of blending/mixing to ensure that contamination levels have been reduced sufficiently. Therefore, testing apparatus must be calibrated and accurate
Technical factors influencing effectiveness of recovery option	Availability of alternative drinking water, the extent to which the cleaner source of water (ie free from contamination) can be provided and the speed with which blending can be implemented There can be problems associated with mixing very soft and very hard water Restrictions on the use of water may be required where there are shortages

Feasibility and intervention costs

Specific equipment	No cost implications in the short term. If this option is being considered as a long-term remediation measure, existing infrastructure may need to be upgraded (eg new build)
Utilities and infrastructure	The water company must have access to different water sources/supplies and be able to adjust the amount of water from each source that enters the drinking water supply
Consumables	None
Skills, personnel and operator time	No specific skills are required, other than those already employed by the water company It may be possible to undertake blending during the course of normal work practices. However, there may be additional time costs for the operator due to the need to undertake a full risk assessment to ensure that rezoning supplies (to enable blending) would not create another problem, such as the supply of discoloured water or causing bursts in distribution pipes
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	None

Waste

Amount and type	None. This option will not produce any contaminated waste water
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A

Exposure

Averted exposure	Ingestion, inhalation or dermal contact with contaminated water (eg drinking, food preparation or washing)
Potential increased worker exposure	None

Other considerations

Agricultural impact	There may be an agricultural impact if water was diverted from agricultural use, which could lead to a shortage of water for irrigation, particularly in conditions of limited water resources. Licences to abstract water for agricultural use may be withdrawn temporarily
Compensation issues	Unlikely to be applicable

(5) Controlled blending of drinking water supplies

Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented. Communication with the affected communities about the rationale for choosing this option would be desirable. This information must be developed in partnership with other experts, government agencies and departments The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Experience also confirms the need to ensure that other measures are put into place to keep the community informed of developments when regular briefings have been terminated. Previous incidents and exercises suggest weekly or monthly newsletters; site boards or banners around sites can be effective ways of achieving this

Additional information

Practical experience	
Key references	Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Rundblad G. The semantics and pragmatics of water notices and the impact on public health. J Water Health. 2008;6:77–86 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
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(6) Restrict access to inland, recreational or coastal (controlled) water environments

Objective	To reduce possible exposure from biologically contaminated waters and to prevent members of the public from accessing a contaminated area
Other benefits	Any necessary recovery options will be implemented more easily while the population are absent from the contaminated area
Recovery option description	In most cases the public may only require access to inland, recreational or coastal water environments for recreational purposes (eg fishing, swimming and surfing). Water environments to which restricting access could be considered include coastal waters (sea), reservoirs, rivers and lakes. There may be some exceptions to recreational use such as professional fishermen or divers This recovery option could be implemented using communication through the media combined with using appropriate signs. If severe contamination has occurred, a cordon with appropriate security may be required. Following a large-scale incident, coastal waters may not be a high priority for clean-up unless there is the potential for the contamination to spread to drinking water so restricting access may be necessary prior to any clean-up or recovery strategy being implemented This recovery option could be implemented more easily in the short term; members of the public may be less likely to adhere to notices over a period of months or years if they wish to use the water environments for recreational purposes Realistically, only a total prohibition on access will be enforceable. Any partial restriction cannot be controlled and it will not be possible to control the exposures received by members of the public The Secretary of States Representative for Maritime Salvage and Intervention (SOSREP) may issue an exclusion zone which would encompass both shipping and aerial traffic
Key information requirements	What is the nature or use of recreational water by the public (eg fishing, sailing or swimming)? What is the extent of the contamination?
Linked recovery options	This is a protection option and may need to be linked to remediation options This option could be considered in conjunction with (7) Restrict transport to inland, recreational or coastal (controlled) water environments
Target environment	People who may use water environments for recreational purposes
Targeted organisms	This recovery option is applicable to all biological agents that could contaminate water and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Exposure could be by multiple routes depending on the biological agent and nature of the incident. However, dermal, inhalational and ingestion exposures are most likely to be associated with contaminated water environments
Time of application	This recovery option can be implemented in the early to late phase (hours to months or years) Restricting access may be necessary prior to any clean-up being implemented. There would be maximum benefit if this recovery option was implemented soon after the initial contamination or incident. There are no time limits associated with this recovery option; it can be applied at any time and for any duration

Considerations

Public health considerations	None, if implemented correctly
Legal implications and obligations	May require legislation to restrict access to land, depending on ownership. Restricting use of private areas may not be allowed by law. Refer to Appendix A for more information
Social implications	There may be issues with compliance and there might be pressure to re-open a site depending on what function it had previously (eg sailing clubs, recreational water areas or surfing) Members of the public may be unhappy at being prevented from carrying out their normal activities This option may disrupt routine social activities and commercial activities relating to the water environment (eg sailing clubs or angling) There could be a change in public perception of the acceptability of recreational water areas
Environmental considerations	None
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)

(6)	Restrict access to inland, recreational or coastal (controlled) water environments
Effectiveness	
Recovery option effectiveness	If complied with, there should be no further exposure to members of the public
Technical factors influencing effectiveness of recovery option	Effectively isolating an area from public access may be difficult if the contaminant has not been fully contained (eg in river or open sea). Effective exclusion of people from an area may be difficult to demonstrate (eg success of barriers and fences, if used) This option assumes that the contaminated water environment has been contained and that restrictive access intervention is a viable option
Feasibility and intervention costs	
Specific equipment	Barriers and other equipment to block off access to the water environment Machines may be required to erect effective barriers Water buoys and warning signs May require machinery if large fencing and/or barriers are required
Utilities and infrastructure	Access routes such as roads to the contaminated water area
Consumables	Notices, signs and barriers
Skills, personnel and operator time	Limited skills required to set up barriers and signs
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Duration for which this recovery option is required to be in place (security to restrict access to the affected area)
Waste	
Amount and type	None
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Exposure could be by multiple routes depending on the biological agent and nature of the incident. However, dermal, inhalational and ingestion exposures are most likely to be associated with contaminated water environments
Potential increased worker exposure	Worker and public exposure will be reduced by 100% if access is effectively stopped
Other considerations	
Agricultural impact	There may be an agricultural impact if animals are kept away from an open water source. Licences to abstract water for agricultural use may be withdrawn temporarily
Compensation issues	There may be requests for compensation for costs associated with loss of normal water activities (ie sailing, fishing or farming practices) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk

(6)	Restrict access to inland, recreational or coastal (controlled) water environments
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments In this case communication with the affected communities about the rationale for choosing this option would be desirable and should form part of a wider communication and information strategy
Additional information	
Practical experience	This recovery option was implemented to restrict public access to the beach during the remediation of the MSC Napoli (2009). Although no biological contamination was present, this still provides a demonstration of how this option can be applied
Key references	Bennett S and Bolton P. Operation MSC Napoli. Chemical Hazards and Poisons Report. 2009;14: 15–18. Available (September 2015) at https://www.gov.uk/government/publications/chemical-hazards-and-poisons-report-issue-14 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
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(7)	Restrict transport to inland, recreational or coastal (controlled) water environments
Objective	To reduce or prevent exposure to biological contamination in water environments to members of the public and to prevent spread of contamination in the environment by water vessels
Other benefits	Other recovery options necessary for the recovery of the incident could be carried out more easily in the absence of water vessels
Recovery option description	Prohibits use of vessels (of any form, size and purpose) within a contaminated water environment This option also includes the potential closing of ports and harbours to prevent use of transport This option will not reduce contamination levels in the environment, but it will prevent vessels from spreading contamination This option may also limit the import/export of goods if an incident occurred in major shipping area
Key information requirements	Location and spread of contamination
Linked recovery options	This is a protection option and may need to be linked to remediation options This recovery option will not reduce contamination levels in the environment, but it will prevent vessels from spreading contamination. Therefore, this recovery option should be considered in conjunction with (15) Natural inactivation
Target	Aquatic vessels
Targeted organisms and dispersion methods	This recovery option is potentially applicable to all biological agents. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	All routes (ingestion, skin contact, inhalation) depending on the characteristics of the biological agent
Time of application	Implementation should be undertaken in the early phase
Considerations	
Public health considerations	None
Legal implications and obligations	Refer to Appendix A for more information
Social implications	There may be issues with compliance and there could be pressure to re-open access through the affected environment, especially those whose livelihoods would be affected (ie fishermen) Members of public may be unhappy at being prevented from carrying out their normal activities This option may disrupt routine social activities and commercial activities relating to the water environment (eg sailing clubs and angling)
Environmental considerations	Any environmental impact of using vehicles on water may be reduced
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) There may be a risk of exposure to those enforcing the restriction zone
Effectiveness	
Recovery option effectiveness	This option is effective in preventing vessels from spreading contamination
Technical factors influencing effectiveness of recovery option	Compliance: an effective public information strategy will be essential This option is likely to be implemented more easily in the short term; people may be less likely to adhere to notices over a period of months or years if they wish to use the water environments for recreational or work purposes
Feasibility and intervention costs	
Specific equipment	Boats may be required to patrol areas to ensure enforcement in marine environments
Utilities and infrastructure	None

(7) Restrict transport to inland, recreational or coastal (controlled) water environments	
Consumables	Signs
Skills, personnel and operator time	Boat handling skills for marine environments Operator time will depend on the scale of the incident and the restrictions and enforcements required
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	There may be costs associated with enforcing the restrictions over protracted period
Waste	
Amount and type	None
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	All routes (ingestion, skin contact and inhalation), depending on the properties of the biological contamination
Potential increased worker exposure	This will depend on the properties of the biological agent involved and there is a risk of exposure to those enforcing the restriction zone (ie ingestion hazard)
Other considerations	
Agricultural impact	None
Compensation issues	There may be requests for compensation for costs associated with loss of trade (ie fishing or transport of goods). Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments In this case communication with the affected communities about the rationale for choosing this option would be desirable and should form part of a wider communication and information strategy
Additional information	
Practical experience	The Marine Coastguard Agency (MCA) has a range of experience in restricting water vehicle access during maritime pollution incidents, but this experience could also be applied to a biological incident
Key references	Bennett S and Bolton P. Operation MSC Napoli. Chemical Hazards and Poisons Report. 2009;14: 15–18. Available (September 2015) at https://www.gov.uk/government/publications/chemical-hazards-and-poisons-report-issue-14 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
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(8) Removal/treatment of contamination source

Objective	To remove or treat the source of the biological contamination
Other benefits	This option can remove the need for extensive water treatment programmes by reducing the concentration of the contaminant
Recovery option description	This option requires the identification and then removal or treatment of the contamination source After identification of the contamination source, a decision will be made as to whether it can be removed or decontaminated
Key information requirements	Has the point of contamination been determined? Is the size of the contamination known? What is the contaminating agent? Are alternative drinking water supplies available?
Linked recovery options	This is a remediation option and may need to be linked to other protective and remediation options This recovery option should be considered with (1) Isolate and contain water supply, (2) Restrict water use (DND/DNU notices), (4) Boil notices, (10) Introduction/modification of existing water treatment, (11) Changes to water abstraction point or location of water source, (13) Flush distribution system and (16) Drain to temporary storage
Target	Public and private drinking water supplies and open water environments
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Any
Exposure pathway prevention	Ingestion and contact of contaminated water
Time of application	This recovery option should be implemented as soon as contamination has been determined. The efficacy of this recovery option will need to be determined through microbiological testing of the area and water supply to ensure the contamination has been removed
Considerations	
Public health considerations	Public health will need to be considered when dealing with the source of the contamination. Removal and transport of the source might cause contamination of other areas. User should consult the food production systems and inhabited areas sections of the handbook if contamination is thought to have occurred in these areas
Legal implications and obligations	Seek specialist advice and guidance For matters involving public health, specific laboratories may need to be involved in appropriate accredited testing
Social implications	Success of this option will improve public perception of the incident as the public will feel reassured that the source of contamination is known and dealt with
Environmental considerations	This will depend on the location of the contamination and how the contamination is removed
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN). For complete and detailed guidance, see the Human Rights Act
Effectiveness	
Recovery option effectiveness	If contamination source can be identified and remediated this will be 100% effective at preventing further contamination of the water system
Technical factors influencing effectiveness of recovery option	Effectiveness is dependent on being able to identify the contamination source and acceptable remediation options being available

(8) Removal/treatment of contamination source

Feasibility and intervention costs	
Specific equipment	Sampling equipment for identification Equipment necessary for remediation of the contamination source
Utilities and infrastructure	Laboratory service for sampling analysis
Consumables	Consumables dependent on method of sampling and remediation
Skills, personnel and operator time	Qualified personnel for sampling Laboratory personnel for sampling analysis Experienced personnel for remediation techniques
Safety precautions	Appropriate PPE will be required for collection of samples. Laboratories where analysis will take place will have standard operating procedures (SOPs) already in place for sampling analysis Appropriate PPE will be required for remediation of contamination source
Other limitations/ factors influencing costs	Number of samples needing to be collected and analysed may affect costs
Waste	
Amount and type	Contaminated PPE Waste from remediation of contamination source Contamination source may need disposal (if applicable)
Possible transport, treatment, disposal and storage routes	Depending on the nature of the biological agent and contamination source, waste may be classified as dangerous in transport and subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Factors influencing waste issues (eg cost)	Quantity and type of waste generated
Exposure	
Averted exposure	Continuing contamination of water source
Potential increased worker exposure	Individuals involved in sampling and remediation will be at greater risk of exposure Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that recovery workers (ie plant operatives) use appropriate PPE (if required) and follow SOPs
Other considerations	
Agricultural impact	This may depend on the location of the contamination source and the methods used for remediation
Compensation issues	Dependent on the source of contamination, most water suppliers will be covered by an insurance policy
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed. Rapid communication may pre-empt conflicting actions in other EU member states Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments
Additional information	
Practical experience	*Escherichia coli* in water treatment works (Broken Scar), 2012

(8) Removal/treatment of contamination source

Key references	Drinking Water Inspectorate. The Chief Inspector's Report. 2012. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. Health Protection Agency. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
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(9) Continuing normal water treatment (with monitoring)

Objective	Continuing the use of normal water treatment as a mechanism to remove or partially remove biological contamination in drinking water
Other benefits	No changes to existing practices
Recovery option description	There are several processes used routinely at water treatment plants to remove impurities from drinking water, all of which will remove biological agents (to some extent), including flocculation or clarification, slow or rapid gravity sand filtration, carbon filtration, membrane filtration, ion exchange and reverse osmosis A full monitoring programme would be needed to support this option and to confirm that water treatment is effective for the biological agents of concern and that normal water treatment will maintain biological agent concentrations in the treated water below the UK drinking water standards
Key information requirements	Seek specialist advice and guidance Where are the water sources treated, and what water treatment methods are used? Is there information on the efficacy of water treatment processes in reducing the biological contamination?
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (5) Controlled blending of drinking water supplies and (15) Natural inactivation Storage and treatment of contaminated water (post-treatment) may also need to be considered, such as (14) Treatment of sludge
Target	Public drinking water supplies This option is also appropriate for private drinking water supplies if water treatment is undertaken
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents (to some extent) that could contaminate drinking water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance (ie from the Environment Agency (EA) in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland and the Northern Ireland Environment Agency (NIEA) and local water suppliers) should be sought on the efficacy of standard water treatment practice and processes for the removal of the biological contamination on an incident- and site-specific basis
Scale of application	Large scale: all drinking water supplied by water companies undergoes treatment to some extent. Private water supplies may undergo localised treatment or treatment at the point of use (tap)
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option can be implemented in the early to middle phases (hours to months) of a biological incident. This recovery option does not require any amendments or changes to existing water treatment practices; normal water treatment may be sufficient to remove or reduce biological contamination levels

Considerations

Public health considerations	Continuing normal treatment of contaminated water may give rise to increased exposure to water treatment operatives. This could be as a direct result of exposure to contaminated water or to the accumulation and storage of contaminated waste from treatment (see Appendix A)
Legal implications and obligations	Drinking water undergoes treatment normally to comply with water quality standards (and would comply with the UK drinking water standards). Any waste arising from treatment may need a new authorisation. Refer to Appendix A for more information
Social implications	Loss of confidence in the quality of water provided by water companies to the public (and other parties for private water supplies) There may be the potential for an increased demand for bottled water Possible loss of public confidence that the problem of contamination is being managed effectively For aesthetic-type incidents where there is no significant public health risk, it is important to consider the public's perception of risk and potential loss of public confidence
Environmental considerations	If normal disposal routes for waste water and other solid wastes are used, there may be a risk of spreading low levels of contamination in the environment, eg in natural watercourses
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)

(9)	Continuing normal water treatment (with monitoring)
	Consideration should be given to possible exposure to operatives There may be inequity between beneficiaries (water consumers) and those living close to waste facilities
Effectiveness	
Recovery option effectiveness	Expert guidance (ie from EA, SEPA or NIEA and water suppliers) should be sought on the efficacy of standard water treatment practice and processes for the removal of the biological contamination on an incident- and site-specific basis Physical filtration is very effective at removing particulate matter. Membrane filtration is a physical process used for 'clean' water sources with a very low content of solids and no chemical processes are involved 'Clean' ground water sources (eg some boreholes and aquifers) only undergo minimal treatment and this recovery option would be less effective at removing contamination in these water sources
Technical factors influencing effectiveness of recovery option	Effectiveness will be dependent on the types and number of treatment processes used and also on the biological agent involved. 'Normal' water treatment practices and processes may vary between different water companies
Feasibility and intervention costs	
Specific equipment	No additional specific equipment would be required to implement this recovery option, as it involves continuing normal water treatment practices and processes
Utilities and infrastructure	None, if using existing facilities; however, infrastructure would need to be in place to support the expansion of, or changes to, water treatment works if additional treatments are to be brought 'online' (increased frequency of operations, 'new build', etc)
Consumables	Increased frequency of replenishing treatment materials (eg filter beds and resins will give rise to additional costs)
Skills, personnel and operator time	No specific skills are required other than those already employed However, there could be additional operator time if operations were performed more frequently. Monitoring will be required (additional personnel) and therefore result in some increased costs
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring at the water treatment works and of operatives may be required to ensure that any limits on operative exposure are not exceeded. Changes to other working and safety practices may be required to minimise exposure to operatives
Other limitations/ factors influencing costs	Costs could increase if operations were performed outside normal working patterns and shifts
Waste	
Amount and type	Waste is produced following water treatment (eg contaminated material from filter or resin beds, waste water or sludge); depending on the biological contamination, waste from normal water treatment processes may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance Large quantities of waste material could be generated (eg contaminated sand and activated charcoal from filter beds and sludge) that is above levels permitted for normal use, which may require additional treatment prior to disposal, see (14) Treatment of sludge Sludge is generated continuously as part of normal water treatment; the quantity depends on the content of solids in the raw water. Larger quantities of sludge are often stored on site prior to recovery or disposal and may require an environmental permit or a registered waste exemption. Sludge is also generated during cleaning of storage tanks. Cleaning of storage tanks and the replenishment of filters and resins may take place more frequently following biological contamination to prevent high concentrations of biological waste arising

(9) Continuing normal water treatment (with monitoring)

Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Waste arising from the normal treatment of water may require disposal and/or storage under authorisation and a suitable disposal route Contaminated material such as waste water or sludge may be classified as dangerous in transport and will be subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated waste material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport. Solids should be transported in bulk transport units fitted with liners that can be closed for transport or in sift-proof receptacles Experience has shown that there may be a need to identify and establish an intermediate temporary site, or sites, between the site of the incident itself and the ultimate final destination(s) of debris. Such sites may be required for sorting out large amounts of contaminated waste
Factors influencing waste issues (eg cost)	Disposal of contaminated material generated from water treatment may be expensive as large quantities of contaminated waste could potentially be generated (eg sand from filter beds and sludge) Cost can also be influenced by the availability of a suitable disposal route, cost of hazardous waste treatment and/or disposal, levels of contamination and amounts of waste requiring disposal
Exposure	
Averted exposure	N/A
Potential increased worker exposure	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that water treatment operatives use appropriate PPE (if required) and follow SOPs Monitoring at the water treatment works and of operatives may be required to ensure that any limits on operative exposure are not exceeded. Changes to other working and safety practices may be required to minimise exposure to operatives
Other considerations	
Agricultural impact	Sludge may not be acceptable for amendment of agricultural soil
Compensation issues	None expected
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Implementing this recovery option would require an effective communication strategy to assure the affected population that the water was potable (suitable for drinking) and meets the required quality standards. Any restrictions on the use of drinking water need to be explained Workers at the water treatment plants would need to be informed that they could be exposed to biological contamination
Additional information	
Practical experience	Carried out under normal procedures by water companies to deal with numerous incidents, an example of which is the finding of *E. coli* contamination at Harlow Hill service reservoir, 2012
Key references	Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance Yorkshire Water Services Ltd. Annual Report and Financial Statements. 2014. Available (September 2015) at https://www.yorkshirewater.com/sites/default/files/Yorkshire%20Water%20Annual%20Report%202014.pdf
Comments	
Document history	

(10) Introduction/modification of existing water treatment

Objective	To reduce exposure to consumers by modifying existing water treatment practices and processes to remove biological contamination in drinking water, in the event of biological agent concentrations in the supplied (treated) water exceeding UK water quality standards
Other benefits	Will remove other impurities
Recovery option description	Any changes to existing water treatment processes to enhance removal of biological agents from water, eg increased frequency of replenishing or cleaning filter material or application of chlorine The introduction of completely new processes will often require major extensions to treatment works and new buildings ranging from ion exchange units to new treatment works This recovery option is more appropriate for longer-term remediation strategies, to deal with chronic contamination
Key information requirements	Seek specialist advice and guidance Where are the water sources treated, and what water treatment methods are used? Is there information on the efficacy of water treatment processes in reducing the biological contamination? What additional water treatment options/solution could be provided?
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (5) Controlled blending of drinking water supplies, (12) Water treatment at point of use (tap) and (15) Natural inactivation If contaminated water has already been treated, wastes arising from water treatment may be contaminated, see (14) Treatment of sludge, (16) Drain to temporary storage and (17) Discharge off site using tankers (tankering)
Target	This recovery option is suitable for public drinking water supplies. The introduction of a new treatment could also be applicable to some (usually larger) private water supplies if the current treatment was ineffective at reducing or removing contamination or no treatment is currently undertaken
Targeted organisms	This recovery option is applicable to all biological agents (to some extent) that could contaminate drinking water supplies and poses a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance (ie from the Environment Agency (EA) in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland and the Northern Ireland Environment Agency (NIEA) and water suppliers) should be sought on the efficacy of standard water treatment practices and processes for the removal of the biological contamination on an incident- and site-specific basis
Scale of application	Any Large scale: building of new water treatment works Medium scale: introduction of chemicals to raw water at treatment works or to raw water sources, or adding new treatment to existing treatment regimens, for example: • chlorination • ozonation • filtration • aeration • wood fibre filters • reverse osmosis (under high pressure) • ion exchange mechanisms • portable ultraviolet (UV) radiation Small scale: introduction of new treatments for private water supplies • ion exchange • reverse osmosis • aeration/holding tanks
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option can be implemented in the early to late phase (hours to months or years) of a biological incident. Potential changes or modifications to existing water treatment processes should be identified as soon as contamination is confirmed (and the agents identified) However, there may be a delay in implementing changes to existing water treatment processes (from several days to weeks). If new processes (eg 'new build') are initiated, equipment and infrastructure

(10) Introduction/modification of existing water treatment	
	are required and installation could take some time, with the recovery option operating over months to years. This recovery option should only be considered for a chronic situation
Considerations	
Public health considerations	Changes to water treatment processes used may give rise to increased exposure to water treatment operatives. This could be as a direct result of exposure to contaminated water or to the accumulation and storage of contaminated waste from treatment (see Appendix A)
Legal implications and obligations	Drinking water produced following any changes to water treatment processes will have to comply with the UK drinking water standards. Refer to Appendix A for more information
Social implications	There may be a loss of confidence in the quality of water provided by water companies to the public (and other parties for private water supplies) Public acceptability and trust in water treatment processes to remove or reduce biological contamination There may be issues regarding the acceptability of residual levels of contamination by the public; this is likely to be related to the availability of alternative supplies (eg bottled water) Potential increased demand for bottled water Social disruption if modification of existing water treatment requires a new construction or facility (eg 'new build')
Environmental considerations	If normal disposal routes for waste water and other solid wastes are used, there may be a risk of spreading low levels of contamination in the environment, eg in natural watercourses
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) Consideration should be given to possible exposure to operatives, and any risks associated with additional tasks undertaken by operatives at the water treatment plants would need to be assessed. There may be inequality between beneficiaries (water consumers) and those living close to waste facilities
Effectiveness	
Recovery option effectiveness	The properties of the biological contaminant will influence whether or not this option is a suitable remediation technique. Expert guidance (ie from EA, SEPA or NIEA and water suppliers) should be sought on the efficacy of standard water treatment practice and processes for the removal of the biological contamination on an incident- and site-specific basis Generally, treatments used to remove a high content of solids (which lead to colour or turbidity in treated water) from surface water sources may be effective at removing some biological contamination because microorganisms will be removed along with particulate matter in the water. Physical filtration is also very effective at removing this particulate material 'Clean' ground water sources (eg some boreholes and aquifers) may only undergo minimal treatment and this would be less effective at removing contamination Membrane filtration is a physical process used for 'clean' water sources with a very low content of solids and no chemical processes are involved
Technical factors influencing effectiveness of recovery option	The effectiveness of this recovery option is dependent on the types and number of treatment processes used and also biological agent involved and properties. 'Normal' water treatment may vary between different water companies Infrastructure needs to be in place to support the expansion of or changes to water treatment works if additional treatments are to be brought 'online' (increased frequency of operations or 'new build') Modification to private water supplies may necessitate the installation of additional water treatment equipment under the sink which could concentrate biological contaminants in filter media
Feasibility and intervention costs	
Specific equipment	Specific equipment is likely to be required for the modification of existing water treatment options or techniques
Utilities and infrastructure	Infrastructure needs to be in place to support the expansion of, or changes to, water treatment works if additional treatments are to be brought 'online' (increased frequency of operations or 'new build') For private water supplies there may be a requirement to build additional outbuildings to house treatment unit

(10) Introduction/modification of existing water treatment

Consumables	Additional natural sorbents and materials such as activated charcoal or natural clay minerals
Skills, personnel and operator time	Training of operatives may be required if new treatment processes are implemented There could be additional operator time if operations were performed more frequently. Transport of raw materials and waste to and from treatment works may also require additional operator time (loading and driving) 'New build' may require additional staff
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring in the treatment works and of operatives may be required to ensure that any limits on operative exposure are not exceeded and to confirm that the new treatment is having the desired effect. Changes to other working and safety practices may be required to minimise exposure to operatives
Other limitations/ factors influencing costs	Increased frequency of replenishing treatment materials will also give rise to additional costs
Waste	
Amount and type	Waste is produced following water treatment (eg contaminated material from filter or resin beds, waste water or sludge); depending on the biological contamination, waste from modified water treatment processes may come under the classification of 'infectious/hazardous waste'. To help determine is a waste is infectious or not, seek expert opinion and consult available national guidance Sludge is generated continuously as part of normal water treatment; the quantity depends on the content of solids in the raw water. Larger quantities of sludge are often stored on site prior to disposal. Sludge is also generated during cleaning of storage tanks. Cleaning of storage tanks and the replenishment of filters and resins may take place more frequently following biological contamination to prevent high concentrations of chemical waste arising
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Waste arising from the normal treatment of water may require disposal and/or storage under authorisation and a suitable disposal route Contaminated material such as waste water or sludge may be classified as dangerous in transport and will be subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated waste material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport. Solids should be transported in bulk transport units fitted with liners that can be closed for transport or in sift-proof receptacles Experience has shown that there may be a need to identify and establish an intermediate temporary site, or sites, between the site of the incident itself and the ultimate final destination(s) of debris. Such sites may be required for sorting out large amounts of contaminated waste
Factors influencing waste issues (eg cost)	Disposal of contaminated material generated from modified water treatment may be expensive as large quantities of contaminated waste could potentially be generated (eg sand from filter beds and sludge) Cost may also be influenced by the availability of a suitable disposal route, cost of contaminated waste disposal, chemicals involved and levels of contamination and amounts of waste requiring disposal
Exposure	
Averted exposure	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing). Averted exposure is influenced by the effectiveness of the recovery option and efficacy of modified water treatment practices to remove the biological contamination
Potential increased worker exposure	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that water treatment operatives use appropriate PPE (if required) and follow SOPs

(10) Introduction/modification of existing water treatment

	If working practices change due to the modification of a treatment works (eg sand filters are replenished more frequently than normal or new processes are added), this may give rise to a potential increased worker exposure. Due to the specific nature of these tasks and the wide variety of treatment works, it is not possible to estimate the likely increased exposure. Exposures would, however, need to be assessed on a site-specific basis in the event of any incident involving contaminated water prior to treatment. Therefore, monitoring at the water treatment works and of operatives may be required to ensure that any limits on operative exposure are not exceeded. Changes to other working and safety practices may be required to minimise exposure to operatives

Other considerations

Agricultural impact	Limited impact
Compensation issues	There may be requests for compensation for costs associated with loss of normal water supplies provided by water companies and suppliers (eg manufacturing, production or farming practices) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Implementing this recovery option would require an effective communication strategy to assure the affected population that the water was potable (suitable for drinking) and meets the required quality standards. Any restrictions on the use of drinking water need to be explained There would be a need to be a clear communication strategy to assure consumers that the water produced was potable and met the required drinking water quality standards. Any restrictions on the use of drinking water need to be explained. Workers at the water treatment plants would need to be informed that they could be exposed to biological contamination

Additional information

Practical experience	*E. coli* in water treatment works (Broken Scar), 2012 *Cryptosporidium* outbreak in North Thames area, 1997 Outbreak of *Cryptosporidium* in public water supply, Sweden, 2010 *E. coli* contamination, Northumberland, 2009 Hepatitis A outbreak in a middle school in China, 2012 *E. coli* incident in Hurlfield service reservoir, 2012 Irton works *Cryptosporidium* incident, 2012 Killiganoon service reservoir contamination, 2010 King Sutton water contamination following a burst main, 2010 Malton service reservoir *enterococci* incident, 2012 Private water supply contamination, 2011 Sowerby service reservoir contamination, 2012
Key references	Drinking Water Inspectorate. The Chief Inspector's Report. 2012. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Willocks L, Crampin A, Milne L, Seng C, Susman M, Gair R, et al. A large outbreak of cryptosporidiosis associated with a public water supply from a deep chalk borehole. Commun Dis Public Health. 1998;1(4):239–43 Widerström M, Schönning C, Lilja M, Lebbad M, Ljung T, Allestam G, et al. Large outbreak of Cryptosporidium hominis infection transmitted through the public water supply, Sweden. Emerg Infect Dis. 2014;20(4):581–9 Drinking Water Inspectorate. The Chief Inspector's Report. 2009. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Yorkshire Water Services Ltd. Annual Report and Financial Statements. 2014. Available (September 2015) at https://www.yorkshirewater.com/sites/default/files/Yorkshire%20Water%20Annual%20Report%202014.pdf Drinking Water Inspectorate. The Chief Inspector's Report. 2011. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/

(10) Introduction/modification of existing water treatment

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Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance

Comments

Document history

(11) Changes to water abstraction point or location of water source

Objective	To reduce biological contamination in drinking water in the event of biological agent concentrations in normal water supply (treated) exceeding UK drinking water standards
Other benefits	None
Recovery option description	This recovery option considers changes in abstraction points from within a reservoir and rivers; the use of alternative water sources and movement of water within distributed water networks (usually referred to as rezoning) It may take several days (dependent on characteristics of biological agents) or more for contamination to be evenly distributed through the water column of reservoirs due to their size and depth or climate (eg hydrological cycling). It may be possible to use water from deeper parts of a reservoir (before contamination has reached it) by opening lower sluice gates and using water that has not yet been contaminated. It may also be possible for water companies to use other reservoirs under their responsibility that have not been contaminated For rivers, water could be abstracted upstream of any contamination if several abstraction points are available. Water could also be used from downstream of the contamination if the abstraction point is sufficiently far enough away that the contamination has not reached there yet, although this would be difficult to determine during a biological incident It may be possible to change to an alternative sources of water (eg change from river abstraction to boreholes) It may be possible for other nearby water companies to share uncontaminated water, if there is sufficient spare capacity and distributed networks exist to transfer the water to the desired location
Key information requirements	Potential for contamination of other water sources Is there capacity for supply from alternative water sources? Where is the river catchment area?
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (1) Isolate and contain water supply, (2) Restrict water use (DND/DNU notices), (3) Alternative drinking water supply and (15) Natural inactivation
Target	Public drinking water supplies. Unlikely to be appropriate for private drinking water supplies in general (technical factors influencing effectiveness of the recovery option)
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate drinking water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small to medium scale: water suppliers could apply this option as long as sufficient drinking water supplies can be maintained, or until the contamination has been sufficiently dispersed or diluted
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option would need to be implemented when biological contamination becomes apparent. It will need to be in place for the duration of the contamination event, or until contamination is within water quality standards

Considerations

Public health considerations	None
Legal implications and obligations	Any drinking water supplies would need to comply with the UK drinking water standards. Refer to Appendix A for more information
Social implications	There may be problems regarding the acceptability of any remaining contamination in water supplies; this is likely to be related to the availability of alternative supplies, such as bottled water Demand for bottled water may increase sharply if people prefer drinking bottled water (for any reason)
Environmental considerations	Widespread contamination or water shortages during periods of drought could result in fewer opportunities for changing abstraction Management of abstraction would need to be monitored more closely than usual to ensure that permanent damage to natural water sources is avoided. For example, changes in the manipulation of reservoir water may affect downstream biota. Potential for release of discoloured water into distribution system
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN)

(11) Changes to water abstraction point or location of water source

	This option may lead to possible water shortages in other areas. Water from a new abstraction point may also be contaminated, but to a lesser extent. Any increase in exposure compared with that prior to the incident would need to be weighed against the need to supply drinking water to the affected population
Effectiveness	
Recovery option effectiveness	If the water at the new abstraction point or water source is uncontaminated then this recovery option would be up to 100% effective in reducing concentrations in drinking water The effectiveness of this measure depends on a programme of testing new abstraction points
Technical factors influencing effectiveness of recovery option	Priorities need to be decided depending on the vulnerability of water supplies to the biological incident. Surface water supplies, such as rivers and reservoirs, are likely to be of higher priority than boreholes in the short term, and this should be taken into account when formulating a monitoring strategy and identifying supplies of potential concern. In the longer term, monitoring and the implementation of this option may need to focus more on ground water sources such as boreholes Changes to abstraction or water sources could be implemented as soon as contamination of a water source is confirmed (and would need to be implemented quickly). This recovery option can only be used for a few days or weeks, until contamination is fully mixed (eg in reservoirs, or until contamination has spread to the new abstraction point, such as rivers, except where the new abstraction point is upstream of the release). This option is unlikely to be used in the longer term unless switching to deep boreholes unaffected by surface water contamination is an option. Changes made to water supply sources need to be linked very closely to a detailed monitoring programme to ensure the optimal timing of the changes to water abstraction points or location of water source The effectiveness of this option will also be influenced by the extent to which water at the new abstraction point or water source is contaminated For reservoir abstraction, water will need to be drawn from a sufficient depth to ensure that abstracted water has a lower/no biological contamination concentration. The effectiveness of implementing this recovery option for surface reservoirs is likely to be low, and has limited acceptability The time taken for contamination to reach abstraction points or a new water supply should also be considered (eg water from a borehole would require monitoring) Changing from river abstraction to deep boreholes may only be an option in the short term if the boreholes only have a limited water capacity compared to rivers Changing the water source or abstraction point is unlikely to be an option for private water supplies since it is unlikely that a second source of uncontaminated water would be available. However, some private water supplies do have an additional source of supply where one source can dry up during the summer. It should be noted that the water from the alternative source is often not very palatable and so probably could not be used in the long term
Feasibility and intervention costs	
Specific equipment	None in the short-term other than monitoring equipment. However, if this countermeasure was being considered as a longer-term option (switching to deep boreholes) then pipework/infrastructure may be required. Additional monitoring may be needed at abstraction points to ensure contamination has not reached the new abstraction point or water source, or is below UK water quality standards
Utilities and infrastructure	Water companies or suppliers would have to have a sufficiently flexible and integrated system of water supply control to allow them to change abstraction points and/or water sources. This would mean that probably only the larger suppliers would be able to implement this option
Consumables	None
Skills, personnel and operator time	No specific skills are required other than those already employed by the water company/supplier Additional time costs might be witnessed for the operator as any actions might need to be completed rapidly and therefore outside normal working hours
Safety precautions	None
Other limitations/ factors influencing costs	Cost will vary depending on the size and the scale of the biological incident
Waste	
Amount and type	This option will not produce any contaminated waste water directly

(11) Changes to water abstraction point or location of water source

Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Ingestion, inhalation or dermal contact with contaminated water (eg drinking, food preparation, washing and bathing)
Potential increased worker exposure	None
Other considerations	
Agricultural impact	There may be an agricultural impact if water was diverted from agricultural use, which could lead to a shortage of water for irrigation and animal welfare, particularly in conditions of limited water resources. Licences to abstract water for agricultural use may be withdrawn
Compensation issues	None
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Communication routes already in use by the water companies/suppliers could be used to give instructions to their operators. However, communication with the affected communities about the rationale for choosing this option would be desirable and should form part of a wider communication and information strategy
Additional information	
Practical experience	*Cryptosporidium* outbreak in North Thames area, 1997 *E. coli* contamination, Northumberland, 2009 Gastroenteritis outbreak from a private borehole, 1995 Private water supply contamination, 2011
Key references	Willocks L, Crampin A, Milne L, Seng C, Susman M, Gair R, et al. A large outbreak of cryptosporidiosis associated with a public water supply from a deep chalk borehole. Commun Dis Public Health. 1998;1(4):239–43 Drinking Water Inspectorate. The Chief Inspector's Report. 2009. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Reacher M, Ludlam H, Irish N, Buttery R, Murray V. Outbreak of gastroenteritis associated with contamination of a private borehole water supply. Commun Dis Public Health. 1999;2(1):27–31 Drinking Water Inspectorate. The Chief Inspector's Report. 2011. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
Document history	

(12) Water treatment at point of use (tap)

Objective	To reduce ingestion exposure to consumers by applying additional treatment 'at the tap' to remove or partially remove biological contamination from drinking water, in the event of biological agent concentrations in supplied water exceeding the UK drinking water standards
Other benefits	Other impurities will be removed This is a 'self-help' option May provide additional reassurance regarding the quality of drinking water and the levels of biological contaminants in the water, even if the water is deemed potable
Recovery option description	There are commercially available options that can be used in the home or private premises that will reduce contamination of drinking water from mains or private water supplies. Seek expert advice and guidance as the scope and efficacy of commercially available options will need to be evaluated on an incident- and agent-specific basis This recovery option sheet considers the use of small reverse osmosis units that can be installed under a sink and are suitable for both mains and private water supplies
Key information requirements	Details on effectiveness at tap water treatments for agent of concern Availability of equipment for treatment at tap
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (2) Restrict water use (DND/DNU notices), (4) Boil notices, (9) Continuing normal water treatment (with monitoring) and (15) Natural inactivation The provision of alternative water supply (bottled or tankered water) may be more effective and acceptable than reliance on individuals to employ this self-help option; therefore this option should be considered with (3) Alternative drinking water supply
Target	Drinking water from private supplies. This is also an additional measure that could be used for public water supplies if it is suspected that contamination has occurred after water treatment
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents (to some extent) that could contaminate drinking water supplies and poses a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance (ie from the Environment Agency (EA) in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland and the Northern Ireland Environment Agency (NIEA) and water suppliers) should be sought on the efficacy of standard water treatment practice and processes for the removal of the biological contamination on an incident- and site-specific basis
Scale of application	Small to medium scale – reverse osmosis units would be suitable for larger-scale use such as for entire premises, although units would have to be fitted to designated and identified taps. This option is suitable for producing several tens of litres of purified water a day The scale of application will depend on the availability of equipment and resources and the numbers of properties. In most cases sanitary water needs no purification
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option is suitable for implementation during the early to medium phase (hours to weeks) of a biological incident. Reverse osmosis units are more specialised pieces of equipment and may not be available 'off the shelf'. They also need fitting by a specialist engineer. The delay in purchasing and fitting one of these units could be several weeks

Considerations

Public health considerations	None
Legal implications and obligations	Private water supplies have to comply with the UK drinking water standards. Refer to Appendix A for more information
Social implications	This option relies on individuals purchasing the units, and in the case of reverse osmosis units, arranging installation either individually or with the person responsible for the supply Appropriate use of designated drinking water in the premises depends on the individual. In addition, this recovery option will result in some disruption and access to people's homes There could be a change in personal habits with regard to which tap is used for drinking water if a designated tap has to be used for drinking water. Potential loss of confidence in water for other uses such as sanitation if the water has not gone through water treatment

(12) Water treatment at point of use (tap)

	There may be an increased demand for bottled water The provision of alternative water supply (bottled or tankered water) may be more effective and acceptable than reliance on individuals to employ a self-help option
Environmental considerations	None
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) Whether the cost of equipment should be paid for by the householder or the individual responsible for premises. Also there is a reliance on this option being implemented by individuals
Effectiveness	
Recovery option effectiveness	Water treatment at point of use (tap) techniques are effective at reducing the amount of biological contamination in the water as supplied at 'the tap'. Reverse osmosis units are suitable for removing certain biological contaminants, including those most frequently seen in water contamination (eg *Cryptosporidium* and *Giardia)*, although the filter size used will need to be appropriate Seek expert advice and guidance Dermal effects may still be seen following use of water which is provided from an untreated source eg following showering, bathing or garden watering
Technical factors influencing effectiveness of recovery option	Effectiveness will be dependent on the biological agent(s) involved and their characteristics Reverse osmosis are specialised pieces of equipment and need to be fitted by a specialist engineer. Flow rate through some filters can be slow. Filters could also be difficult to maintain
Feasibility and intervention costs	
Specific equipment	Reverse osmosis unit A pump may be needed to ensure that there is adequate water pressure for the reverse osmosis units to work effectively. A minimum water pressure is a requirement. The installer would be able to advise whether a pump is needed Reverse osmosis units are comparatively expensive >£300 with additional costs for pumps (if required) Replacement filter cartridges and filters are inexpensive compared with the rest of the equipment <£10
Utilities and infrastructure	For the reverse osmosis units a trained engineer (plumber) would be required for the initial installation
Consumables	Membranes for reverse osmosis units
Skills, personnel and operator time	This is a 'self-help' option, although skilled personnel would be required for installation of reverse osmosis units
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs) Gloves and protective clothing may be needed for the removal of contaminated filter media (eg carbon cartridges and membranes) due to accumulation of biological contamination
Other limitations/ factors influencing costs	Availability of reverse osmosis units and qualified fitters Availability of equipment and the number of households or premises affected There are also costs associated with fitting/installation of reverse osmosis units and for the collection, transport and disposal of spent filters
Waste	
Amount and type	Waste is produced following water treatment (eg spent filter cartridges and membranes from reverse osmosis filter units), depending on the biological contamination; waste may come under the classification of 'hazardous waste'. To help determine if a waste is hazardous or not, seek expert opinion and consult available national guidance Membranes for the reverse osmosis unit may need changing after six months Specific monitoring or research would be required to establish when the efficiency of the filter systems

(12) Water treatment at point of use (tap)	
	declines and the filter needs changing. Changing of filter cartridges and cleaning of membranes is likely to be more frequent over the period when biological concentrations in the water are higher
Possible transport, treatment, disposal and storage routes	It is possible that spent filters may be considered 'hazardous waste' and so require special consideration for collection and transport and for recovery, disposal and storage. Seek specialist advice and guidance. Contaminated material such as spent filters may be classified as dangerous in transport and will be subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods
Factors influencing waste issues (eg cost)	The number and rate of spent filters produced. Biological concentrations within the spent filters will have to be assessed and monitored. There are also costs associated with the collection, transport and disposal of waste
Exposure	
Averted exposure	Reduced exposure to contaminated drinking water Averted exposure is influenced by both the effectiveness of the recovery option and the efficacy of water treatment at the point of use (tap) techniques to remove the biological contamination
Potential increased worker exposure	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that water treatment operatives use appropriate PPE (if required) and follow SOPs Fitting and removal of filters may give rise to incremental exposure. However, the task that is likely to give rise to the highest incremental exposure is the removal of filters installed in the home and premises
Other considerations	
Agricultural impact	N/A
Compensation issues	There may be requests for compensation for costs associated with the purchase of tap treatment units Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Implementing this recovery option would require an effective communication strategy to assure the affected population that the water was potable (suitable for drinking) and meets the required quality standards. Any restrictions on the use of drinking water need to be explained Implement this recovery option will require a clear communication strategy with householders and individuals on whether existing water treatment is adequate for private water supply users, what type of equipment should be purchased, the length of time that these options should be in place, and correct usage of filters, particularly with respect to the disposal of filter cartridges
Additional information	
Practical experience	Reverse osmosis units are used routinely in domestic and commercial properties to reduce other contaminants in drinking water
Key references	Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
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(13) Flush distribution system

Objective	To reduce exposure to agents of concern in available drinking water by flushing through the water distribution system
Other benefits	None
Recovery option description	If water contamination cannot be isolated, then a water treatment company may consider procedures such as flushing. Although flushing is a routine operation with which water companies are familiar, flushing following a biological incident should be implemented with care as the type and concentration of the potential contaminant may be unknown at this time. Thus, worker safety/protection measures should be taken and possible impacts to the environment (due to discharged water) should be considered This recovery option should be supported by a suitable monitoring strategy wherever possible. The Environment Agency (EA) in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland or the Northern Ireland Environment Agency (NIEA) should be consulted for any planned discharges to a wastewater collection systems or surface waters If contamination is confirmed or suspected in the supply or distribution system, the water supplier should isolate that part of the system to prevent further spread of contamination. The contaminated water should be contained until such time as the contaminating agent can be determined and the appropriate treatment identified. Once the water has been treated and the contaminant made safe, further treatment may be necessary to make the water fit for disposal to the environment
Key information requirements	Important considerations should be taken into account before flushing water distribution system, including: • whether the water supplier has obtained appropriate regulatory clearances • if isolation is feasible (eg if contaminant source/spread is unknown or contamination has dispersed to system areas lacking the technical capacity or configuration to support isolation) • customer notification is anticipated to have limited effectiveness (eg contamination spread involves the notification of many, widespread users) The weight of evidence suggests contamination is compatible with a flush response (eg the contaminant type and concentration are sufficiently well known and deemed low risk in a release context or, in the absence of this specificity, there are strong indications that a release from the system will have no tolerable environmental, general public health, and sewer system impacts)
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (2) Restrict water use (DND/DNU notices), (3) Alternative drinking water supply and (4) Boil notices Storage/treatment of contaminated water (post-treatment) would also need to be considered, recovery options include (16) Drain to temporary storage and (17) Discharge off site using tankers (tankering)
Target	Public drinking water supplies. May also be viable for certain larger private water supplies depending on their distribution network
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate drinking water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Will depend on the size of the water network or distribution system contaminated
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option should be implemented in the early phase (hours to days) of a biological incident

Considerations

Public health considerations	Flushing of the distribution system should continue until the contamination has been completely removed from the distribution system or diluted to a level, which is below water quality standards, or an agreed level which does not pose a long-term risk to health
Legal implications and obligations	There is a legal duty on water companies to provide alternative water supplies such as bottled water – see (3) Alternative drinking water supply. Refer to Appendix A for more information
Social implications	Public acceptability and trust in the flushing processes to remove or reduce biological contamination. There may be issues regarding the acceptability of residual levels of contamination by the public, which may also be linked to the availability of alternative supplies (eg increased demand for bottled water)

(13) Flush distribution system	
	There may be a loss of confidence in the quality of water provided by water companies to the public (and other parties for private water supplies) Possible increase in public confidence that the problem of contamination is being effectively managed Social impacts depend on whether the flushing process is protracted requiring water companies to provide alternative water supplies, such as bottled water. Otherwise there is only likely to be a short-term social impact
Environmental considerations	If normal disposal routes for waste water and other solid wastes from treatment continue, this could lead to the spread of low levels of contamination in the environment, eg in natural watercourses In most cases the contaminated water will pass through a sewage treatment process or be diverted in its diluted state to storm tanks. However, despite best endeavours, it may not be possible to divert contaminated water into the foul sewer and that the flow will be direct to a watercourse. If this happens, the EA, SEPA and NIEA will take the appropriate action to mitigate the effect on the environment
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) The risk of ingestion exposure would need to be measured against the need to provide drinking water
Effectiveness	
Recovery option effectiveness	Can be effective in preventing exposure, although it is possible that some members of the community will not adhere to the notice or understand the instructions if access to water is restricted while the flushing process takes place The efficacy of the recovery option depends on efficacy of the communication medium and compliance of the community to adhere to warning notices
Technical factors influencing effectiveness of recovery option	Some people may ignore restrictions and continue to drink the contaminated water Some people may not be aware that restrictions are in place and that an alternative supply is available. Shortages of alternative supplies could lead to people drinking the contaminated water. If the area affected involved large numbers of people, the supplies might not meet demand Mainly compliance of individuals and length of time this notice is in force
Feasibility and intervention costs	
Specific equipment	None in the short-term; however, if protracted then alternative water supply will need to be considered – see (3) Alternative drinking water supply
Utilities and infrastructure	See above
Consumables	N/A
Skills, personnel and operator time	No specific skills are required other than those already employed by the water company/supplier
Safety precautions	Will depend on the biological involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	Staff and personnel costs should not be significantly in excess of normal working practices There may be costs associated with the provision of alternative drinking water supplies if implementation of this recovery option is expected to be protracted
Waste	
Amount and type	Seek specialist advice and guidance. This recovery option will likely produce a large amount of waste water that will need to be processed
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Waste arising from treatment of water may require disposal and/or storage under authorisation and a suitable disposal route. In the majority of options available for the disposal of contaminated water the ultimate use of the sewerage system and the sewage treatment

(13) Flush distribution system

	works is the most practical. Diversion of the contaminated water by the sewerage system to storm tanks provides time for the method of final disposal to be properly planned Contaminated material such as waste water or sludge may be classified as dangerous in transport and will be subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated waste material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport. Solids should be transported in bulk transport units fitted with liners that can be closed for transport or in sift-proof receptacles Experience has shown that there may be a need to identify and establish an intermediate temporary site, or sites, between the site of the incident itself and the ultimate final destination(s) of debris. Such sites may be required for sorting out large amounts of contaminated waste
Factors influencing waste issues (eg cost)	In the managed disposal of the water from the distribution system, water undertakers should consider the following options in consultation with the EA, SEPA or NIEA (as appropriate), the Drinking Water Inspectorate, the local environmental health officer and the sewerage undertaker: (16) Drain to temporary storage and (17) Discharge off site using tankers (tankering)
Exposure	
Averted exposure	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing). Exposure to the public will be influenced by their knowledge, understanding and compliance of associated advisory notices, warning about the incident
Potential increased worker exposure	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that water treatment operatives use appropriate PPE (if required) and follow SOPs Exposure could be received by individuals in connection with implementing the recovery option and will be determined by risk assessments, safety plans and procedures adopted by the water companies to protect their operators
Other considerations	
Agricultural impact	There may be an agricultural impact if the water supply is restricted for a period of time due to flushing of the distribution system. During this period alternative sources would need to be identified
Compensation issues	There may be requests for compensation for costs associated with loss of normal water supplies provided by water companies (eg manufacturing, production or farming practices) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments In this case, communication regarding the following aspects will need to be addressed: • planned work on the water supply: advance notices are delivered to each building in the affected streets. The notice will give details of the work, particularly the timing of any shutdown of the supply. For example, it may advise that water may be discoloured when the supply is restored and what to do if this does not clear on flushing the mains tap • adequate and effective communication to ensure compliance. All responding agencies should ensure that only a common agreed form of public advice in the form of, for example, frequently asked questions (FAQ) is provided to their staff in call centres or placed on websites

(13) Flush distribution system

Additional information

Practical experience	Water companies have considerable experience in flushing water systems following pipe repairs or maintenance *Cryptosporidium* outbreak in high-rise apartment in Seoul, 2012 Outbreak of *Cryptosporidium* in public water supply, Sweden, 2010 Private water supply contamination, 2011 *E. coli* contamination, Northumberland, 2009 Sewage contamination of drinking water, 1997
Key references	Cho EJ, Yang JY, Lee ES, Kim SC, Cha SY, Kim ST, et al. A waterborne outbreak and detection of *Cryptosporidium* oocysts in drinking water of an older high-rise apartment complex in Seoul. Korean J Parasitol 2013;51(4):461–6 Widerström M, Schönning C, Lilja M, Lebbad M, Ljung T, Allestam G, et al. Large outbreak of Cryptosporidium hominis infection transmitted through the public water supply, Sweden. Emerg Infect Dis. 2014;20(4):581–9 Drinking Water Inspectorate. The Chief Inspector's Report. 2011. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ Drinking Water Inspectorate. The Chief Inspector's Report. 2009. Available (September 2015) at http://dwi.defra.gov.uk/about/annual-report/ O'Donnell M, Platt C, Aston R. Effect of a boil water notice on behaviour in the management of a water contamination incident. Commun Dis Public Health. 2000 Mar;3(1):56–9 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
Document history	

(14) Treatment of sludge

Objective	Complex technique(s) to deal with any sludge produced which is an infection risk
Other benefits	None
Recovery option description	If the decision is made that the contaminated water can flow through the treatment processes, contaminated sludge may be produced. If the normal operation is to spread sludge on agricultural land, this may no longer be acceptable. Initially this will be retained in sludge lagoons (where available). Specialist techniques may be required to deal with biologically contaminated sludge In the managed disposal of the sludge, the following options will be considered, depending on the nature of the contamination, in consultation with the Environment Agency (EA) in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland or the Northern Ireland Environment Agency (NIEA): • incineration or advanced sludge treatment • landfill (with or without pasteurisation) • on-site encapsulation (with or without pasteurisation)
Key information requirements	Effectiveness of treatment for biological agent of concern Quantity of sludge requiring treatment
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (17) Discharge off site using tankers (tankering)
Target	Biological agents that could be bound in sewage sludge
Targeted organisms and dispersion methods	This recovery option is potentially applicable to all biological agents. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on the efficacy of treatment of sludge from standard water treatment practice and processes for the removal of the biological contamination on an incident- and site-specific basis This recovery option is suitable for all agents (including very persistent agents) in the environment
Scale of application	Small to medium
Exposure pathway prevention	Dermal contact and inhalation from aerosols released from contamination
Time of application	This recovery option can be implemented in the medium to late phase (weeks to months or years) of a biological incident. The time taken to implement this option will depend on the volume of contaminated sludge requiring treatment
Considerations	
Public health considerations	None
Legal implications and obligations	Waste disposal legislation. Any waste arising from treatment may need a new authorisation. Refer to Appendix A for more information
Social implications	There may be issues regarding the acceptability of spreading sludge There may be loss of confidence in the quality of water provided by water companies to the public (and other parties for private water supplies) Possible increase in public confidence that the problem of contamination is being effectively managed
Environmental considerations	Might disrupt the landscape of the site Use or disposal of contaminated sludge needs to be considered as the biological concentrations in the sludge may be above the levels permitted for normal use (land spreading or landfill)
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) Consideration should be given to possible exposure to operatives
Effectiveness	
Recovery option effectiveness	The effectiveness of this recovery option will depend on the amount of sludge present and the efficiency of the technique for the contamination being dealt with
Technical factors influencing	Monitoring in the treatment works and of operatives may be required to ensure that any limits on operatives are not exceeded and to confirm that the new treatment is having the desired effect

(14) Treatment of sludge	
effectiveness of recovery option	
Feasibility and intervention costs	
Specific equipment	Seek expert advice and guidance (eg water companies) as specific technical equipment is likely to be required, including specialist tanker contractors with trained drivers and pumping equipment may be required
Utilities and infrastructure	Existing landfill sites Incinerators Specialist incineration
Consumables	Variable
Skills, personnel and operator time	Seek specialist advice and guidance as skilled personnel are likely to be required to undertake this recovery option. Operator time and personnel requirements will vary depending on the size and scale of the biological incident Training of operatives may be required if new processes are implemented
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring in the treatment works and of operatives may be required to ensure that any limits on operative exposure are not exceeded and to confirm that the new treatment is having the desired effect Appropriate safety equipment (eg overalls, gloves and boots and respiratory protection) may be required if the biological contaminant is an inhalation hazard and health risk
Other limitations/ factors influencing costs	The complexity of sludge contamination will influence remediation costs. There could be additional operator time if operations were performed more frequently. Transport of raw materials and waste to and from treatment works will also require additional operator time (loading and driving)
Waste	
Amount and type	Seek specialist advice and guidance Waste is produced following water treatment (eg contaminated material from filter or resin beds, waste water or sludge); depending on the biological contamination, waste from modified water treatment processes may come under the classification of ‘infectious/hazardous waste’. To help determine if a waste is infectious or not, seek expert opinion and consult available national guidance Sludge is generated continuously as part of normal water treatment; the quantity depends on the content of solids in the raw water. Larger quantities of sludge are often stored on site prior to disposal. Sludge is also generated during cleaning of storage tanks. Cleaning of storage tanks and the replenishment of filters and resins may take place more frequently following biological contamination, to prevent high concentrations of biological waste arising Large quantities of contaminated sludge above levels permitted for normal disposal (eg land spreading) may require additional treatment prior to disposal
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Waste arising from treatment of water may require disposal and/or storage under authorisation and a suitable disposal route. EA, SEPA and NIEA have special powers to respond to waste issues during major incidents. EA, SEPA and NIEA would determine a legal disposal route for contaminated waste, although they are not responsible for removing the waste Contaminated material such as waste water or sludge may be classified as dangerous in transport and will be subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated waste material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport. Solids should be transported in bulk transport units fitted with liners that can be closed for transport or in sift-proof receptacles

(14) Treatment of sludge

	Experience has shown that there may be a need to identify and establish an intermediate temporary site, or sites, between the site of the incident itself and the ultimate final destination(s) of debris. Such sites may be required for sorting out large amounts of contaminated waste
Factors influencing waste issues (eg cost)	Will depend on the amount and type of waste generated Nature of the biological contamination Availability of a suitable disposal route
Exposure	
Averted exposure	Exposure to the public will be influenced by their knowledge, understanding and compliance with associated advisory notices and warning about the incident
Potential increased worker exposure	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs) Exposure could be received by individuals in connection with implementing the recovery option and will be determined by risk assessments, safety plans and procedures adopted by the water companies to protect their operators
Other considerations	
Agricultural impact	Sludge may not be acceptable for discharge to land for fertilisation
Compensation issues	There may be requests for compensation for costs associated with loss of normal water supplies provided by water companies and suppliers (ie manufacturing, production or farming practices) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments In this case effective communication is required to convey to affected members of the public that the measures being implemented are likely to benefit public health and reduce contamination in the environment. Workers would need to be informed that they could be exposed to biological contamination
Additional information	
Practical experience	
Key references	Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	
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(15) Natural inactivation

Objective	To allow the natural inactivation of a biological agent in all water environments with monitoring
Other benefits	None
Recovery option description	Natural inactivation processes include a variety of physical, chemical or biological processes that, under favourable conditions, act without human intervention to reduce the mobility, volume or concentration of contaminants in ground water. These processes include: • destructive mechanisms: biodegradation, destruction, abiotic oxidation and hydrolysis • non-destructive mechanisms: dispersion and dilution Monitoring of water environments is needed to confirm whether natural inactivation processes are acting at a sufficient rate to ensure that the wider environment is unaffected and that remedial objectives will be achieved within a reasonable timescale
Key information requirements	To properly evaluate this recovery option, it is necessary to know the location, concentration of the contaminant and how the contaminant behaves in the environment (ie characteristics) Is there sufficient site data to support monitored natural degradation as a viable recovery option? Do the site characterisation data and results of modelling demonstrate that natural inactivation is occurring and can achieve the risk management objectives (eg what are the water temperature and depth)? Is the monitoring programme sufficiently robust? Do the results of the monitoring demonstrate that remedial goals have been achieved and monitoring can cease?
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option may form a component of an integrated treatment approach, incorporating active remedial measures. Therefore, this recovery option should be considered in conjunction with (2) Restrict water use (DND/DNU notices), (3) Alternative drinking water supply, (4) Boil notices, (13) Flush distribution system, (14) Treatment of sludge, (16) Drain to temporary storage and (17) Discharge off site using tankers (tankering)
Target	Contaminated ground water drinking supplies
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate drinking water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis This recovery option is suitable for agents that have a short persistence. The persistence of and agent can be identified by consultation with PHE and reference to Appendix E
Scale of application	Any
Exposure pathway prevention	Ingestion, inhalation and dermal contact with contaminated water (eg drinking, food preparation and washing)
Time of application	This recovery option can be implemented in the early to medium phase (hours to weeks) of a biological incident
Considerations	
Public health considerations	Aerosolisation of contamination can present some health risks. Potential for users of recreational water to be effected by long term contamination
Legal implications and obligations	Depending on the nature of the contamination, consultation with the Environment Agency (EA) in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland or the Northern Ireland Environment Agency (NIEA) will be required. Refer to Appendix A for more information
Social implications	Acceptance of monitored natural inactivation requires liaison and agreement with various stakeholders (landowners, insurers, financiers and prospective purchasers) and the relevant regulators. Regular consultation is recommended throughout the screening, demonstration, assessment and implementation stages of this recovery option The public may perceive this option as ’doing nothing’, which can have negative implications
Environmental considerations	The nature of the agent needs to be considered, eg spore-forming bacteria could sporolate, leading to greater persistence in the environment Potential for spread of contamination in environment if the agent does not inactivate

(15) Natural inactivation

Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) The option may be perceived as 'doing nothing', which could have negative implications
Effectiveness	
Recovery option effectiveness	The effectiveness of this recovery option will depend on the characteristics of the biological agent
Technical factors influencing effectiveness of recovery option	Implementation of this recovery option should only be used against biological agents that have a limited persistence in the environment, and may take from hours to several weeks to arrive at a satisfactory outcome. Therefore this potentially makes the recovery option susceptible to changes in various technical, economic and regulatory conditions, including water geochemistry. These factors need to be considered in the design and application if natural inactivation is considered as a long-term remediation strategy In addition, the level of perceived or actual risk will influence the appropriateness of implementing this recovery option, including: • sensitivity of the site (strategic resource value of the water environment) • characteristics of the biological agent involved • level of uncertainty in the definition of the conceptual model and in assessment/monitoring data available
Feasibility and intervention costs	
Specific equipment	Sampling and monitoring equipment
Utilities and infrastructure	Capacity to analysis samples (ie laboratory facilities)
Consumables	Sample equipment and PPE for the sampling process
Skills, personnel and operator time	Skilled personnel to take samples and undertake analysis
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs)
Other limitations/ factors influencing costs	There is the potential for the long-term monitoring to be required, which will require significant financial provision. Other recovery options may provide a more favourable cost-to-benefit ratio; there is also a risk that data may confirm that active remediation is required after all. Finally, the cost of developing contingency plans may be prohibitive
Waste	
Amount and type	No waste is generated by this option
Possible transport, treatment, disposal and storage routes	N/A
Factors influencing waste issues (eg cost)	N/A
Exposure	
Averted exposure	Exposure to the public will be influenced by their knowledge, understanding and compliance with associated advisory notices, warning about the incident
Potential increased worker exposure	Recovery workers (ie sampling team) may be at risk of exposure. The appropriateness of implementing this recovery option will be determined by risk assessments, safety plans and procedures adopted by the water companies to protect their operators

(15) Natural inactivation

Other considerations

Agricultural impact	Due to the potential for spread on contamination in the environment, there is also a risk of agricultural impacts in the affected area
Compensation issues	There may be requests for compensation for costs associated with loss of normal water supplies provided by water companies and suppliers (ie manufacturing, production or farming practices) Financial and legal advice relating to compensation after a major incident can be found at https://www.gov.uk
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments Acceptance of natural attenuation (with monitoring) requires liaison and agreement with various stakeholders (landowners, insurers, financiers and prospective purchasers) and the relevant regulators. Regular consultation is recommended throughout the screening, demonstration, assessment and implementation stages of this recovery option Potential concerns could be raised due to the civil liabilities associated with migration of contamination between neighbouring properties; therefore communication of site monitoring is of key importance

Additional information

Practical experience	
Key references	Drinking Water Inspectorate. Drinking Water Safety, Guidance to health and water professionals. 2009. Available (September 2015) at http://dwi.defra.gov.uk/stakeholders/information-letters/2009/09_2009annex.pdf Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications
Comments	Natural inactivation is used when referring to the naturally occurring physical, chemical and biological processes that act within a water environment
Document history	

(16) Drain to temporary storage

Objective	To remove the potential for biological infection from contaminated water by removing that water source
Other benefits	Will remove other impurities
Recovery option description	The basic principles of containment, identification, treatment and disposal apply to water supply sites and distribution networks. If contamination is confirmed or suspected in the supply or distribution system network, the water company may isolate part of the system to prevent further spread of contamination. Contaminated water could be contained in temporary storage where the contaminant can be determined and an appropriate treatment method identified. Once the water has been treated and the contaminant made safe, further treatment may be necessary to make the water fit for disposal to the environment (Water UK, 2012)
Key information requirements	Are appropriate storage containers available? What are the potential waste-water disposal routes?
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (14) Treatment of sludge
Target	Drinking water supplies
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate drinking water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small to medium
Exposure pathway prevention	Ingestion and dermal contact with contaminated drinking water
Time of application	This recovery option should be implemented in the early to medium phase (hours to weeks) of a biological incident. However, it could take days to weeks to drain the affected area Changes to water treatment processes should be identified as soon as contamination is confirmed and the agent(s) of concern have been identified However, there may be a delay in implementing changes to existing water treatment process that could be several days to weeks
Considerations	
Public health considerations	Modifications to water treatment processes may result in increased exposure of water treatment operatives. This could be as a direct result of exposure to contaminated water or to the accumulation and storage of contaminated waste from treatment (see Appendix A)
Legal implications and obligations	Drinking water produced after changes to water treatment will have to comply with UK drinking water standards. Refer to Appendix A for more information
Social implications	Public acceptability and trust in water treatment processes to remove or reduce biological contamination. There may be issues regarding the acceptability of residual levels of contamination by the public, which may also be linked to the availability of alternative supplies (eg increased demand for bottled water) There may be loss of confidence in the quality of water provided by water companies to the public (and other parties for private water supplies) Possible increase in public confidence that the problem of contamination is being effectively managed
Environmental considerations	Volume/capacity that the water supplier can store and where Disposal routes for waste water and other solid wastes from treatment could lead to the spread of low levels of contamination in the environment (eg in natural watercourses)
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) Any risks associated with additional tasks undertaken by operatives at the water treatment plants would need to be assessed. There may be inequity between beneficiaries ('water drinkers') and those living by waste facilities
Effectiveness	
Recovery option effectiveness	The recovery option will be highly effective if the contaminated water source can be drained and removed, therefore reducing the contaminated water that is present

(16) Drain to temporary storage

Technical factors influencing effectiveness of recovery option	The effectiveness of this recovery option will be dependent on the type(s) and number of treatment processes used, but also on the characteristics of the biological contaminants This recovery option will need to be undertaken by skilled personnel Availability of raw materials and the time needed to deliver them may influence the effectiveness of this option, and the capacity to store any additional waste
Feasibility and intervention costs	
Specific equipment	Seek expert advice and guidance (ie water company) as specific technical equipment is likely to be required Installation of new equipment and infrastructure may be required to enable additional treatment processes, which may be expensive or take a long time to install
Utilities and infrastructure	Infrastructure needs to be in place to support the expansion of, or changes to, treatment works if additional treatments are to be brought 'online' (increased frequency of operations or 'new build')
Consumables	Storage containers to contain the contaminated water Spill kits might be needed to ensure no water escapes into the environment
Skills, personnel and operator time	Training of operatives may be required if new treatment processes are implemented There could be additional operator time if operations were performed more frequently. The transport of raw materials (including waste to and from treatment works) will require additional operator time (loading and driving) Infrastructure needs to be in place, and if a 'new build' is required, this will result in additional staff (and increased costs)
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring in the treatment works and of operatives may be required to ensure that any limits on operative exposure are not exceeded and to confirm that the new treatment is having the desired effect. Changes to other working and safety practices may be required to minimise exposure to operatives Appropriate safety equipment (eg hats, lifelines, waterproof safety clothing and boots) may be required
Other limitations/ factors influencing costs	Cost will depend on whether the equipment is available Cost of consumables (ie sorbents) and increased frequency of replenishing treatment materials will need to be considered Availability of suitable disposal routes for contaminated waste
Waste	
Amount and type	This option will potentially produce a large quantity of waste water that may be decontaminated prior to disposal
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Waste arising from treatment of water may require disposal and/or storage under authorisation and a suitable disposal route Contaminated material such as waste water or sludge may be classified as dangerous in transport and will be subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated waste material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport Experience has shown that there may be a need to identify and establish an intermediate temporary site, or sites, between the site of the incident itself and the ultimate final destination(s) of debris. Such sites may be required for sorting out large amounts of contaminated waste
Factors influencing waste issues (eg cost)	Disposal of the contaminated water generated from this temporary storage option will be incident specific as the waste levels will vary Cost may also be influenced by the availability of a suitable disposal route

(16) Drain to temporary storage

Exposure

Averted exposure	Ingestion and dermal contact with contaminated drinking water
Potential increased worker exposure	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs) If working practices change due to the modification of a treatment works (eg sand filters are replenished more frequently than normal or new processes are added), this may give rise to a potential increased worker exposure. Due to the specific nature of these tasks and the wide variety of treatment works, it is not possible to estimate likely increased exposure. They would, however, need to be assessed on a site-specific basis in the event of any incident involving contaminated water prior to treatment. Therefore, monitoring at the water treatment works and of operatives may be required to ensure that any limits on operative exposure are not exceeded. Changes to other working and safety practices may be required to minimise exposure to operatives

Other considerations

Agricultural impact	None
Compensation issues	N/A
Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments

Additional information

Practical experience	
Key references	Water UK. 2012. Disposal of Contaminated Water – Protocol for the disposal of contaminated water and associated wastes at incidents. Available (September 2015) at http://www.water.org.uk/publications/water-industry-guidance/disposal-contaminated-water-october-2012 Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
Document history	

(17) Discharge off site using tankers (tankering)	
Objective	To reduce ingestion exposure to consumers by removal or partial removal of contaminated drinking water
Other benefits	Will remove other impurities
Recovery option description	Disposal of contaminated water and potentially contaminated water from water supply sites, water distribution networks and service reservoirs. Disposal of contaminated water from the distribution system using tankers where the water treatment system is unable to treat or contain the contaminated water
Key information requirements	Are appropriate storage containers available? What are the potential waste-water disposal routes?
Linked recovery options	This is a remediation option and may need to be linked to protection options This recovery option should be considered in conjunction with (15) Natural inactivation
Target	Public and private drinking water supplies
Targeted organisms and dispersion methods	This recovery option is applicable to all biological agents that could contaminate drinking water supplies and pose a risk to public health. However, the characteristics of the biological agent will influence whether or not this option is a suitable remediation technique. Expert guidance should be sought on an incident- and site-specific basis
Scale of application	Small to medium
Exposure pathway prevention	Ingestion and dermal contact with contaminated drinking water
Time of application	This recovery option should be implemented in the early to medium phase (hours to weeks) of a biological incident However, there may be a delay in implementing this option depending on the availability of the tankers This option is unlikely to be sustainable for the long-term phase of a biological incident
Considerations	
Public health considerations	The process of tankering water from one site to another might raise public health concerns if there is an issue during transport where the contaminated water is released
Legal implications and obligations	Any transportation of contaminated water will be required to be undertaken under appropriate authorisation. Refer to Appendix A for more information
Social implications	Public acceptability and trust in water treatment processes to remove or reduce biological contamination. There may be issues regarding the acceptability of residual levels of contamination by the public, which may also be linked to the availability of alternative supplies (eg increased demand for bottled water) There may be loss of confidence in the quality of water provided by water companies to the public (and other parties for private water supplies) Conversely possible increase in public confidence that the problem of contamination is being effectively managed
Environmental considerations	Disposal routes for waste water from tankers could lead to the spread of low levels of contamination in the environment (eg in natural watercourses)
Ethical considerations	This recovery option should consider the human rights of the affected population to ensure that actions are proportionate, legal, accountable and necessary (PLAN) Any risks associated with additional tasks undertaken by operatives at the water treatment plants would need to be assessed. There may be inequity between beneficiaries ('water drinkers') and those living by waste facilities
Effectiveness	
Recovery option effectiveness	If the contaminated water can be isolated and removed from the system then the effectiveness will be up to 100% in reducing contamination to the drinking water system
Technical factors influencing effectiveness of recovery option	This recovery option will need to be undertaken by skilled personnel The effectiveness of this recovery option will be dependent on the characteristics of the biological contaminants, and availability of suitable storage and disposal routes

(17) Discharge off site using tankers (tankering)

Feasibility and intervention costs

Specific equipment	Seek expert advice and guidance (ie water company) as specific technical equipment is likely to be required, including specialist tanker contractors with trained drivers and pumping equipment
Utilities and infrastructure	Power (electricity) supply, water and suitable storage containers and roads
Consumables	None
Skills, personnel and operator time	Seek specialist advice and guidance as skilled personnel are likely to be required to undertake this recovery option. Operator time and personnel requirements will vary depending on the size and scale of the biological incident
Safety precautions	Will depend on the biological agent involved and a risk assessment would need to be undertaken. Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the Health and Safety at Work etc Act (HSWA) to ensure that water treatment operatives use appropriate PPE (if required) and follow standard operating procedures (SOPs) Monitoring of recovery workers may be required to ensure that any limits on operative exposure are not exceeded. Appropriate safety equipment (eg hats, lifelines, waterproof safety clothing and boots) may be required
Other limitations/ factors influencing costs	The cost will be influenced by the availability of: • appropriate equipment • suitable disposal routes for contaminated waste • staff and personnel requirements (if operations were performed outside normal working patterns and shifts this may increase costs)

Waste

Amount and type	The waste produced from the collection of contaminated water will be transferred to an appropriately identified site for discharge and/or treatment
Possible transport, treatment, disposal and storage routes	Seek specialist advice and guidance. Waste arising from treatment of water may require disposal and/or storage under authorisation and a suitable disposal route Contaminated material such as waste water or sludge may be classified as dangerous in transport and will be subject to the transport of dangerous goods legislation whatever the mode of transport used. For more information see https://www.gov.uk/government/collections/transporting-dangerous-goods Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated waste material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport
Factors influencing waste issues (eg cost)	Cost may also be influenced by the availability of a suitable disposal route, the cost of contaminated waste disposal and chemicals involved in the decontamination of waste water

Exposure

Averted exposure	Ingestion and dermal contact with contaminated drinking water
Potential increased worker exposure	Seek specialist advice and guidance Employers have a duty of care to protect employees from hazards and risks in the workplace. Employers have to comply with the HSWA to ensure that water treatment operatives use appropriate PPE (if required) and follow SOPs Changes in worker activities would need to be assessed on a case-by-case basis in the event of any incident involving contaminated water being removed from the site by tankers

Other considerations

Agricultural impact	N/A
Compensation issues	N/A

(17) Discharge off site using tankers (tankering)

Public information	It is essential that prior to, during and after the response to a biological incident or event, clear communication strategies are developed and implemented The probability that the event may not only be the focus of local, regional, national and international media scrutiny, but that it may also attract government interest at local, regional, national and international level should be addressed Any communication strategy must consider and define the information that is suitable to be given to the public at the scene and in the local (affected) area. This information must be developed in partnership with other experts, government agencies and departments In this case, effective communication is required to convey to members of the public that the measures being implemented are likely to benefit public health and reduce contamination in the environment. Workers would need to be informed that they could be exposed to biological contamination

Additional information

Practical experience	
Key references	Wyke-Sanders S, Brooke N, Dobney A, Baker D, Murray V. The UK Recovery Handbook for Chemical Incidents. HPA. 2012. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance
Comments	
Document history	

10 Worked Examples

This chapter uses generic scenarios for each environment to illustrate how the handbook can be used to remediate a biological incident. The worked examples also show users how the decision-making framework should be used, guiding them through general incidents. Additionally, the worked examples can be used as a tool for training by potential users.

The worked examples are provided solely to illustrate the use of the decision-making framework and for training purposes. The recovery options for the worked examples should not be used as proposed solutions to real-life incidents similar to the worked examples as each incident should be dealt with on an individual basis. The examples used in this chapter have been chosen for their ability to demonstrate the application of the handbook.

10.1 Food production systems: *Escherichia coli* incident

This section should be read in conjunction with Chapters 4 and 5 on food production systems.

Scenario

Contamination of salad watercress

Escherichia coli STEC O157 has been identified as the contaminating agent

Detected by sampling the produce from one farm that solely produces watercress for salads

Thirteen people from England have become unwell, with four cases in Wales and one in Scotland

Before going through the generic steps involved in selecting and combining options, users should appreciate that when using the handbook to develop a recovery strategy they should:

- establish dialogue with national and local stakeholders (see Appendix E for further details)
- be familiar with the structure and content of the handbook
- develop knowledge of the technical information underpinning a recovery strategy
- have an understanding of the factors influencing implementation of options and selection of a recovery strategy

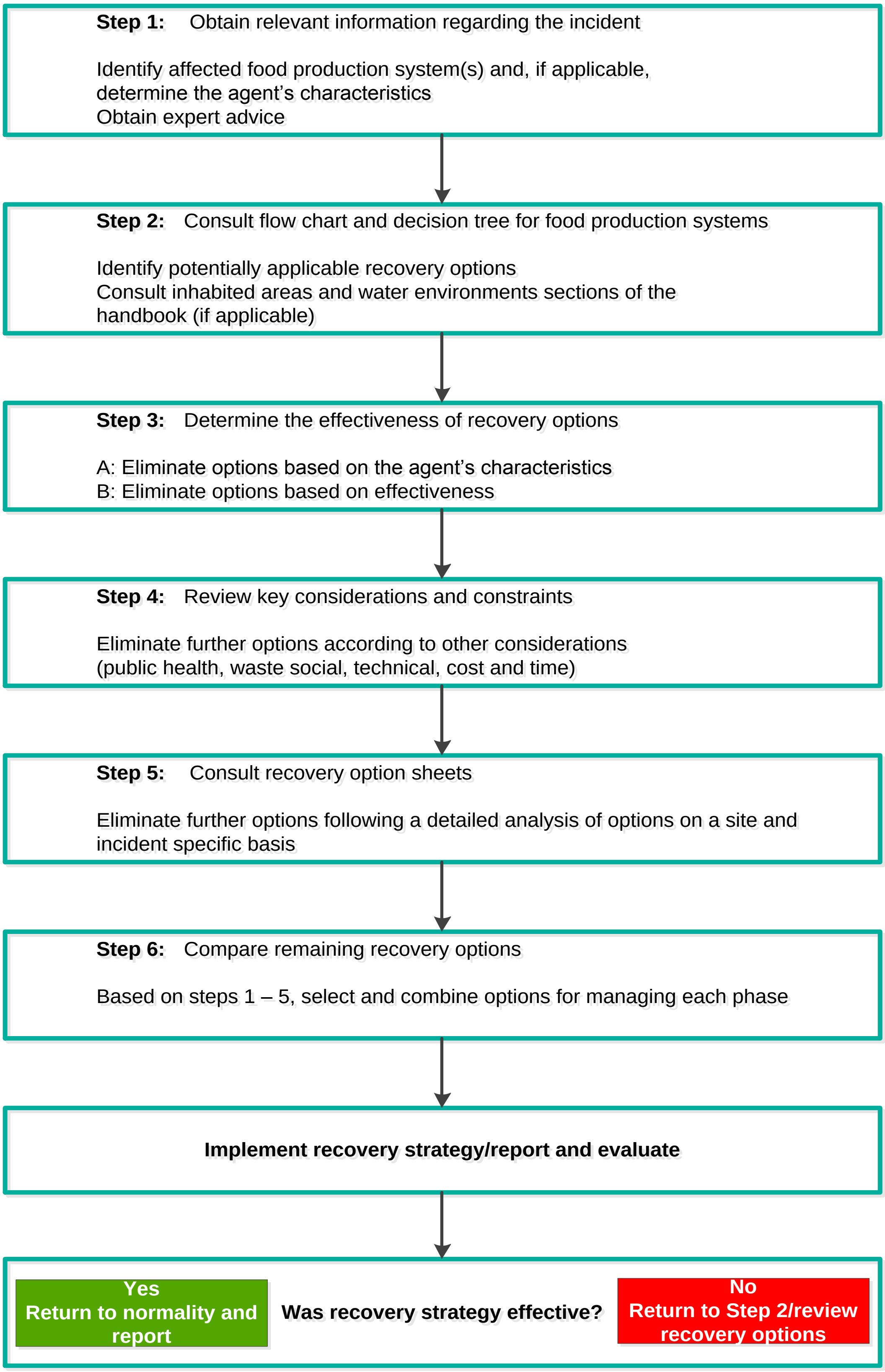

Figure 10.1: Six-step decision-making framework for food production systems

Step 1 Obtain relevant information regarding the incident

Determine the properties of the biological organism(s)

Identify affected food production system(s) and obtain expert advice

In addition to the information that would be initially identified about the incident, in this example brief information is supplied in the grey scenario box, it is important to determine as much about the contaminating agent(s) as possible. Expert advice should be sought from the relevant government agencies, eg Food Standards Agency and Public Health England, on the contaminating agent *Escherichia coli* STEC 0157. This information should be used to complete the agent data sheet (Table 10.1) which will direct the decision maker to key points to consider when dealing with the agent. Table 4.7 in Chapter 4 (food production systems) should be used to record the process of choosing the appropriate recovery options. This table should be used to help identify the rationale for any option selection or removal and will assist with any audit or reports produced after recovery from the incident. The decision tree should then be followed to help choose appropriate protective recovery options (Step 2).

Table 10.1: Agent data sheet for *E. coli* O157 and related strains

<table>
<tr><th rowspan="2">Agent characteristics</th><th rowspan="2">Description</th><th rowspan="2">Interpretation</th><th colspan="2">Biological agent</th></tr>
<tr><th>Characteristic</th><th>Interpretation</th></tr>
<tr><td>Agent’s species</td><td>Agent’s taxonomy</td><td>Further details about the agent can be determined from literature searches and consultation with experts
For example Clostridium difficile<table><tr><td>Genus</td><td>Clostridium</td></tr><tr><td>Species</td><td>difficile</td></tr></table>The persistence of and efficacy of disinfection techniques can be determined by agent species, genus or family</td><td><table><tr><td>Genus</td><td>Escherichia</td></tr><tr><td>Species</td><td>coli</td></tr></table>O157 and related toxigenic strains</td><td></td></tr>
<tr><td>Organism form</td><td>Bacteria, bacterial spore, virus, fungi, parasite, oocyte</td><td>The form of the organism will help to determine the persistence of the agent and types of disinfection methods that are most effective for decontamination. It is possible that more than one form may be present, in which case the method of disinfection should consider the more resistant form
For example, alcohol-based solutions are very effective for disinfection of some vegetative bacteria; however, they are ineffective against bacterial spores</td><td>Gram negative, non-spore forming bacterium</td><td>This vegetative bacteria will be susceptible to most disinfectants and decontamination techniques</td></tr>
<tr><td>Persistence</td><td>How long will the agent survive in the environment?</td><td>How long a biological agent can persist in the environment will influence which recovery options should be considered for the remediation strategy (consult the persistence database)
An additional factor that should be considered is ‘What is the environment used for?’ This may also influence which recovery options are selected
For example, protective options (restrict public access) could be used if an agent has limited persistence (1–2 days) as natural inactivation (natural weathering) would eliminate the agent from the environment. However, this would not be appropriate for persistent agents, more active decontamination, or removal options need to be considered</td><td>E. coli O157 has been shown to survive on leafy vegetables for up to 63 days, but for much longer periods on other vegetables and in different water types. In soil microcosms E. coli was detectable after 130 days, therefore it is classified as being persistent (survives ≥101 days)
The environment is used for food production</td><td>The persistence of the agents in this environment indicates that protection, restoration and disposal of produce options will need to be selected</td></tr>
<tr><td>Resistance</td><td>Is the agent known to be resistant to disinfection processes or methods?</td><td>If the biological agent exhibits increased resistance to a disinfection method (eg vapour hydrogen peroxide) then alternative recovery options should be considered (consult the disinfection database)
Repeating disinfection with more effective disinfection techniques may result in delays and increase costs for remediation</td><td>The cells of E. coli are susceptible to liquid disinfectant and physical inactivation methods</td><td>A wide range of decontamination methods can be chosen for effective use against the agent</td></tr>
</table>

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Person to person spread/route of transmission	Can the agent be spread from person-to-person or animal to human? How is the agent infectious? (gastrointestinal/inhalation) Is the agent zoonotic?	Further recovery options might be necessary to stop the spread of the agent from person to person The route of transmission will affect the prioritisation of recovery from the agent *For example, a scenario where an agent causes gastrointestinal upset but is not infectious through the aerosol route may lend more time to develop a recovery strategy than a scenario with highly infectious or contagious agents that would need to be dealt with as a priority*	The agent can be contracted from ingesting contaminated food and the infectious dose is thought to be as low as 10 organisms. Person-to-person spread is extremely likely	The contamination is potentially in a form that can be spread to humans, meaning that protective and decontamination options need to be chosen to protect the public Selection of appropriate PPE will be necessary to protect the workers from these risks Infected individuals will potentially contaminate other individuals
Prophylaxis, vaccination and treatment	Is there medical intervention available with activity against the agent?	The risk to the public and workers will be increased if there is no prophylaxis or treatment available	The illness can be self-limiting and may not require treatment although it is readily treatable with a range of antibiotics. There is no vaccination available	Medical interventions can be used to protect the public and workers, but only after exposure
Hazard group	What is the ACDP hazard group of the agent?	Agents with a hazard group of 3 or 4 are more likely to cause serious infection and pose a significant risk to public health The recovery from incidents involving hazard group 3 or 4 agents could have increased cost implications, may take longer to remediate, require appropriate levels of worker PPE, and may involve specialist techniques	*E. coli* STEC O157 is classified as an ACDP hazard group 3 agent	ACDP hazard group 3 agents are able to infect humans so PPE will be needed during the decontamination. The agent will need to be handled in a suitable laboratory and waste produced will come under guidance from the HSE
Production of toxins	Does the agent produce a toxin? What is the stability of the toxin?	Toxins might persist in the environment after the destruction of the parent agent. Therefore consideration should be given to potential release of harmful toxins from the parent agent. Additionally, they may also be volatile and therefore difficult to contain Recovery options will need to be effective against the parent agent and subsequent toxins (eg mycotoxin). Seek expert advice and guidance for information on toxicology of toxic compounds Some toxins are heat resistant and may not be inactivated by processes used to inactivate microbial agents	*E. coli* STEC O157 produces an enterotoxin	These toxins are harmful to human health, but must be ingested to cause ill-health. Appropriate PPE will be required for anyone contacting the contamination and disinfection options will be needed to remove the toxins

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Background level of agent	Are the levels of the agent within the environment before the incident known?	This level will determine the extent of the contamination and the levels that need to be achieved during decontamination. The recovery phase must return the agent's level to at least the background amount	*E. coli* STEC can be found in the natural environment in very low levels, especially in animals	The contamination must be reduced to at least these levels
Will the agent multiply in the environment?	Is the agent able to replicate in the environment in which it is found?	If the agent has the ability to replicate in the environment in which it is found then the level and spread of contamination could increase If the agent can replicate in the environment then the decontamination recovery options will need to be employed earlier to limit the growth and spread of the agent. This will be further dependent on the environmental conditions at the time, including the availability of water and nutrients, the relative humidity and the ambient temperature	The host of *E. coli* is either human or animal. Replication outside the host may occur in food and other organic matter dependent on conditions such as the formulation of the product and storage temperature	The conditions found in this environment indicate that *E. coli* STEC would be unlikely to replicate

Step 2 Consult decision tree/diagrams for food production systems

Identify potentially applicable recovery options

Consult inhabited areas and water environments chapters (if applicable)

Table 10.2: Application of the food production systems decision tree

Decision tree step	Decision	Comments
Food production systems decision tree part 1		
ENTER DECISION TREE		
Are inhabited areas or water environments potentially contaminated?	No	The information regarding the incident suggests that the contamination is limited to the food production system under investigation Contamination must be decreased to ensure there are no further incidents. If it is later deemed that other areas are contaminated, consult these sections of the handbook
Is monitoring data available?	Yes	Data is already available where contamination has been found, therefore protective options can be employed immediately
Review preliminary risk assessment and consider (4) Restriction of entry into food chain/ withdrawal from market Consult with experts as necessary (Appendix E)		
Is there a risk to animal or plant health?	Yes	If the decision maker deems there is a risk to animal health from the agent then Defra and APHA should be contacted using the routes described in Appendix E

Decision tree step	Decision	Comments
Identify the area of contamination and contact the appropriate authorities: For animal pathogens contact Defra and APHA. For plant pathogens contact Defra and FERA.		
Is there a risk to human health?		In this incident there is a risk to human health so the user should continue to part 2 of the decision tree
Food production systems decision tree part 2		
Has contamination already reached the food chain?	Yes	Contamination has been detected in the food chain so appropriate protection options should be taken
Contact Food Standards Agency and consider immediate protection options (2) Precautionary (food safety) advice (4) Restriction of entry into food chain/ withdrawal from market (5) Product recall		
Can the contamination be spread further in the environment?	Yes	The contamination source has not yet been determined so protective options must be put in place

Decision tree step	Decision	Comments
Consider immediate protection options (2) Precautionary (food safety) advice (4) Restriction of entry into food chain/ withdrawal from market (5) Product recall (6) Closure of air intake systems at food processing plants (7) Minimise spread from contaminated crops (10) Relocation of animals (13) Ban or restrictions on hunting, fishing and foraging (15) Processing or treatment of food products		
Is there a requirement to decrease contamination levels irrespective of potential exposure?	Yes	Potential contamination must be decreased to ensure further incidents do not occur
Using Steps 3-6 of the decision-aiding framework, identify the relevant management options for the affected food production systems		
Plan and execute the recover strategy and repeat monitoring		Following implementation of recovery options further monitoring should be undertaken to ensure the recovery has been completed
Have acceptable levels been reached?	Yes	
Return to normality Report on incident, was Handbook effective?		

The decision tree for food production systems will guide the user to the appropriate protection options that should be implemented as soon as possible if they have not already been put in place prior to consulting the handbook. Table 10.3 below shows the protection options that have been identified.

Table 10.3: Protection options selected after Step 2

Recovery options	Retain?	Rationale
(1) Restrict/controlled access	Yes	Access should be controlled to limit the potential exposure of the workforce
(2) Precautionary (food safety) advice	Yes	Food safety advice should be given to the public to help reduce the potential for infection from the contaminated watercress
(3) Medical intervention	Yes	May be required dependent on severity of disease
(4) Restriction of entry into food chain/withdrawal from market	Yes	Any watercress that is potentially contaminated should not be allowed to enter the food chain and/or should be withdrawn from the market
(5) Product recall	Yes	All retail outlets that sold the contaminated produce should issue a product recall to ask customers to return the product
(6) Closure of air intake systems at food processing plants	No	Air intake systems are unlikely to affect the contamination spread
(7) Minimise spread from contaminated crops	Yes	Management of the contaminated crops will ensure that *E. coli* O157 contamination is contained at the watercress farm
(8) Issue of a FEPA order	No	FEPA order not applicable
(9) Pest control	No	Pests are unlikely to spread the contamination and existing measures should already be in place
(10) Relocation of animals	No	No animals are present
(11) Restrictions on animal transport/movement	No	No animals are present
(12) Restrictions on animal breeding	No	No animals are present
(13) Ban or restrictions on hunting, fishing and foraging	No	The food is not acquired through any of these activities

There are 13 protection options identified for food production system. Of these, six have been deemed applicable for this incident and seven are deemed inapplicable and can be discarded.

Step 3 Determine effectiveness of recovery options

A	**Eliminate options based on contamination properties**
B	**Eliminate options based on effectiveness**

A Eliminate options based on contamination properties

During Step 3A the user will be able to remove certain recovery options based on the contaminating agents and the sub-environment contaminated, because they will not be applicable to the contaminating agent or its form. Table 10.4 shows the remediation and waste disposal recovery options that can be eliminated for this incident and the rationale behind the selection.

Table 10.4: Recovery options selected after Step 3A

Recovery options	Retain?	Rationale
Remediation options		
(14) Identification/removal of contamination source	Yes	The contamination source needs to be identified and treated/removed
(15) Processing or treatment of food products	Yes	The produce could be treated using validated means
(16) Selection of alternative land use	No	The farm should not be used until the contamination and its source have been dealt with
(17) Removal of topsoil	No	There is no topsoil to remove
(18) Capping of contaminated land	No	This cannot be performed
(19) Liquid decontamination of soil	No	There is no soil present
(20) Natural inactivation	Yes	The contamination can be transient so this option can be chosen
(21) Cleaning feeding/selective grazing regime	No	No animals are kept on the farm
(22) Veterinary intervention to animals	No	No animals are kept on the farm
(23) Culling of livestock	No	No animals are kept on the farm
(24) Decontamination of animal premises	No	No animals are kept on the farm
(25) Decontamination of food premises	Yes	Contamination of the processing plant may be required
Waste disposal options		
(26) Selection of alternative product use	Yes	The product could have alternative uses, ie soup
(27) Burning in-situ (pre-harvested crops)	No	Burning would not be practical
(28) Disposal of foodstuffs	Yes	The harvested crops will need to be disposed of
(29) Disposal of animal wastes	No	No animals are kept on the farm

There are 16 recovery options that can be applied to this incident, excluding protection options. Of these, six are applicable and have been taken to the next step in the decision-making process.

B Eliminate options based on effectiveness

The selected recovery options from Step 3A will now be reviewed for their applicability based on their effectiveness and potential for increased worker exposure to the agent. Table 10.5 details the effectiveness and exposure in a shaded format.

Table 10.5: Recovery options effectiveness

Key: Effectiveness	Up to 100% effective	Potentially effective	Limited effectiveness
Key: Potential worker exposure	**Low risk**	**Moderate risk**	**High risk**

Recovery options	Effectiveness	Potential worker exposure	Retain?
Protection options			
(1) Restrict/controlled access			Yes
(2) Precautionary (food safety) advice			Yes
(3) Medical intervention			Yes
(4) Restriction of entry into food chain/withdrawal from market			Yes
(5) Product recall			Yes
(7) Minimise spread from contaminated crops			Yes
Remediation options			
(14) Identification/removal of contamination source			Yes
(15) Processing or treatment of food products			Yes
(20) Natural inactivation			Yes
(25) Decontamination of food premises			Yes
Waste disposal options			
(26) Selection of alternative product use			Yes
(28) Disposal of foodstuffs			Yes

Reviewing the effectiveness and worker exposure for the recovery options shows that they are all applicable to the incident and should be taken to the next step for review in greater detail.

Step 4 Review key considerations and constraints

Eliminate further options according to other considerations (public health, waste, social, technical, cost and time)

Each recovery option will have constraints that are associated with it and its implementation. The constraints take into account considerations such as public health, waste, social, technical, cost and time points. Table 10.6 shows the major and moderate considerations for the identified recovery options. If a recovery option does have a major or moderate consideration then it does not mean that the recovery option should not be used, the decision maker should review the recovery option on an incident by incident basis prior to selection or removal.

Table 10.6: Key considerations for the remaining recovery options

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Protection options		
(1) Restrict/controlled access	**None**	**Social** – Effective communication is required to inform the public about the restriction and the potential health risks posed by the contaminant with the aim of ensuring compliance. Possible disruption and restricted access to an area may not be well received by members of the public, with pressure to reopen the area
(2) Precautionary (food safety) advice	**None**	**Social** – This is an advice option and is difficult to enforce. Food safety legislation does not apply to home grown produce **Technical** – There may be difficulty ensuring that advice reaches all consumers
(3) Medical intervention	**Technical** – It may be difficult to administer prophylaxis and/or vaccinations to everyone who needs it. Medical professionals will be needed to administer these treatments **Cost** – The cost of this measure will be influenced by the number of people needing treatment, the cost of the treatment itself and the number of medical professionals needed to administer the treatment	**Social** – Effective communication is required to inform the individuals at risk that treatment may be necessary and to avoid panic among the general public **Time** – This option could extend for large periods of time as those that are affected and/or 'at risk' will need to be identified and then brought in for treatment. These people will then need to be continually monitored over a set period of time, which could extend for months
(4) Restriction of entry into food chain/withdrawal from market	**Waste –** There may be significant amounts of contaminated food products that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence. Long-term restrictions (eg FEPA order) may also lead to culling and disposal of livestock	**Cost** – There may be a cost associated with disposal of contaminated food
(5) Product recall	**Waste** – There may be significant amounts of contaminated recalled food products that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence	**Social** – Consumers may lose confidence in the product, manufacturer or store **Technical** – Contacting members of the public **Cost** – There may be a cost associated with disposal of contaminated food **Time** – The time between contamination and recall is important as a delay between these events increases consumer exposure
(7) Minimise spread from contaminated crops: (a) harvested; (b) greenhouse	**None**	**Public health** – Potential for increased exposure of farm workers while protecting crops **Waste** – Disposal of contaminated crops **Technical** – Availability of materials to protect crops **Cost** – May be high, considering equipment, personnel and volume of the affected crop area that needs protection

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Remediation options		
(14) Identification/removal of contamination source	**Time** – This option will need to be undertaken prior to any other remediation option being carried out	**Technical** – There may be problems with accessibility as the contamination source might be in an inaccessible location **Cost** – This will be dependent on the incident in question as the cost will vary depending on the accessibility and type of contamination
(15) Processing or treatment of food products	**Technical** – Availability, capability and capacity of facilities to process contaminated foods	**Waste** – There may be significant amounts of contaminated food products (ie crops) and production processes that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence **Cost** – May be high, considering equipment, personnel, type of contaminated food product and waste disposal
(20) Natural inactivation	**Time –** This option can take long periods of time dependent on the persistence of the agent in question	**Public health** – Potential for leaching of biological agents into groundwater. Access to land may have to be restricted while contamination levels are high **Social –** This option may be perceived as doing 'nothing' by the public, which has negative implications and may be unacceptable to members of the public
(25) Decontamination of food premises	**None**	**Waste** – This option may generate large quantities of waste depending on the decontamination method chosen **Technical** – Some decontamination methodologies require specialist contractors to carry out **Cost** – May be a high cost in this recovery option as there will be large areas to decontaminate and specialist contractors may be required **Time** – This recovery option may need to be implemented over a long period of time
Waste disposal options		
(26) Selection of alternative product use	**Waste** – There may be significant amounts of contaminated food products (eg crops) and by-products from processing that will require a suitable disposal route, and may require disposal and/or storage under a waste transfer licence **Technical** – Depends on the nature of the biological agent, marketing for alternative products and knowledge base	**None**
(28) Disposal of foodstuffs	**None**	**Social** – There may be a negative impact on public perception if large amounts of food are being seen to be thrown away **Cost** – The cost may be high if there are large amounts of crops to be disposed of

Table 10.7: Potentially applicable recovery options identified after Step 4

Recovery options	Retain?	Rationale for exclusion
Protection options		
(1) Restrict/controlled access	Yes	N/A
(2) Precautionary (food safety) advice	Yes	N/A
(3) Medical intervention	Yes	N/A
(4) Restriction of entry into food chain/withdrawal from market	Yes	N/A
(5) Product recall	Yes	N/A
(7) Minimise spread from contaminated crops	Yes	N/A
Remediation options		
(14) Identification/removal of contamination source	Yes	N/A
(15) Processing or treatment of food products	No	This option will be expensive, time consuming and the disposal of foodstuffs can be used as an alternative
(20) Natural inactivation	Yes	N/A
(25) Decontamination of food premises	Yes	N/A
Waste disposal options		
(26) Selection of alternative product use	No	This option would require a large technical input and potentially contaminate other areas with the agent if not completed correctly
(28) Disposal of foodstuffs	Yes	N/A

After Step 4 there are 10 potential recovery options which may be used to remediate the incident.

Step 5 Consult recovery option sheets

Eliminate further options following a detailed analysis of options on a site- and incident-specific basis

In this step the remaining recovery options that have been selected for consideration should be reviewed in greater detail by consulting the full recovery option sheets that are found in Chapter 5 of the handbook. The data sheets will provide detailed analysis over a wide range of important constraints. As mentioned in Step 4, this process should be completed on an incident-specific basis because not all of the constraints will apply in each situation. The remaining applicable recovery options can then be compared in Step 6.

Step 6 Compare the remaining recovery options and implement the recovery strategy

Based on Steps 1–5 select and combine options for managing each phase

This is the final step in the process of developing a recovery strategy. The 10 recovery options that have been identified for dealing with this incident are listed in Table 10.8.

Table 10.8: Recovery options for use to remediate the incident

Recovery options
Protection options
(1) Restrict/controlled access
(2) Precautionary (food safety) advice
(3) Medical intervention
(4) Restriction of entry into food chain/withdrawal from market
(5) Product recall
(7) Minimise spread from contaminated crops
Remediation options
(14) Identification/removal of contamination source
(20) Natural inactivation
(25) Decontamination of food premises
Waste disposal options
(28) Disposal of foodstuffs

The recovery options can be implemented, followed by monitoring of the area if necessary to ensure they have been effective. The monitoring after recovery strategy implementation will allow the decision maker to evaluate the effectiveness of the recovery and will therefore determine if further recovery options needed to be employed.

10.2 Inhabited areas: flood water contamination of a residential area

This section should be read in conjunction with Chapters 6 and 7 on inhabited areas.

Scenario
Several houses were affected by flood water
The flooded area was downstream of a sewage treatment works
Flood water has receded
It is thought the water could have been contaminated with a range of human pathogens including *Salmonella* species, *Clostridium difficile* and *Campylobacter* species
The houses contain a mixture of surfaces

Before going through the generic steps involved in selecting and combining options, users should appreciate that when using the handbook to develop a recovery strategy they should:

- establish dialogue with national and local stakeholders (see Appendix E for further details)
- be familiar with the structure and content of the handbook
- develop knowledge of the technical information underpinning a recovery strategy
- have an understanding of the factors influencing implementation of options and selection

Step 1: Obtain relevant information regarding the incident

Identify affected inhabited areas(s) and, if applicable, determine the agent's characteristics
Obtain expert advice

Step 2: Consult flow chart and decision tree for inhabited areas

Identify potentially applicable recovery options
Consult food production systems and water environments sections of the handbook (if applicable)

Step 3: Determine the effectiveness of recovery options

A: Eliminate options based on the agent's characteristics
B: Eliminate options based on effectiveness

Step 4: Review key considerations and constraints

Eliminate further options according to other considerations (public health, waste social, technical, cost and time)

Step 5: Consult recovery option sheets

Eliminate further options following a detailed analysis of options on a site and incident specific basis

Step 6: Compare remaining recovery options

Based on steps 1 – 5, select and combine options for managing each phase

Implement recovery strategy/report and evaluate

Was recovery strategy effective?

Yes
Return to normality and report

No
Return to Step 2/review recovery options

Figure 10.2: Six-step decision-making framework for inhabited areas

Step 1 Obtain relevant information regarding the incident

Determine the properties of the biological organism(s)
Identify affected inhabited area(s) and obtain expert advice

In addition to the information that would be initially identified about the incident, in this example brief information is supplied in the grey scenario box, it is important to determine as much about the contaminating agent(s) as possible. Expert advice should be sought from relevant government agencies, eg Environment Agency and Public Health England, on the contaminating agents that may be present in the flood water. This information should be used to complete the agent data sheet (Table 10.9) which will direct the decision maker to key points to consider when dealing with the agent. Table 6.6 in Chapter 6 (inhabited areas) should be used to record the process of choosing the appropriate recovery options. This table should be used to help identify the rationale for any option selection or removal and will assist with any audit or reports produced after recovery from the incident. The decision tree should then be followed to help choose appropriate protective recovery options (Step 2).

Table 10.9: Agent data sheet for flooding (multiple agents)

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Agent's species	Agent's taxonomy	Further details about the agent can be determined from literature searches and consultation with experts For example, *Clostridium difficile* *Genus*: *Clostridium* *Species*: *difficile* The persistence of and efficacy of disinfection techniques can be determined by agent species, genus or family	Water sampling has shown high levels of a number of agents	The contaminated water will contain a mixture of enteric agents. This could contain pathogenic agents such as: *Escherichia coli* *Clostridium difficile* *Salmonella species* norovirus
Organism form	Bacteria, bacterial spore, virus, fungi, parasite, oocyte	The form of the organism will help to determine the persistence of the agent and types of disinfection methods that are most effective for decontamination. It is possible that more than one form may be present, in which case the method of disinfection should consider the more resistant form *For example, alcohol-based solutions are very effective for disinfection of some vegetative bacteria; however they are ineffective against bacterial spores*	The agents will be mainly vegetative bacteria and possibly bacterial endospores	The vegetative bacteria will be susceptible to a wide range of disinfection chemicals and technologies; the endospores will exhibit greater resistance to these techniques. The presence of large amounts of organic matter may also reduce efficacy of various decontamination methods
Persistence	How long will the agent survive in the environment?	How long a biological agent can persist in the environment will influence which recovery options should be considered for the remediation strategy (consult the persistence database) An additional factor that should be considered is ***'What is the environment used for?'*** This may also influence which recovery options are selected *For example, protective options (**restrict public access**) could be used if an agent has limited persistence (1–2 days) as **natural inactivation** (natural weathering) would eliminate the agent from the environment. However, this would not be appropriate for persistent agents, more active decontamination, or removal options need to be considered*	Some of the agents that may be contained within the contaminated water, *E. coli, C. difficile* and *Salmonella*, are able to be detected after more than 100 days in water sources, therefore they can be classed as persistent The water is used for recreational and household activities	The agents potentially in the faecal matter and the areas contaminated mean that remediation is necessary to return the area to 'normality'

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	**Interpretation**
Resistance	Is the agent known to be resistant to disinfection processes or methods?	If the biological agent exhibits increased resistance to a disinfection method (eg vapour hydrogen peroxide) then alternative recovery options should be considered (consult the disinfection database) Repeating disinfection with more effective disinfection techniques may result in delays and increase costs for remediation	The sewage contamination may contain agents that exhibit increased resistance to disinfectants, ie bacterial endospores. The agents are also likely to be associated with elevated levels of organic material decreasing the efficacy of disinfectants	Consideration is required to determine the most effective decontamination options. Consult further with experts
Person to person spread/route of transmission	Can the agent be spread from person to person or animal to human? How is the agent infectious? (gastrointestinal/inhalation) Is the agent zoonotic?	Further recovery options might be necessary to stop the spread of the agent from person to person The route of transmission will affect the prioritisation of recovery from the agent *For example, a scenario where an agent causes gastrointestinal upset but is not infectious through the aerosol route may lend more time to develop a recovery strategy than a scenario with highly infectious or contagious agents that would need to be dealt with as a priority*	All of the agents are transmissible through the ingestion route	The contamination is present in a form that can be spread to humans through ingestion, meaning that protective and decontamination options need to be chosen to protect the public. Selection of appropriate PPE will be necessary to protect workers from these risks
Prophylaxis, vaccination and treatment	Is there medical intervention available with activity against the agent?	The risk to the public and workers will be increased if there is no prophylaxis or treatment available	The agents are readily treatable with a range of antibiotics. There is no vaccination available	Medical interventions can be used to protect the public and workers
Hazard group	What is the ACDP hazard group of the agent?	Agents with a hazard group of 3 or 4 are more likely to cause serious infection and pose a significant risk to public health The recovery from incidents involving hazard group 3 or 4 agents could have increased cost implications, may take longer to remediate, require appropriate levels of worker PPE, and may involve specialist techniques	It is thought the agents present would be at a level of ACDP hazard group 2 and below	Hazard group 2 agents can cause infection to people, and coupled with the noxious smell, will require the use of PPE during the recovery

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	**Interpretation**
Production of toxins	Does the agent produce a toxin? What is the stability of the toxin?	Toxins might persist in the environment after the destruction of the parent agent. Therefore consideration should be given to potential release of harmful toxins from the parent agent. Additionally, they may also be volatile and therefore difficult to contain Recovery options will need to be effective against the parent agent and subsequent toxins (eg mycotoxin). Seek expert advice and guidance for information on toxicology of toxic compounds Some toxins are heat resistant and may not be inactivated by processes used to inactivate microbial agents	Some of the agents produce endotoxins. These can potentially cause ill-health if ingested in high enough numbers	Appropriate recovery options must be chosen to limit the contact with toxins
Background level of agent	Are the levels of the agent within the environment before the incident known?	This level will determine the extent of the contamination and the levels that need to be achieved during decontamination. The recovery phase must return the agent's level to at least the background amount	The contaminating agents can be present in low levels in the normal environment	The agents should be reduced to (or below) their background levels
Will the agent multiply in the environment?	Is the agent able to replicate in the environment in which it is found?	If the agent has the ability to replicate in the environment in which it is found then the level and spread of contamination could increase If the agent can replicate in the environment then the decontamination recovery options will need to be employed earlier to limit the growth and spread of the agent. This will be further dependent on the environmental conditions at the time, including the availability of water and nutrients, the relative humidity and the ambient temperature	If the correct conditions are present in the contaminated environment the agents can potentially multiply	It is unlikely the organisms will multiply in the environment, but the high organic loading of the sewage could lead to agent multiplication

Step 2 Consult decision tree/diagrams for inhabited areas

Identify potentially applicable recovery options

Consult food production systems and water environments chapters (if applicable)

Table 10.10: Application of the inhabited areas decision tree

Decision tree step	Decision	Comments
Inhabited areas decision tree part 1		
ENTER DECISION TREE		
Is the extent of contamination known? i.e. visible hot-spots or epidemiological evidence	Yes	The extent of the contamination will be known due to the presence of flood water. After water recedes contamination may be visible
Is there a risk to human health?	Yes	The organisms found within the flood water are hazardous to human health
Consider recovery options (1) Restrict public access (2) Controlled workforce access (4) Temporary relocation from residential areas (5) Medical intervention		These preliminary protective recovery options can be employed to help protect the occupants of the houses and aid in recovery
Is there a national critical infrastructure facility in the contaminated area that needs to be manned?	No	In this situation only private accommodation is affected by the flood water. If critical infrastructure is affected further recovery options may be necessary

Decision tree step	Decision	Comments
Is the contaminated area used by the general public?	No	In this incident only private accommodation is affected by the flood water
Inhabited areas decision tree part 2		
Are people residing in the contaminated areas?	Yes	People are residing in the housing affected by the flood water
High priority for monitoring and exposure assessment		The residents should be given specific advice on the hazards from the flood water. If deemed necessary the residents might need to be relocated. Advice can be found in Appendix E
Consider recovery options: (4) Temporary relocation from residential areas (5) Medical Intervention (6) Pest control		
Does the agent have a short persistency (<1 day)?	No	The organisms found within the flood water are persistent in the specific environment
Is there a need to decontaminate irrespective of potential exposure?	Yes	The contaminating organisms are hazardous and persistent therefore decontamination will be necessary

Decision tree step	Decision	Comments
Using Steps 3-6 of the decision-aiding framework, identify the relevant management options for the affected inhabited areas		
Implement strategy		Following the implementation of recovery options further monitoring should be undertaken to ensure the recovery has been completed
Sample if necessary to determine effectiveness		
Have acceptable levels been reached?	Yes	
Return to normality Report on incident, was Handbook effective?		

The decision tree for inhabited areas will guide the user to the appropriate protection options that should be implemented as soon as possible if they have not already been put in place prior to consulting the handbook. Table 10.11 shows the protection options that have been identified.

Table 10.11: Protection options selected after Step 2

Recovery options	Retain?	Rationale
(1) Restrict public access	Yes	Access needs to be restricted to just the residents of the properties to ensure there is no wider harm from the organisms in the flood water
(2) Controlled workforce access	Yes	Guidelines should be put in place to ensure anyone (including workers) must adhere to the restrictions and PPE selected
(3) Impose restrictions on transport	No	It is envisaged that access will be restricted by the flood water so this option will not necessary
(4) Temporary relocation from residential areas	Yes	The homeowners might be required to vacate their residences if there is a danger to them
(5) Medical intervention	Yes	Medical treatment might be required by the residents if they have come into direct contact with the flood water and/or show symptoms of illness
(6) Pest control	Yes	Pests should be controlled to ensure they do not spread any contamination to uncontaminated areas

There are six protection options identified for the inhabited areas. Of these, five have been deemed applicable for this incident and one is deemed inapplicable and can be discarded.

Step 3 Determine effectiveness of recovery options

A	**Eliminate options based on contamination properties**
B	**Eliminate options based on surface material and biological characteristics**

A Eliminate options based on contamination properties

During Step 3A the user will be able to remove certain recovery options based on the contaminating agents and the sub-environment contaminated, because they will not be applicable to the contaminating agent or its form. Table 10.12 shows the remediation and waste disposal recovery options that can be eliminated for this incident and the rationale behind the selection.

Table 10.12: Recovery options selected after Step 3A

Recovery options	Retain?	Rationale
Remediation options		
(7) Removal/treatment of contamination source	No	This option is not applicable due to the size of the flood water
(8) Reactive gasses and vapours	Yes	These can be used to decontaminate internal surfaces
(9) Gaseous decontamination of objects	Yes	This can be used to decontaminate small objects
(10) Reactive liquids	Yes	These can be used to decontaminate surfaces
(11) Energy decontamination techniques	Yes	These can be used for decontamination of small items
(12) Steam cleaning	Yes	This can be used for the decontamination of surfaces
(13) HEPA vacuum cleaning	Yes	This will only be effective if the vacuum is able to handle wet substances
(14) Modify operation/cleaning of ventilation systems	No	This option looks to reduce contamination spread and in this example the houses do not have ventilation systems
(15) Storage, covering, gentle cleaning	Yes	This can be used for delicate items
(16) Natural inactivation	Yes	This option can be used for external areas
(17) Soil and vegetation removal	Yes	This option might be used for any allotments/vegetable areas found at the properties
(18) Barriers to seal land contamination	No	This option will not be appropriate for the contamination type
Waste disposal options		
(19) Removal and disposal of contaminated material	Yes	Materials that are contaminated and cannot be cleaned will need to be remove and disposed of
(20) Burial in-situ	No	This is not an appropriate option for the incident
(21) Incineration	Yes	This can be applied to the waste that has been generated

There are 15 recovery options that can be applied to this incident, excluding protection options. Of these, 11 are applicable and have been taken to the next step in the decision-making process.

B Eliminate options based on surface material and biological characteristics

The selected recovery options from Step 3A will now be reviewed for their applicability based on their effectiveness against a range of contamination types (free, absorbed and inaccessible) and the type of surface that has been contaminated (robust or sensitive). The contamination will be over a range of surface types that are found in a typical home, eg soft furnishings, tiled floors, wood and plasterboard. Table 10.13 details the effectiveness of the options based on contamination and surface type.

Table 10.13: Recovery options effectiveness

Key: Effectiveness	Up to 100% effective	Potentially effective	Limited effectiveness

Recovery options	Efficacy for type of contamination and surface material					Retain?
	Surface type		Contamination type			
	Robust	Sensitive	Free	Absorbed	Inaccessible	
Remediation options						
(8) Reactive gases and vapours						Yes
(9) Gaseous decontamination of objects						Yes
(10) Reactive liquids						Yes
(11)Energy decontamination techniques						Yes
(12) Steam cleaning						Yes
(13) HEPA vacuum cleaning						Yes
(15) Storage, covering, gentle cleaning of precious objects						Yes
(16) Natural inactivation						Yes
(17) Soil and vegetation removal	N/A	N/A				Yes
Waste disposal options						
(19) Removal and disposal of contaminated material						Yes
(21) Incineration						Yes

Reviewing the effectiveness of each of the recovery options shows that while there may be considerations with the effectiveness for some of the recovery options, the wide variety of surface types present mean that each of the recovery options should be retained for further review in Steps 4 and 5.

Step 4 Review key considerations and constraints

Eliminate further options according to other considerations (public health, waste, social, technical, cost and time)

Each recovery option will have constraints that are associated with it and its implementation. The constraints take into account considerations such as public health, waste, social, technical, cost and time points. Table 10.14 shows the major and moderate considerations for the identified recovery options. If a recovery option does have a major or moderate consideration then it does not mean that the recovery option should be used, the decision maker should review the recovery option on an incident by incident basis prior to selection or removal.

Table 10.14: Key considerations for the remaining recovery options

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Protection options		
(1) Restrict public access	**None**	**Social** – Effective communication is required to inform the public about the restriction and the potential health risks posed by the contaminant, with the aim of ensuring compliance. Possible disruption and access to an area may not be well received by members of the public, with pressure to reopen the area
(2) Controlled workforce access	**None**	**Social** – There may be issues with compliance, guards may need to be appointed to prevent access Cost – This measure may prove expensive if guards are needed to prevent access and if a large amount of PPE for recovery workers is needed, eg respirators Waste – Waste may be generated from used/contaminated PPE worn by recovery workers. This will have to be disposed of in an appropriate manner Technical – For this measure to be successful, appropriate PPE will need to be distributed to the workforce that requires entry, eg in manned infrastructure, and to recovery workers
(4) Temporary relocation from residential areas	**Social** – Evacuation can be a disturbing exercise to the community. In some cases it can be difficult to ensure compliance, eg local business owners may resist leaving an area. Residents cannot be forced to leave their homes **Technical** – To minimise the social disruptions caused by relocation, certain measures should be taken to assist the process, eg leaflets consisting of important information for people being relocated need to be distributed (effective communication). Transport availability needs to be considered to aid the relocation process, especially if the affected area has an elderly population or people with disabilities (population profile). Additionally, an effective monitoring strategy needs to be implemented to determine the risk of adverse health effects to occupants upon return to the area **Cost** – This measure can prove to be expensive for local authorities responsible for relocating residents from an affected area. Cost is also influenced by the length of time for which residents will be temporarily relocated, and the quality of the temporary housing offered (hotels versus hostels)	**Time** – This measure would need to remain in place as long as the contamination is being investigated/remediated, which could extend for months

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(5) Medical intervention	**Technical** – It may be difficult to administer prophylaxis and/or vaccinations to everyone who needs it. Medical professionals will be needed to administer these treatments **Cost** – The cost of this measure will be influenced by the number of people needing treatment, the cost of the treatment itself and the number of medical professionals needed to administer the treatment	**Social** – Effective communication is required to inform the individuals at risk that treatment may be necessary and to avoid panic among the general public **Time** – This option could extend for large periods of time as those affected and/or 'at risk' will need to be identified and then brought in for treatment. These people will then need to be continually monitored over a set period of time which could extend for months
(6) Pest control	**Technical** – This is likely to have to be sourced externally from specialist contractors **Cost** – This option could be quite costly depending on the extent of pest control needed	**Public health** – Large numbers of carcasses that are not cleared up immediately have the potential to spread further disease **Waste** – This option could result in large quantities of waste and the need to dispose of contaminated carcasses **Social** – It may be unacceptable to the public to see pest control measures being undertaken, especially if this results in a large number of carcasses being in view of the public. It would be necessary to remove any carcasses as soon as possible
Remediation options		
(8) Reactive gases and vapours	**Technical** – This option will require specialist equipment which will need to be externally sourced from specialist companies. It is possible that multiple applications will be necessary to remove all of the contamination. It may be difficult to prevent leakage of gases/vapours **Cost** – This option will require specialist equipment and trained personnel to carry out the procedure. This is likely to be sourced externally and could be quite costly	**Social** – This option has the possibility of damaging surfaces and personal objects and people may be anxious about possible damage to their belongings and homes **Technical** – This option will require specialist equipment which will need to be externally sourced from specialist companies. It is possible that multiple applications will be necessary to remove all of the contamination **Time** – The time taken for this option to be implemented has the potential to be lengthy especially if multiple applications are needed
(9) Gaseous decontamination of objects	**Cost** – This option may prove quite costly depending on the hire of the equipment and the amount of objects to be decontaminated	**Technical** – This option will require specialist equipment which will need to be externally sourced from specialist companies. It is possible that multiple applications will be necessary to remove all of the contamination
(10) Reactive liquids	**None**	**Waste** – This option may produce contaminated waste and/or large volumes of liquid that need to be disposed of correctly or may require storage under a waste transfer licence
(11) Energy decontamination techniques	**Technical** – This option may require specialist equipment and suitably trained personnel. It is possible that multiple applications will be necessary to remove all contamination **Cost** – As this option requires specialist equipment, the cost may be quite high	**Time** – The time taken for this option to be implemented has the potential to be lengthy, especially if multiple applications are needed

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(12) Steam cleaning	**None**	**Waste** – Produces water-based wash solutions that are likely to be contaminated which may require disposal and/or storage under a waste transfer licence **Time** – Maximum effectiveness is achieved when carried out soon after a biological incident; this is when the maximum concentration of the contaminant is still on the surface as, with time, weathering could disperse the contaminant into the surrounding environment if the contamination is outside
(13) HEPA vacuum cleaning	**None**	**Waste** – Potential for large amounts of agent-contaminated filters which may have high contamination levels being generated. This waste may require disposal and/or storage under a waste transfer licence **Technical** – The nature and condition of the surface in question can determine the effectiveness of this measure, eg vacuuming is not very effective on wet soot
(15) Storage, covering, gentle cleaning of precious objects	**Time** – This option may prove lengthy if objects need to be stored for long periods of time prior to cleaning	**Public health** – Cleaning of objects can liberate the contaminant so precautions should be taken to avoid the spread of further contamination **Social** – People may be anxious about cleaning methods causing damage to their belongings **Technical** – If objects need to be stored prior to cleaning then storage facilities will be needed. Specialist cleaning chemicals may be required as to not damage precious objects **Cost** – This option can prove costly if storage facilities are needed for long periods of time
(16) Natural inactivation	**Technical** – Monitoring equipment and skilled personnel to take samples will be required. This method may take a prolonged period of time for the contaminant to be broken down in the environment. The length of time is partly dependent on the location of the area in question, eg allowing biological inactivation within a building could take a significantly longer period of time than in an outdoor area. Also this option may be more feasible for rural areas rarely used, in comparison to a commercial district which would need a more urgent remediation due to social pressures **Time** – This option may prove to be lengthy if the contaminant is persistent and could remain viable for extended periods	**Social** – This option may be perceived as doing 'nothing' by the public which may have negative implications **Cost** – May be high, considering monitoring equipment, consumables, skilled personnel (including laboratory analysis) and time (natural attenuation can take months to years)
(17) Soil and vegetation removal	**Social** – May cause damage to habitats and biodiversity. May also cause soil erosion **Cost** – Tools and/or vehicles needed to remove soil and vegetation can be quite costly. If it is decided to replace soil and vegetation with concrete or tarmac then this may also increase the cost	**Waste** – Large quantities of contaminated soil and vegetation are likely to be produced which will require appropriate disposal **Technical** – Effectiveness of this measure depends on the physiochemical properties of the contaminant (eg water solubility; agent must be contained within clay and soil). An effective monitoring strategy needs to also be implemented **Time** – This option could prove to be lengthy if large areas of soil and vegetation need to be removed

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Waste disposal options		
(19) Removal and disposal of contaminated material	**Social** – Entering homes to remove contaminated objects can be disruptive to residents. Compliance issues can arise if personal items such as clothes or home appliances are being removed and are not covered by compensation packages **Waste** – This option is likely to generate large amounts of contaminated material which will require disposal and/or storage under a waste transfer licence **Cost** – Likely to be high. Dismantling is a highly labour intensive process. Additionally, the large amount of waste generated will be costly to dispose of appropriately	**Technical** – Contaminated material needs to be packaged properly before removal from a contaminated environment to prevent the spread of contamination
(21) Incineration	**Cost** – The cost of this option depends on the amount of contaminated material to be incinerated	**Technical** – Incineration facilities need to be informed of the type and amount of waste that needs to be dealt with prior to transfer. If the facility is unable to take the waste straight away, it may need to be stored

Table 10.15: Potentially applicable recovery options identified after Step 4

Recovery options	Retain?	Rationale for exclusion
Protection options		
(1) Restrict public access	Yes	N/A
(2) Controlled workforce access	Yes	N/A
(4) Temporary relocation from residential areas	Yes	N/A
(5) Medical intervention	Yes	N/A
(6) Pest control	Yes	N/A
Remediation options		
(8) Reactive gases and vapours	No	High cost to decontaminate the areas when other recovery options will provide the same level of decontamination
(9) Gaseous decontamination of objects	No	High cost and technical considerations, where other options would also provide decontamination
(10) Reactive liquids	Yes	N/A
(11) Energy decontamination techniques	No	High cost and technical considerations, where other options would also provide decontamination
(12) Steam cleaning	Yes	N/A
(13) HEPA vacuum cleaning	Yes	N/A
(15) Storage, covering, gentle cleaning	Yes	N/A
(16) Natural inactivation	Yes	N/A
(17) Soil and vegetation removal	Yes	This option might be used for any allotments/vegetable areas found at the properties
Waste disposal options		
(19) Removal and disposal of contaminated material	Yes	Materials that are contaminated and cannot be cleaned will need to be remove and disposed of
(21) Incineration	No	Prohibitively costly

After Step 4 there are 12 potential recovery options which may be used to remediate the incident.

Step 5 Consult recovery option sheets

Eliminate further options following a detailed analysis of options on a site- and incident-specific basis

In this step the remaining recovery options that have been selected for consideration should be reviewed in greater detail by consulting the full recovery option sheets that are found in Chapter 7 of the handbook. The data sheets will provide detailed analysis over a wide range of important constraints. As mentioned in Step 4, this process should be completed on an incident-specific basis because not all of the constraints will apply in each situation. The remaining applicable recovery options can then be compared in Step 6.

Step 6 Compare the remaining recovery options and implement the recovery strategy

Based on Steps 1–5 select and combine options for managing each phase

This is the final step in the process of developing a recovery strategy. The 10 recovery options that have been identified for dealing with this incident are listed in Table 10.16.

Table 10.16: Recovery options for use to remediate the incident

Recovery options
Protection options
(1) Restrict public access
(2) Controlled workforce access
(4) Temporary relocation from residential areas
(5) Medical intervention
Remediation options
(10) Reactive liquids
(12) Steam cleaning
(13) HEPA vacuum cleaning
(15) Storage, covering, gentle cleaning
(16) Natural inactivation
(17) Soil and vegetation removal
Waste disposal options
(19) Removal and disposal of contaminated material

It is worth noting that a number of these recovery options will be applicable in different areas of the properties with different surface types. For example, reactive liquids will be most applicable to free contamination on robust surfaces as there will be the possibility for damage if used on sensitive surfaces. Natural inactivation will be applicable to the outdoor areas of the property. Therefore it will be important to identify the areas in which the particular recovery options should be used.

The recovery options can be implemented, followed by monitoring of the area if necessary, to ensure they have been effective. The monitoring after recovery strategy implementation will allow the decision maker to evaluate the effectiveness of the recovery and will therefore determine if further recovery options needed to be employed.

10.3 Water environments: *Giardia intestinalis* contamination of a private drinking water supply

This section should be read in conjunction with Chapters 8 and 9 on water environments.

Scenario

There is a *Giardia* outbreak in a small community

Contaminating agent found to be *Giardia intestinalis*

Agent found in tap water fed from a private well

Local surface water nearby also found positive for *Giardia intestinalis*

Abstraction point found to be within 15 m of nearest surface water

Water treatment involved an old unit that was poorly maintained

Before going through the generic steps involved in selecting and combining options, users should appreciate that when using the handbook to develop a recovery strategy they should:

- establish dialogue with national and local stakeholders (see Appendix E for further details)
- be familiar with the structure and content of the handbook
- develop knowledge of the technical information underpinning a recovery strategy
- have an understanding of the factors influencing implementation of options and selection

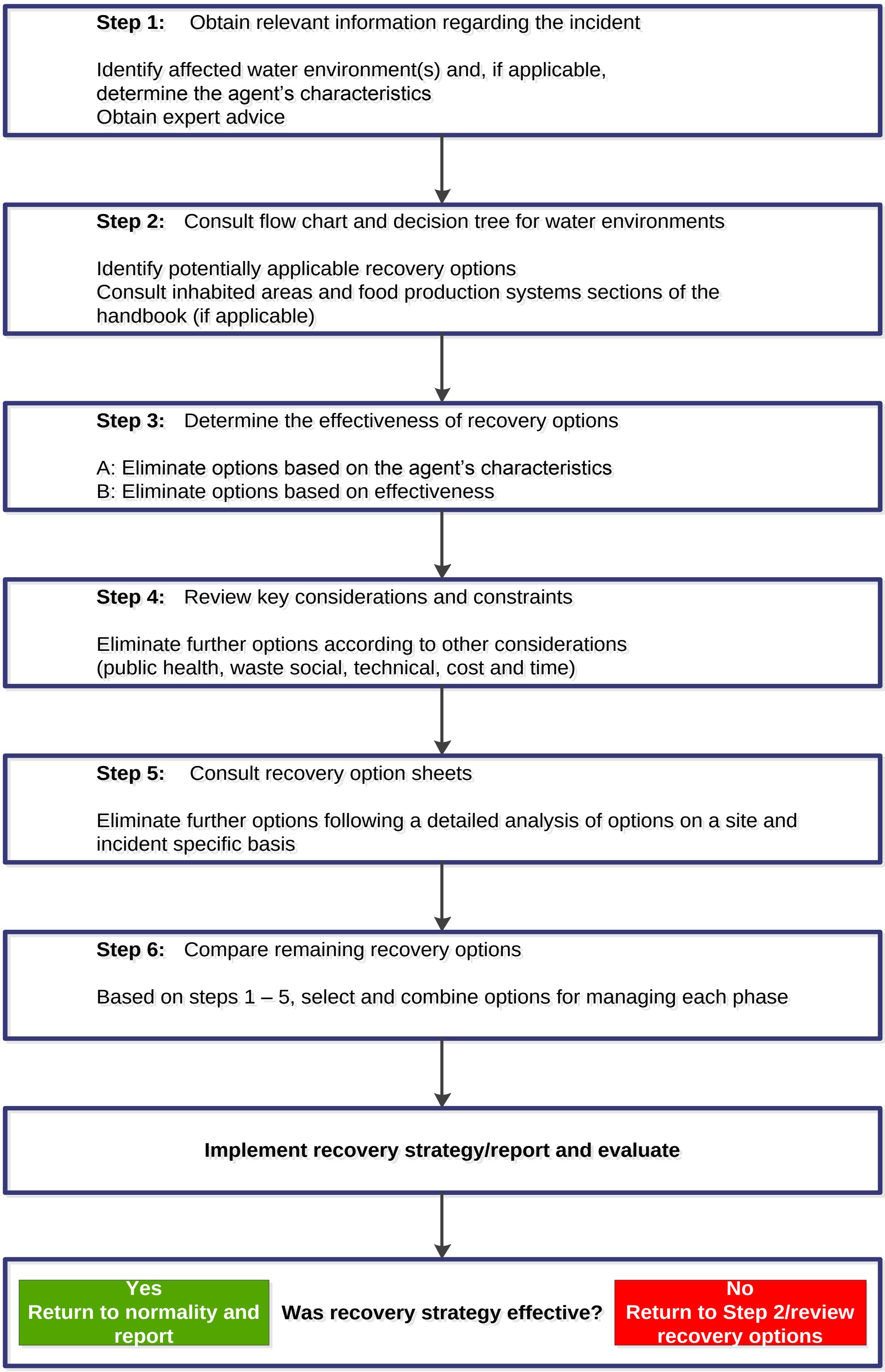

Figure 10.3: Six-step decision-making framework for water environments

Step 1 Obtain relevant information regarding the incident

Determine the properties of the biological organism(s)
Identify affected water environment(s) and obtain expert advice

It is important to determine as much about the incident and contaminating agent as possible. Preliminary information has been given in the grey scenario box relating to the incident and contaminating agent. Expert advice should be sort from the relevant government agencies, such as the Drinking Water Inspectorate and Public Health England, on the agent, *Giardia intestinalis*. This information should be used to complete the agent data sheet (Table 10.17) which will direct the decision maker to the key points to consider when dealing with the recovery from the agent. Table 8.6 in Chapter 8 (water environments) should be used to record the process of choosing the appropriate recovery options. This table should be used to help identify the rationale for any option selection or removal and will assist with any audit or reports that are produced after recovery from the incident. The decision tree should then be followed to help choose appropriate protective recovery options (Step 2).

Table 10.17: Agent data sheet for *Giardia intestinalis*

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	**Interpretation**
Agent's species	Agent's taxonomy	Further details about the agent can be determined from literature searches and consultation with experts For example, *Clostridium difficile* *Genus*: *Clostridium* *Species*: *difficile* The persistence of and efficacy of disinfection techniques can be determined by agent species, genus or family	Genus: *Giardia* Species: *intestinalis*	
Organism form	Bacteria, bacterial spore, virus, fungi, parasite, oocyte	The form of the organism will help to determine the persistence of the agent and types of disinfection methods that are most effective for decontamination. It is possible that more than one form may be present, in which case the method of disinfection should consider the more resistant form *For example, alcohol-based solutions are very effective for disinfection of some vegetative bacteria; however they are ineffective against bacterial spores*	Oocyst forming protozoa	Certain decontamination chemicals and applications may not be effective on the oocysts of this protozoon, eg increased resistance to chlorination. This means that alternative options will need to be considered
Persistence	How long will the agent survive in the environment?	How long a biological agent can persist in the environment will influence which recovery options should be considered for the remediation strategy (consult the persistence database) An additional factor that should be considered is ***'What is the environment used for?'*** This may also influence which recovery options are selected *For example, protective options (**restrict public access**) could be used if an agent has limited persistence (1–2 days) as **natural inactivation** (natural weathering) would eliminate the agent from the environment. However, this would not be appropriate for persistent agents, more active decontamination, or removal options need to be considered*	*G. intestinalis* oocysts can persist in the water environment for several months, therefore it has intermediate persistence (survives from 8–100 days) The water is used for drinking	The persistence of the agent in this environment indicates that decontamination options will need to be selected to disinfect the area if the source cannot be identified and dealt with
Resistance	Is the agent known to be resistant to disinfection processes or methods?	If the biological agent exhibits increased resistance to a disinfection method (eg vapour hydrogen peroxide) then alternative recovery options should be considered (consult the disinfection database) Repeating disinfection with more effective disinfection techniques may result in delays and increase costs for remediation	The oocysts of *G. intestinalis* are resistant to a number of disinfection options	The appropriate disinfection method should be chosen to reduce the agent contamination

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Person to person spread/route of transmission	Can the agent be spread from person to person or animal to human? How is the agent infectious? (gastrointestinal/inhalation) Is the agent zoonotic?	Further recovery options might be necessary to stop the spread of the agent from person to person The route of transmission will affect the prioritisation of recovery from the agent *For example, a scenario where an agent causes gastrointestinal upset but is not infectious through the aerosol route may lend more time to develop a recovery strategy than a scenario with highly infectious or contagious agents that would need to be dealt with as a priority*	*G. intestinalis* is transmissible from person to person. It is contracted through the faecal oral route, and through ingestion of contaminated water	The contamination is present in a form that can be spread to humans, meaning that protective and decontamination options need to be chosen to protect the public. Selection of appropriate PPE will be necessary to protect workers from these risks
Prophylaxis, vaccination and treatment	Is there medical intervention available with activity against the agent?	The risk to the public and workers will be increased if there is no prophylaxis or treatment available	Effective antibiotic treatment is available against the agent	Medical interventions can be used to protect the public and workers
Hazard group	What is the ACDP hazard group of the agent?	Agents with a hazard group of 3 or 4 are more likely to cause serious infection and pose a significant risk to public health The recovery from incidents involving hazard group 3 or 4 agents could have increased cost implications, may take longer to remediate, require appropriate levels of worker PPE, and may involve specialist techniques	*G. intestinalis* is an ACDP hazard group 2 agent	ACDP hazard group 2 agents will be able to infect humans so PPE will be needed during the remediation of the environment
Production of toxins	Does the agent produce a toxin? What is the stability of the toxin?	Toxins might persist in the environment after the destruction of the parent agent. Therefore consideration should be given to potential release of harmful toxins from the parent agent. Additionally, they may also be volatile and therefore difficult to contain Recovery options will need to be effective against the parent agent and subsequent toxins (eg mycotoxin). Seek expert advice and guidance for information on toxicology of toxic compounds Some toxins are heat resistant and may not be inactivated by processes used to inactivate microbial agents	*G. intestinalis* is suspected to produce a toxin but this has not been proven yet	N/A
Background level of agent	Are the levels of the agent within the environment before the incident known?	This level will determine the extent of the contamination and the levels that need to be achieved during decontamination. The recovery phase must return the agent's level to at least the background amount	Background levels of *G. intestinalis* oocysts have been found at ≤10 oocysts/litre in drinking water	Levels of *G. intestinalis* must be reduced to below this level, but potentially to undetectable levels

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Will the agent multiply in the environment?	Is the agent able to replicate in the environment in which it is found?	If the agent has the ability to replicate in the environment in which it is found then the level and spread of contamination could increase If the agent can replicate in the environment then the decontamination recovery options will need to be employed earlier to limit the growth and spread of the agent. This will be further dependent on the environmental conditions at the time, including the availability of water and nutrients, the relative humidity and the ambient temperature	*G. intestinalis* is a parasitic organism that needs to infect a host to multiply; this might occur in other non-human hosts	Whilst unable to multiply without a host, wild animals can act as a reservoir and therefore a source of *G intestinalis*

Step 2 Consult decision tree/diagrams for water environments

Identify potentially applicable recovery options

Consult food production systems and inhabited areas chapters (if applicable)

Table 10.18: Application of the water environments decision tree

Decision tree step	Decision	Comments
Water environments decision tree part 1		
ENTER DECISION TREE FOR DRINKING WATER		
Has drinking water been contaminated?	Yes	It has been established by sampling and epidemiological data that the drinking water supply is contaminated with *Giardia intestinalis*
High Priority for further analysis and sampling. Perform a preliminary risk assessment based on available data. (2) Restrict water use (DND/DNU notices)	Yes	The organisms found within the flood water are hazardous to human health
Is it possible that contamination of the water supply occurred after water treatment?	No	Sampling of the standing water shows high levels of *G. intestinalis*, therefore contamination must have happened before treatment
Has raw water been contaminated? Identify and initiate monitoring supplies that are of potential concern taking into account likely timescales of contamination for public and private water supply.		Monitoring of the raw water shows contamination

Decision tree step	Decision	Comments
Is there potential for existing/ additional treatment process at water treatment works/ private water supplies to reduce contamination?	Yes	Treatment unit is old and poorly maintained
Consider recovery options (9) Continuing normal water treatment (with monitoring) (10) Modification of existing water treatment (12) Water treatment at point of use (tap)		
Water environments decision tree part 2		
Is monitoring data available for drinking water supplied 'at the tap'?	Yes	Monitoring of the tap water shows *G. intestinalis* contamination
Do monitoring results in treated drinking water/ water supplied 'at the tap' indicate there is a potential health risk to consumers?	Yes	*G. intestinalis* levels measured can pose a health risk to the water users
Water environments decision tree part 3		
Consider all identified contaminated drinking water supplies		
Private water supply	Yes	The information provided shows that the water source is a private water supply

Decision tree step	Decision	Comments
Contact Local Authority. Consider the following options: (2) Restrict water use (DND/DNU notices) (3) Alternative water supply (4) Boil notice (8) Removal/ treatment of contamination source (10) Introduction/ modification of existing teatment (12) Water treatment at point of us [tap] (13) Flush distribution system (15) Natural inactivation		
Have acceptable levels been reached?	Yes	Following implementation of the recovery options further monitoring should be undertaken to ensure the recovery has been completed
Return to normality Report on incident, was Handbook effective?		

The decision tree for the water environments will guide the user to the appropriate protection options that should be implemented as soon as possible if they have not already been put in place prior to consulting the handbook. Table 10.19 below shows the protection options that have been identified.

Table 10.19: Protection options selected after Step 2

Recovery options	Retain?	Rationale
(1) Isolate and contain water supply	No	As a private source of drinking water it will already have been contained and not used by the wider public
(2) Restrict water use (DND/DNU notices)	Yes	The water is contaminated so therefore restrictions on its use need to be put in place
(3) Alternative drinking water supply	Yes	An alternative source of water needs to be introduced to provide clean, safe water for the residents
(4) Boil notices	Yes	Water can be made safe by boiling prior to use if necessary
(5) Controlled blending of drinking water supplies	No	A large volume of water would be needed to dilute the contamination to a safe level. It is preferable to introduce alternative sources
(6) Restrict access to inland, recreational or coastal (controlled) water environments	No	This option applies to open water ways
(7) Restrict transport to inland, recreational or coastal (controlled) water environments	No	This option applies to open water ways

There are seven protection options identified for the water environments. Of these, three have been deemed applicable for this incident and four are deemed inapplicable and can be discarded.

Step 3 Determine effectiveness of recovery options

A	**Eliminate options based on contamination properties**
B	**Eliminate options based on surface material and biological characteristics**

A Eliminate options based on contamination properties

During Step 3A the user will be able to remove certain recovery options based on the contaminating agents and the sub-environment contaminated, because they will not be applicable to the contaminating agent or its form. Table 10.20 shows the remediation and waste disposal recovery options that can be eliminated for this incident and the rationale behind the selection.

Table 10.20: Recovery options selected after Step 3A

Recovery options	Retain?	Rationale
Remediation options		
(8) Removal/treatment of contamination source	Yes	Source of the contamination has been identified
(9) Continuing normal water treatment (with monitoring)	No	Water treatment is currently not adequate to remove contamination
(10) Introduction/modification of existing water treatment	Yes	New/modifications to the water treatment system in place can be made
(11) Changes to the water abstraction point or location of water source	Yes	The water abstraction point can be moved
(12) Water treatment at point of use (tap)	Yes	Water treatment devices at the point of use can be made
(13) Flush distribution system	Yes	The system can be flushed through
(14) Treatment of sludge	No	No sludge is present
(15) Natural inactivation	Yes	Using the persistence database shows that *Giardia* has intermediate persistence in water (8–100 days), therefore natural degradation can be used (but further review is necessary dependent on the timescales)
Waste disposal options		
(16) Drain to temporary storage	Yes	Contaminated water could be drained
(17) Discharge off site using tankers (tankering)	Yes	Contaminated water could be collected and discharged off site

There are 10 recovery options that can be applied to this incident, excluding protection options. Of these, eight are applicable and have been taken to the next step in the decision-making process.

B Eliminate options based on surface material and biological characteristics

The selected recovery options from Step 3A will now be reviewed for their applicability based on their effectiveness for use with a private water source. Table 10.21 details the effectiveness of the options using a shaded colour system.

Table 10.21: Recovery options effectiveness

Key: Effectiveness	Up to 100% effective	Potentially effective	Limited effectiveness
	Effectiveness		
	Drinking water		
Recovery options	Public	Private	**Retain?**
(2) Restrict water use (DND/DNU notices)			Yes
(3) Alternative drinking water supply			Yes
(4) Boil notices			Yes
(8) Removal/treatment of contamination source			Yes
(10) Introduction/modification of existing water treatment			Yes
(11) Changes to water abstraction point or location of water source			Yes
(12) Water treatment at point of use (tap)			Yes
(13) Flush distribution system			Yes
(15) Natural inactivation			Yes
(16) Drain to temporary storage		N/A	No
(17) Discharge of site using tankers (tankering)		N/A	No

Reviewing the recovery options previously selected shows that there are two which are not generally appropriate for private water supplies. These limitations are explained in more detail in the recovery option sheets in Chapter 9. The remaining recovery options can be taken forward to the next step for review in greater detail.

Step 4 Review key considerations and constraints

Eliminate further options according to other considerations (public health, waste, social, technical, cost and time)

Each recovery option will have constraints that are associated with it and its implementation. The constraints take into account considerations such as public health, waste, social, technical, cost and time points. Table 10.22 shows the major and moderate considerations for the identified recovery options. If a recovery option does have a major or moderate consideration then it does not mean that the recovery option should not be used; the decision maker should review the recovery option on an incident by incident basis prior to selection or removal.

Table 10.22: Key considerations for the remaining recovery options

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
Protection options		
(2) Restrict water use (DND/DNU notices)	**Public health** – This recovery option should only be implemented if alternative water supplies are available/provided. Although existing water supplies may be suitable for sanitation purposes, convincing people that water is safe to bathe in, but not safe to drink or cook with may be difficult, ie compliance. A clear communication plan is required to ensure the water advice reaches the customers it needs to in a timely manner **Social** – Reluctance of the affected population to comply with, and adhere to, the restriction being imposed. Additionally, the social implications of providing an alternative water supply would need to be considered for this option (see above) **Cost** – May be high, considering options that will need to be implemented alongside this. For example, for alternative water supplies the following cost factors would need to be considered: vehicle hire (tankers and bowsers), consumables (fuel, bottles or containers for transporting water) and personnel (eg travelling time for drivers and, possibly, unsociable hours)	**Waste** – Providing bottled water would produce bottle plastics waste **Technical** – Ensuring the affected population are aware that restrictions are in place and that an alternative supply is available. Shortages of alternative supplies could lead to people drinking contaminated water and, if the area affected involves large numbers of people, the supplies might not meet demand.
(3) Alternative drinking water supply	**Social –** People will not want to travel too far to water distribution points. Older people and people with disabilities will require assistance in getting water to their homes. It should be noted that water companies do keep records of vulnerable customers and key users in their region, and would therefore deliver water directly to these people. However, the customer list is voluntary (ie depends on people registering themselves with their water companies), therefore these companies may need to work with local authorities to identify other vulnerable customers. Bulk buying at shops is likely to lead to shortages of bottled water supplies **Technical** – Separate individual supplies would need to be provided for hospitals, schools, office buildings and any other large premises containing large numbers of people. If bowsers are used, there is a requirement to sample the water in them every 48 hours and analyse for a full suite of contaminants or to refresh the water on a regular basis. This would involve a number of personnel and significant resources in the laboratory depending on the number of bowsers/tanks required and tankering requirements **Cost** – May be high, considering vehicle hire (tankers and bowsers), consumables (fuel, bottles or containers for transporting water) and personnel (eg travelling time for drivers and, possibly, unsociable hours)	**Public health** – Although existing water supplies may be suitable for sanitation purposes, convincing people that water is safe to bathe in, but not safe to drink or cook with, may be difficult, ie compliance. This can also have implications for lack of hygiene practices such as hand washing (as people are concerned about using the water, and they may reduce hand washing or stop altogether). The same applies to food hygiene and preparation. Clear public health messages should be given alongside any instructions about the water supply **Waste** – Providing bottled water would produce bottle plastics waste

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(4) Boil notices	**Public health** – This recovery options relies on people boiling their water effectively to inactivate the biological agent in question. There is a potential compliance issue and convincing people that water will be safe after boiling may be difficult. A clear communication plan is required to ensure water advice reaches the customers in a timely manner **Social** – Reluctance of affected population to comply with, and adhere to, the notice being imposed	**Technical** – Ensuring the affected population are aware that a boil notice is in place
Remediation options		
(8) Removal/treatment of contamination source	**Technical** – The source of contamination might be difficult to find and access	**Waste** – The process of the removal of the contamination might generate a high volume of waste. The source of contamination might be in an isolated area, making waste removal difficult **Cost** – The production of waste in an isolated area where the contamination source could occur will increase the cost of the option **Time** – The production of waste in an isolated area where the contamination source could occur will increase the time that the option will take
(10) Modification of existing water treatment	**Technical** – Infrastructure needs to be in place to support the expansion of, or changes to, water treatment works if additional treatments are required (increased frequency of operations, 'new build', space requirements for new kit, etc) **Cost** – May be high, considering infrastructure (adaption of current treatment plant or installation of a 'new build'), equipment, technology and personnel (builders and specialist engineers), timescale (could take months to years to install or build) and disposal of contaminated water (availability of suitable disposal route)	**Public health** – Changes to water treatment processes may give rise to increased exposure to water treatment operatives, either from direct exposure to contaminated water or through the accumulation and storage of contaminated waste from treatment **Waste** – There may be significant amounts of contaminated water, which may require disposal and/or storage under a waste transfer licence **Social** – Public acceptability and trust in water treatment processes to remove or reduce biological contamination. There are also issues around the acceptability of residual levels of contamination by the public and the availability of alternative supplies (ie bottled water). There is also an aspect of disruption if modifications to existing water treatment require construction (ie 'new build')

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(11) Changes to water abstraction point	**Cost** – May be high, considering infrastructure (adaption of current treatment plant or installation of a 'new build'), equipment, technology and personnel (builders and specialist engineers), timescale (could take months to years to install or build) and disposal of contaminated water (availability of suitable disposal route)	**Social** – There may be problems regarding the acceptability of any remaining contamination in water supplies; there may also be concerns over the availability of alternative supplies. Where rezoning is used, or an alternative raw water source, acceptability may be an issue as customers may not like or be used to the alternative supply (eg upland water versus lowland or hard ground water versus soft water) **Technical** – Priorities also need to be decided depending on the vulnerability of water supplies to the biological incident. Surface water supplies, such as rivers and reservoirs, are likely to be of higher priority than boreholes in the short term and this should be taken into account when formulating a monitoring strategy and identifying drinking water supplies of potential concern. In the longer term, monitoring and implementing this option may need to focus more on ground water sources, such as boreholes. The effectiveness of this measure depends on a programme of testing new abstraction points. Testing apparatus must be accurate
(12) Water treatment at point of use (tap)	**Technical** – The practicality of this option will be influenced by the availability of, and installation of, appropriate equipment	**Social** – This option relies upon individuals purchasing units, or arranging installation, as well as using them in an appropriate manner (eg not removing parts or bypassing them) **Technical** – Reverse osmosis units require specialist engineers to install them and maintain/service them – if these activities are not carried out frequently, there are water quality risks **Cost** – Depends on the size of the area affected, and may be high, considering equipment (jug filters are relatively inexpensive <£40, whereas reverse osmosis units are more expensive >£300), installation and maintenance (specialist engineers) and consumables (additional filters or pumps, if needed) **Time** – This option may take some time to implement considering the components required
(13) Flush distribution system	**Public health** – An alternative drinking water supply (and appropriate water notifications) would have to be available while the system is being flushed **Waste** – There may be significant amounts of contaminated water to be flushed through the water distribution system, which could potentially lead to the spread of low levels of contamination in the environment	**Time** – This option could take some time to implement depending on the size of the distribution system

Recovery options	Major (key) considerations for selected recovery options	Moderate considerations for selected recovery options
(15) Natural inactivation	**None**	**Social** – This option may be perceived as doing ‘nothing’ by the public, which has negative implications. However, some may argue that continuing with normal water treatment is a positive message to the public **Technical** – Monitoring equipment and skilled personnel to take samples. May take prolonged period of time for contamination to be broken down in the environment **Cost** – May be high, considering monitoring equipment, consumables, skilled personnel (including laboratory analysis) and time (natural attenuation can take months to years) **Time** – This option can take a very long time (months to years) for some biological agents

Table 10.23: Potentially applicable recovery options identified after Step 4

Recovery options	Retain?	Rationale for exclusion
Protection options		
(2) Restrict water use (DND/DNU notices)	Yes	N/A
(3) Alternative drinking water supply	Yes	N/A
(4) Boil notices	Yes	N/A
Remediation options		
(8) Removal/treatment of contamination source	No	The contamination source has been identified as the surface water, but this is too large a volume to remediate. Other recovery options selected mean this can be dropped
(10) Introduction/modification of existing water treatment	Yes	N/A
(11) Changes to the water abstraction point or location of water source	Yes	N/A
(12) Water treatment at point of use (tap)	Yes	N/A
(13) Flush distribution system	Yes	N/A
(15) Natural inactivation	No	While the contamination is known, the persistence of *Giardia* in the water distribution system means that other recovery options are necessary to remediate from the incident

After Step 4 there are seven potential recovery options which may be used to remediate the incident.

Step 5 Consult recovery option sheets

Eliminate further options following a detailed analysis of options on a site- and incident-specific basis

In this step the remaining recovery options that have been selected for consideration should be reviewed in greater detail by consulting the full recovery option sheets that are found in Chapter 9 of the handbook. The data sheets will provide detailed analysis over a wide range of important constraints. As mentioned in Step 4, this process should be completed on an incident-specific basis because not all of the constraints will apply in each situation. The remaining applicable recovery options can then be compared in Step 6.

Step 6 Compare the remaining recovery options and implement the recovery strategy

Based on Steps 1–5 select and combine options for managing each phase

This is the final step in the process of developing a recovery strategy. The ten recovery options that have been identified for dealing with this incident are listed in Table 10.24.

Table 10.24: Recovery options for use to remediate the incident

Recovery options
Protection options
(2) Restrict water use (DND/DNU notices)
(3) Alternative drinking water supply
(4) Boil notices
Remediation options
(10) Introduction/modification of existing water treatment
(11) Changes to the water abstraction point or location of water source
(12) Water treatment at point of use (tap)
(13) Flush distribution system

In this example, no waste disposal options have been identified. This is because any contaminated water will be collected from taps by the normal drainage system and treated within the sewage plant in a manner that will inactivate *Giardia* organisms.

The recovery options can be implemented, followed by monitoring of the area if necessary to ensure they have been effective. The monitoring after recovery strategy implementation will allow the decision maker to evaluate the effectiveness of the recovery and will therefore determine if further recovery options needed to be employed.

Appendix A Relevant Legislation and Regulations

The management of the recovery phase following a biological incident must be in accordance with any applicable legislation and regulations. This appendix provides details of legislation relevant to the three environments discussed within the handbook and further generic legislation which may need to be considered.

A1 Food production systems

A1.1 General food safety

The Food Safety Act 1990 provides the framework for all food legislation in England, Wales and Scotland, with The Food Safety (Northern Ireland) Order as an equivilant. The aim of the act is to set a standard of food safety which provides consumer protection and allows authorities to take action against producers who are not abiding by it.

Additionally, the General Food Law Regulations 2002 promote protection of public health by requiring that food must not be unsafe for human consumption, labelling must not be misleading, the source of foodstuffs must be traceable and unsafe foodstuffs must be removed or recalled as appropriate.

With specific relation to microbiological contamination, EU Regulation 2073/2005 details how "foodstuffs should not contain microorganisms or their toxins or metabolites in quantities that present an unacceptable risk for human health".

Further details on UK legislation relating to general food safety can be found on the Food Standards Agency website at http://www.food.gov.uk/enforcement/regulation.

A1.2 Animal by-products

Slaughterhouses, cutting plants and other meat plants produce material that is either unfit or not intended for human consumption, at which point it is defined as animal by-products (ABPs). ABPs are the entire body, part of an animal or a product of animal origin which is not intended for human consumption. For example, material may still be fit for human consumption but have no commercial value or not be intended for use on aesthetic grounds. Once material becomes ABP it cannot later revert to being a foodstuff.

There are regulations (see Table A1) that lay down strict animal and public health rules for the collection, transport, storage, handling, processing and use or disposal of all ABPs. These regulations are in place to ensure ABPs:

- do not compromise the hygienic production of meat by being inadvertently or fraudulently diverted away from the disposal route back into the food chain
- that human and animal health is protected and pathogens are not inadvertently spread
- that they are safely and suitably handled and disposed of

Animal by-products can be split into three categories and examples are given below[1].

Category 1: classed as high risk

These ABPs include carcasses and all body parts of animals suspected of being infected with transmissible spongiform encephalopathy (TSE), carcasses of wild animals suspected of being infected with a disease that humans or animals could contract and carcasses of animals used in experiments. Specified risk material (SRM) includes body parts that pose a specific disease risk (eg cows' spinal cords).

Category 2: classed as high risk

These include animals rejected from abattoirs due to having infectious diseases, unhatched poultry that has died in its shell and carcasses of animals killed for disease control purposes (unless they fall into category 1). Additionally, manure and digestive tract contents are included in this category.

Category 3: classed as low risk

These ABPs includes foodstuffs containing meat or products of animal origin no longer intended for human consumption due to commercial reasons or packaging defects. Additionally, eggs, egg by-products, hatched by-products and egg shell are included. Animal hides, skins hooves, feathers, wool horns and hair that had no signs of infectious disease at death will also fall into this category.

The full list of ABP categorisation can be found at https://www.gov.uk/animal-by-product-categories-site-approval-hygiene-and-disposal. If a site uses ABPs then it will need to be registered with the Animal and Plant Health Agency.

This categorisation will influence potential waste disposal options. Any waste falling into the above categories cannot normally be disposed of to landfill. Options for disposal include rendering, incineration, or disposal at an approved biogas or composting plant. Restrictions apply to all categories of ABPs and will need to be consulted prior to disposal.

For discharge to sewers, premises undergoing slaughtering of animals are required to have drain traps or gratings with a maximum size of 6 mm in place to collect category 1 and 2 material. If waste water is discharged to a sewer in plants processing ruminant carcases the premises should have drain traps or gratings with a maximum size of 4 mm in place.

A1.3 Animal welfare

The Animal Welfare Act 2006 was established to ensure the protection of animals from cruelty and contains general laws relating to animal welfare. Additionally, The Welfare of Farmed Animals Regulations 2007 presents a statutory requirement to protect animal welfare on farms. Farmers and other companies or individuals working with animals will be familiar with the above-mentioned requirements; however, it is important that these are still adhered to in case of an incident or emergency in which remediation involves the relocation or removal of live animals.

A1.4 Foraging, hunting and fishing

The Wildlife and Countryside Act 1981 is the primary legislation which protects animals, plants and certain habitats in the UK. This Act (and the Wildlife Order in Northern Ireland) protects wild plants and contains a list of endangered plants which may need to be considered, dependent on the nature and location of the biological incident. The Wildlife and Countryside Act also protects wild animals, one exception being game birds that are instead protected by the Game Act during the closed season. Farmed fish are protected by The Welfare of Farmed Animals Regulations (see Section A1.3), as are ducks, geese, turkeys, rabbits and other animals bred for farming purposes.

As with animal welfare, in the case of an incident or emergency which may impact wild animals, the regulations need to be adhered to, ensuring animals are protected.

Good agricultural practice should be used during all stages of crop production and preparation. There are specific codes of practice relating to hunting which ensure that animals hunted or used for hunting are fairly treated.

Table A1: Regulations and legislation relevant to food production systems in the handbook

General food safety
Food and Environment Protection Act (FEPA) 1985 (including updates)
Food Irradiation (England) (Amendment) Regulations 2010
General Food Law Regulation (EC) 178/2002
Microbiological Criteria EU Regulation No. 2073/2005 (as amended by EU Regulation No. 1441/2007)
The Contaminants in Food (England) Regulations 2013
The Contaminants in Food (Scotland) Regulations 2013
The Contaminants in Food (Wales) Regulations 2013
The Contaminants in Food (Northern Ireland) Regulations 2013
The Food Safety Act 1990
The Food Standards Act 1999
The General Food Regulations 2002
The Natural Mineral Water, Spring Water and Bottled Drinking Water (England) (Amendment) Regulations 2011
Animal by-products
Animal By-Products (Enforcement) (England) Regulations 2013
Animal By-Products (Enforcement) (Scotland) Regulations 2013
Animal By-Products (Enforcement) (Wales) Regulations 2014
Animal By-Products (Enforcement) Regulations (Northern Ireland) 2011
EU Regulation No. 1069/2009 laying down health rules as regards animal by-products and derived products not intended for human consumption
Regulation (EC) No. 1774/2002 (ABPR) made under the European Communities Act 1972

Animal welfare

Agriculture Act 1970
Agriculture (Miscellaneous Provisions) Act 1968 (c.34)
Animal Welfare Act 2006
Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999
European Directive 2008/120/EC laying down minimum standards for the protection of pigs
EU Calves Directive 91/629/EEC (Amended by 97/2/EC, 1997)
EU General Directive 98/58/EC (Amended 2003, Regulation 806/2003)
EU Laying Hens Directive 99/74/EC
Protection of Animals Act 1911
The Feed (Hygiene and Enforcement) and the Animal Feed (England) (Amendment) Regulations 2013
The Feed (Hygiene and Enforcement) and the Animal Feed (Scotland) (Amendment) Regulations 2013
The Feed (Hygiene and Enforcement) and the Animal Feed (Wales) (Amendment) Regulations 2013
The Feed (Hygiene and Enforcement) and the Animal Feed (Northern Ireland) (Amendment) Regulations 2013
The Welfare of Animals (Slaughter or Killing) Regulations 1995 (as amended) (England)
The Welfare of Animals (Slaughter or Killing) Regulations 1996 (as amended) (Northern Ireland)
The Welfare of Animals at the Time of Killing (Wales) Regulations 2014
The Welfare of Animals at the Time of Killing (Scotland) Regulations 2012
The Welfare of Animals (Transport) (England) Order 2006
The Welfare of Farmed Animals (England) (Amendment) Regulations 2010
The Welfare of Farmed Animals (Scotland) Regulations 2010
The Welfare of Farmed Animals (Wales) Regulations 2007
The Welfare of Farmed Animals (Northern Ireland) Regulations 2012

Foraging, hunting and fishing

Game Act 1831
Game (Scotland) Act 1832
Game Preservation (Amendment) Act (Northern Ireland) 2002
Salmon and Freshwater Fisheries Act 1975 (as amended)
Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003
The Wildlife (Northern Ireland) Order 1985
Water Resources Act 1991
Wildlife and Countryside Act 1981

A2 Inhabited areas

A2.1 Air

Many biological incidents can result in the contamination of air either directly or through aerosolisation of a contaminating agent. However, unless specified (eg a clean room environment) there are no regulations or guidelines determining air quality in relation to the presence of microorganisms in the UK. Therefore, a risk assessment approach will need to be undertaken to ensure that the correct protection is used during the remediation process. With respect to the recovery option chosen, there will also need to be consideration if chemicals are used as part of the remediation, as these may also require the use of respiratory protection dependent on the workplace exposure limit (WEL); these will be discussed in Section A4.

A2.2 Contaminated land

Part IIA of the Environmental Protection Act 1990 is part of primary legislation which was introduced to provide a better way to identify and remediate contaminated land. It was inserted into the Environmental Protection Act 1990 by Section 57 of the Environment Act 1995, and came into force in April 2000 in England, July 2000 in Scotland and September 2001 in Wales. It was introduced to identify and regulate the remediation of land where contamination has resulted in significant harm or the potential for significant harm to human health or the environment. In 2012 the guidance was reviewed and updated by Defra and a revised version issued.

Regulations and legislation relevant to inhabited areas is given in Table A2; legislation relating to waste which may be produced during remediation is detailed in Section A5.

A3 Water environments

A3.1 Public water supplies

The government has set legal standards for drinking water quality. Most of these standards come directly from an obligatory European Directive (EU Directive 98/83/EC) and are based on World Health Organization guidelines. A total of 48 parameters (microbiological, chemical and other indicators) are to be monitored and tested regularly in accordance with the water quality regulations[2]. The UK has adopted additional standards to ensure an extremely high quality of water. The standards are strict and generally include wide safety margins.

A3.2 Private water supplies

Private water supplies are monitored for water quality by local authorities under the private water supplies regulations (see Table A3). These regulations apply to private supplies for purely domestic purposes, or are used in commercial food production, that is to say the making, processing, preserving, preparing or marketing of food or drink (including water) or sale for human consumption. The regulations contain the same water quality standards as those for public drinking water supplies, but the frequency of monitoring and the parameters tested will vary according to how many people use the supply, its use and the volume of water used daily and is based on an assessment of the risks to the supply as determined by the relevant local authority.

Table A2: Regulations and legislation relevant to inhabited areas in the handbook

Ancient Monuments and Archaeological Areas Act 1979
Countryside and Rights of Way Act 2000
Environment Act 1995
Environmental Damage (Prevention and Remediation) (England) Regulations 2015
Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009 (as amended)
Environmental Damage (Prevention and Remediation) Regulations 2009
Environmental Impact Assessment (Agriculture) (England) Regulations 2006
Environmental Impact Assessment (Agriculture) (Scotland) Regulations 2006
Environmental Impact Assessment (Agriculture) (Wales) Regulations 2007
Environmental Impact Assessment (Agriculture) Regulations (Northern Ireland) 2007
Environmental Impact Assessment (EIA) (Agriculture) Regulations 2007
Environmental Impact Assessment (Forestry) (England and Wales) (Amendment) Regulations 2006
Environmental Impact Assessment (Forestry) (Scotland) Regulations1999
Environmental Impact Assessment (Scotland) Amendment Regulations 2009
Environmental Impact Assessment (Uncultivated Land and Semi-Natural Areas) (Scotland) Regulations 2002
Environmental Impact Assessment (Uncultivated Land and Semi-Natural Areas) (England) (Amendment) Regulations 2005
Environmental Impact Assessment (Uncultivated Land and Semi-Natural Areas) (Wales) (Amendment) Regulations 2007
European Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage (The Environmental Liability Directive)
European Directive 2009/147/EC on the conservation of wild birds (The Birds Directive)
European Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (The Habitats Directive)
Historic Monuments and Archaeological Objects (Northern Ireland) Order 1995
Natural Environment and Rural Communities Act 2006 (as amended)
The Conservation of Habitats and Species Regulations 2010 (as amended)
The Environmental Liability (Prevention and Remediation) (Amendment) Regulations (Northern Ireland) 2009
The Environmental Liability (Scotland) Regulations 2009
The Environmental Protection Act 1990 (as amended)
Wildlife and Countryside Act 1981 (as amended)

Owners and users of private water supplies need to be aware of the potential for water contamination and what can be done to reduce the risk. Private water supplies are not subject to the directions issued by the Secretary of State for Environment, Food and Rural Affairs in respect of national security or emergency planning, and any emergency arrangements are entirely dependent upon what an individual local authority might have in place. Local authorities may use powers under the Public Health Act 1936[3] to close or restrict the use of water from contaminated private sources of supply. Sections 26 and 27 of the Water (Scotland) Act 1980[4] provide local authorities in Scotland with the power to apply to the sheriff to make an order to close or restrict the use of water from a contaminated source including wells. Section 80 of the Water Industry Act 1991[5] could possibly be used to improve supplies but there is a 28-day minimum time on the notice that has to be given. Contingencies for the replacement of a private supply in the event of a biological incident need further consideration.

A3.3 *Legionella*

Regulations associated with the management and control of *Legionella* in water systems within a workplace include the Health and Safety at Work etc Act 1974, the Control of Substances Hazardous to Health (COSHH) 2002, Management of Health and Safety at Work Regulations 1999 and the Reporting of Injuries, Diseases or Dangerous Occurrences Regulations (RIDDOR) 2013. However, there are also guidance documents which can be used by employers to ensure that risks have been controlled to an acceptable level. The HSE Approved Code of Practice 2013, also known as L8, may be referred to for guidance on implementation of the regulations and is available on the HSE website.

A4 Workplace exposure limits

Although there are no workplace exposure limits (WELs) set for microorganisms, some of the chemicals used in remediation processes are subject to WELs and this will need to be considered when undertaking remediation[6]. Workplace exposure limits are published by the HSE in the UK (document EH40/2005) and are available at the following link: http://www.hse.gov.uk/pubns/books/eh40.htm. WELs are not available for a large proportion of chemicals. In such cases expert advice should be sought and a risk assessment undertaken. Secondary exposure of workers following implementation of recovery options also needs to be considered.

When dealing with hazardous substances, including microorganisms, a risk assessment must be undertaken to consider how workers may be exposed and what can be done to limit any exposure. COSHH requires that exposure must be adequately controlled to a level that will not harm people’s health. This applies not only to recovery workers but also to those who may come into contact with the biological agent, such as members of the public.

The Advisory Committee on Dangerous Pathogens provide a guidance document which can be used to aid the risk assessment process and provides information on the chain of infection, sources of infection, transmission routes and host factors, all of which need to be considered prior to the commencement of a remediation strategy[7]. The document is available at the following link http://www.hse.gov.uk/pubns/infection.pdf.

Table A3: Regulations and legislation relevant to water environments in the handbook

General regulations
Control of Major Accident Hazard Regulations 2015
Control of Pollution (Applications, Appeals and Registers) Regulations 1996 SSI 2971
Council Directive 91/27/EEC concerning urban waste water treatment
Council Directive 98/83/EC of 3 November 1998 on quality of water intended for human consumption
Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution caused by certain dangerous substances
Drainage (Northern Ireland) Order 1973 (as amended)
Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009 SSI 995 (as amended)
Environmental Damage (Prevention and Remediation) (England) Regulations 2015 SI 1810
Environmental Permitting (England and Wales) Regulations 2010 SI 675 (as amended)
Groundwater Regulations (Northern Ireland) 2009
Notification of Cooling Towers and Evaporative Condensers Regulations 1992
Public Water Supplies (Scotland) Regulations 2014 SSI 2014/364
Sewerage (Scotland) Act 1968 c. 47 (as amended)
Surface Waters and Water Resources (Miscellaneous Revocations) Regulations 2015 SI 524
The Natural Mineral Water, Spring Water and Bottled Drinking Water (England) Regulations 2007 SI 2785 (as amended)
The Private Water Supplies Regulations 2009 SI 3101
The Private Water Supplies (Wales) Regulations 2010 SI 66 (as amended)
The Private Water Supplies (Scotland) Regulations 2006 SI 209 (as amended)
The Private Water Supplies (Amendment) Regulations (Northern Ireland) 2010 SI 131
The Water Supply Regulations 2010 SI 991
The Water Supply (Water Fittings) Regulations 1999 SI1148
The Water Supply (Water Quality) Regulations (Northern Ireland) 2007 SI 147
Trade Effluent (Prescribed Processes and Substances) (Amendment) Regulations 1990 SI 1629
Urban Waste Water Treatment (England and Wales) Regulations 1994 SI 2841 (as amended)
Urban Waste Water Treatment (Scotland) Regulations 1994 SI 2842 (as amended)
Urban Waste Water Treatment Regulations (Northern Ireland) 2007 SI 187
Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) SR 2006/482 (as amended)
Water Act 2014
Water and Sewerage Services (Northern Ireland) Order 1973 (as amended)
Water (Scotland) Act 1980 (c.45) Sections 26 and 27

Water Environment (Controlled Activities) (Scotland) Regulations 2011 SSI 209 (as amended)
Water Environment (Diffuse Pollution) (Scotland) Regulations 2008 SSI 54 (as amended)
Water (Prevention of Pollution) (Code of Practice) (Scotland) Order 2005 SSI 63
Water Environment and Water Services (Scotland) Act 2003 (as modified)
Water Industry Act 1991 (as amended)
Water Industry (Scotland) Act 2002 (as modified)
Water (Northern Ireland) Order 1999 SI 662 (as amended)
Water Resources Act 1991 (Amendment) (England and Wales) Regulations SI 3104
Water Resources (Abstraction and Impounding) Regulations 2006 SI 641
Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (Wales) Regulations 2010 SI 1493
Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (England) (Amendment) Regulations 2010 SI 639
Water Resources (Environmental Impact Assessment) (England and Wales) (Amendment) Regulations 2006 SI 3124
Water Services (Scotland) Act 2005 (as amended)
Water Quality (Scotland) Regulations 2010 SSI 95 (as amended)

Emergencies

Security and Emergency Measures (Water Undertakers) Direction 2006
Security and Emergency Measures (Scottish Water) (Scotland) Directions 2002

Recreational and coastal waters

Control of Pollution Act 1974 as amended
Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy OJ L 327
Environment Act 1995 (as amended)
Environmental Damage (Prevention and Remediation) (England) Regulations 2015 SI 810
Environmental Damage (Prevention and Remediation) (Amendment) (Wales) Regulations 2015 SI 1394
Environmental Liability (Prevention and Remediation) Regulations (Northern Ireland) 2009
Environmental Liability (Scotland) Regulations 2009 SI 252
Flood and Water Management Act 2010 (as amended)
Marine and Coastal Access Act 2009 (as amended)
Quality of Bathing Water (Amendment) Regulations (Northern Ireland) 2012 SI 218
The Bathing Water Regulations 2013 SI 1675
The Bathing Waters Regulations 2013 SI 1675
Transfrontier Shipment of Waste Regulations 2007 SI 1711 (as amended)

Further documentation to be consulted includes the COSHH 2002 regulations and The Personal Protective Equipment at Work Regulations 1992. Both of these legislative documents can be used to provide information on the type of personal protective equipment (PPE) which may be used by recovery workers during the development of a risk assessment for the remediation process. As discussed in Chapter 2 of this handbook, recovery workers should be trained in any necessary PPE required prior to starting work. It is also possible that following a large-scale biological incident volunteers may act as recovery workers and hence require increased and intense training in the use of PPE.

A5 Waste categorisation and legislation in the UK

Some of the recovery options recommended in this handbook will result in the generation of waste or waste by-products (eg water run-off) due to the nature of the recovery and clean-up process.

Remediation work may generate large quantities of waste which must be managed appropriately. When dealing with waste from the recovery phase of a biological incident it is necessary to determine whether the contaminated material is hazardous or not, how it should be removed and whether it should be treated on site or off site. Hazardous waste is essentially any waste which contains hazardous properties that may render it harmful to human health or the environment. The EU Waste Frame Directive (2008/98/EC) (WFD) provides the legislative framework for the collection, transport, recovery and disposal of waste.

The regulations that govern the classification and management of waste in the UK are listed in Table A4.

A5.1 Classification of waste

A hazardous waste is defined as a waste that has one of more of the 15 specified hazardous properties listed in Annex III to the WFD. Determination of the type of hazardous waste comes from the WFD and the List of Wastes Decision (200/532/EC), also known as the European Waste Catalogue.

The Environmental Protection Act 1990 imposes a duty of care on all those who import, produce, carry, keep, treat and dispose of controlled waste. In England and Wales, the Environment Agency (EA) is the competent authority in dealing with contaminated waste. If waste is determined as hazardous the Environment Agency must be consulted for the disposal of waste.

The Northern Ireland Environment Agency (NIEA) is the competent authority for dealing with contaminated waste in Northern Ireland. Details of transfer stations within Northern Ireland that are licensed to accept hazardous waste can be obtained from NIEA.

In Scotland, the Scottish Environment Protection Agency (SEPA) is the competent authority. Contaminated waste is classified as 'special waste' and is essentially any waste with hazardous properties which may render it harmful to human health or the environment. Elsewhere in the UK and the EU, it is referred to as being 'hazardous waste'. Guidance on how to classify and assess special waste can be found in the EA technical guidance document WM3: Guidance on the classification and assessment of waste[8].

When managing hazardous waste several methods may be considered. These include:

- if necessary, temporary and safe storage of the waste
- preliminary treatment and decontamination
- preparation of waste for transport removal (ie packing appropriately)
- transportation of the waste
- disposal or other treatment

A remedial action plan is required to deal with generated waste appropriately. Initially, laboratory testing of the waste may be required to determine the level of contamination (if not known) and therefore determine how the waste should be disposed of. Knowledge of the waste characteristics determines which precautions are necessary to ensure the safety of those involved in the proper treatment and disposal of the waste.

A5.2 Transport of waste

Transport and disposal of potentially substantial volumes of hazardous waste present particular challenges. The appropriate environment agencies should be consulted for advice on the availability of suitable landfills and other possible options. The latter might include possible extension of any temporary storage arrangements already permitted.

Debris contaminated with material that in itself would be classified as dangerous in transport (eg asbestos) is subject to the transport of dangerous goods legislation whatever the mode of transport used.

Transport of material from the site must be carried out safely and securely in suitable road, rail or inland waterway transport units, particularly if contaminated material is involved. Where such material is classified as dangerous in transport, transport units specified in modal regulations must be used in accordance with any provisions applying to them. For other contaminated material, the transport must be capable of entirely containing the material to prevent any loss during transport. A dangerous goods safety adviser should be appointed to provide competent and professional advice (see https://www.gov.uk/shipping-dangerous-goods/dangerous-goods-safety-adviser).

Experience has shown that there may be a need to identify and establish an intermediate temporary site, or sites, between the site of the incident itself and the ultimate final destination(s) of debris. Such sites may be required to aid forensic investigation as well as sorting large amounts of contaminated waste. Solids should be transported in bulk transport units fitted with liners that can be closed for transport or in sift-proof receptacles.

A5.3 Disposal of waste

Several options exist for waste disposal and these must be determined upon the advice of the appropriate environment agencies. The two major options are:

- **off-site treatment and disposal:** waste is collected into containers/tanks and sent off site for disposal. The type of containers/tanks to be used and their labelling is dependent on the composition of the waste. Appropriate guidance should be provided

- **on-site management:** waste is treated, stored or disposed of on site using temporary units or corrective action management units

Management of solid and liquid waste arising from remediation

Clean-up will result in the generation of solid and liquid waste. It is imperative to manage this waste in an environmentally acceptable and responsible way to minimise the risks to health and safety of workers, the public and the environment. The management of a site during recovery will potentially produce large quantities of contaminated aqueous slurries and solid rubble. Additionally, if statutory measures are put in place to restrict food consumption, there may be large volumes of biodegradable waste crops and farm produce, including animal carcasses and milk, requiring disposal.

For solid wastes, the responsible authority – which for many emergencies will be the local authority (LA) – needs to consider an interim recovery strategy such as the temporary storage of hazardous waste at an appropriate site. This would give operators sufficient time to receive, store, treat and dispose of the waste. Throughout the procedure, the LA should be in constant communication with the relevant agencies and community to inform them about the temporary storage of this waste, the intended transportation routes and disposal locations and risks in order to maintain public confidence and cooperation.

Contaminated soils and solid residues from liquid slurries are likely to be disposed at hazardous waste landfills. Disposal arrangements would need to be discussed with the landfill operator.

Management of contaminated waste (refuse), goods and personal items

During the recovery operations there will be other significant waste generated because of the nature of the work itself, such as lightly contaminated bags holding contaminated clothing and PPE which has been used. This waste will also require appropriate decontamination or treatment/destruction (usually incineration). In principle, these wastes are similar to other hazardous substances which are commonly disposed of from hospitals and research laboratories and are therefore treated as ‘clinical waste’. Such wastes are likely to be taken to incineration plants around the UK with the appropriate permits or licences.

Management of contaminated waste water: rain and natural run-off

The UK water protocol for the disposal of contaminated water[9] provides useful guidance on dealing with incidents involving CBRN contamination of water and disposal of waste water resulting from decontamination work. Run-off water and rinse water from decontamination may contain high concentrations of chlorine if a sodium hypochlorite based solution has been used. The waste water may need to be intercepted and treated to neutralise its chlorine content since this is potentially hazardous to the environment and water treatment works. In urban areas, road drainage systems are particularly vulnerable. Storm water drains may need to be blocked or diverted to holding tanks before decontamination is carried out, in accordance with the UK guidance.

Table A4: Regulations and legislation relevant to the management and transport of waste

Classification of waste
Control of Pollution Act 1974 c.40
Control of Pollution (Amendment) Act 1989 c.14
Environmental Protection Act 1990 c.43
European Waste Catalogue (established by Commission Decision 2000/532/EC)
EU Waste Frame Directive 2008/98/EC
List of Waste (Amendment) Regulations (Northern Ireland) 2005
Planning (Hazardous substances) (Scotland) Act 1997 c.10
The Hazardous Waste (England and Wales) Regulations 2005 (as amended)
The Hazardous Waste Regulations (Northern Ireland) 2005 (as amended)
The Waste (England and Wales) Regulations 2011 (as amended)
Waste Information (Scotland) Regulations 2010 SSI 435
Waste Management Licensing (Scotland) Regulations 2011 SSI 228
Transport of waste
Control of Major Accident Hazard Regulations 2015 SI 483
Control of Major Accident Hazards (Amendment) Regulations (Northern Ireland) 2015 SR 325
Control of Substances Hazardous to Health Regulations 2002 SI 2677
Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations 1991 SI 1624
Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations (Northern Ireland) 1999 SR 362
Dangerous Substances and Explosive Atmospheres Regulations 2002
Environmental Protection (Duty of Care) (Scotland) Regulations 2014 SSI 4
EU Regulation No. 1013/2006 on Shipments of Waste
European Regulation (EC) No. 1272/2008 on classification, labelling and packaging of substances or mixtures – The CLP Regulation
European Agreement concerning the International Carriage of Dangerous Goods by Road – ADR 2015
The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 SI 1348
The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (Northern Ireland) 2010 SR 160
Transfrontier Shipment of Waste (Amendment) Regulations 2014 SI 861
Disposal of waste
Control of Pollution Act 1974 c.40
Control of Pollution (Amendment) Act 1989 c.14
Control of Pollution (Application and Registers) Regulations (Northern Ireland) 2001 SR 284

Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) (Scotland) Regulations 2003 SSI 531
Council Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture
Directive 2010/75/EU on Industrial emissions (integrated Pollution Prevention and Control)
EC Landfill Directive 1999/31/EC
EC Directive No. 2008/118/EC on the protection of groundwater against pollution and deterioration
Environment (Northern Ireland) Order 2002 SI 3153
Environmental Permitting (England and Wales) Regulations 2010 SI 675
Environmental Permitting (England and Wales) (Amendment) Regulations 2015 SI 918
Environmental Protection Act 1990 c.43
Environmental Protection (Prescribed Processes and Substances) Regulations 1991 SI 472
Industrial Pollution Control (Prescribed Processes and Substances) (Amendment) Regulations (Northern Ireland) 2003 SR 96
Groundwater Regulations (Northern Ireland) 2009 SR 254 (as amended)
Landfill (Northern Ireland) Regulations 2003 SR 496 (as amended)
Landfill (Scotland) Regulations 2003 SSI 235 (as amended)
Lifting Operations and Lifting Equipment Regulations 1998
Pollution Control and Local Government (Northern Ireland) Order 1978 DR 1049 (NI 19)
Pollution Prevention and Control (Scotland) Regulations 2012 SSI 360
Pollution Prevention and Control Act 1999 c.24 (PPCT)
Rendering (Fluid Treatment) (Northern Ireland) Order 2001SR 378
Sewerage (Scotland) Act 1968 c.47
Sludge (Use in Agriculture) Regulations 1989 SI 1263
Sludge (Use in Agriculture) Regulations (Northern Ireland) 1990 (as amended)
Special Waste Regulations 1996 SI 972
The Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations (Northern Ireland) 2003 SR 319
The Controlled Waste (England and Wales) Regulations 2012 SI 811
The Controlled Waste and Duty of Care Regulations (Northern Ireland) 2013 SR 255
Urban Waste Water Treatment (England and Wales) Regulations 1994 SI 2841
Urban Waste Water Treatment (Scotland) Regulations 1994 SI 2842 (S.144)
Urban Waste Water Treatment Regulations (Northern Ireland) 2007 SR 187
Urban Waste Water Treatment Directive 91/271/EEC
Waste (England and Wales) Regulations 2011 SI 988
Waste Regulations (Northern Ireland) 2011 SR 127

Waste Incineration (Scotland) Regulations 2003 SSI 170
Waste Incineration Regulations (Northern Ireland) 2003 SR 390
Waste Information (Scotland) Regulations 2010 SSI 435
Waste Management (England and Wales) Regulations 2006 SI 937
Waste Management Regulations (Northern Ireland) 2006 SR 280
Waste Management Regulations 1996 SI 634
Water and Sewerage Services (Northern Ireland) Order 2006 SI 1946 (N.I.21)
Water Environment and Water Services (Scotland) Act 2003 asp3
Water Industry Act 1991 c.56
Water (Northern Ireland) Order 1999 No.662 (N.I.6)
Water Resources Act 1991 c.57
Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (England) Regulations 2010 SI 639
Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (Wales) Regulations 2010 SI 1493 (W.136)
Water Services etc (Scotland) Act 2005 asp3

The water supplies and sewerage services to a particular area are provided by the local water companies, although it should be noted that in some areas two separate companies may be involved in the provision of services. Their expertise on local drainage systems and effluent interception will be very important when planning wet decontamination operations, especially to predict and avoid impacts on watercourses and drinking water supplies[9].

A6 General health, safety and welfare

In addition to those regulations which focus specifically on the area contaminated or the remediation process, it is also critical to consider the health and wellbeing of those affected by the incident, and those who may be involved in the remediation. Examples of legislation related to this are often broader and can be applied to many situations, not just a biological incident (Table A5).

Table A5: Regulations and legislation relevant to general health, safety and welfare

Control of Substances Hazardous to Health Regulations 2002
Health and Safety at Work etc Act 1974
Human Rights Act 1998
The Management of Health and Safety at Work Regulations 1999
Personal Protective Equipment at Work Regulations 1992
Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013

A7 References

1 Defra. Animal by-product categories, site approval, hygiene and disposal. 2014. Available (September 2015) at https://www.gov.uk/animal-by-product-categories-site-approval-hygiene-and-disposal

2 European Commission. The Drinking Water Directive Overview. 1998. Available (September 2015) at http://ec.europa.eu/environment/water/water-drink/legislation_en.html

3 UK Parliament. Public Health Act 1936. Available (September 2015) at www.legislation.gov.uk/ukpga/Geo5and1Edw8/26/49

4 UK Parliament. Water (Scotland) Act (1980). Available (September 2015) at http://www.legislation.gov.uk/ukpga/1980/45

5 UK Parliament. Water Industry Act 1991. Available (September 2015 at http://www.legislation.gov.uk/ukpga/1991/56/contents

6 World Health Organization. WHO Guidelines for Indoor Air Quality: Dampness and Mould. 2009. Available (September 2015) at http://www.who.int/indoorair/publications/7989289041683/en/

7 Advisory Committee on Dangerous Pathogens. Infection at work: Controlling the risks. A guide for employers and the self employed on identifying, assessing and controlling the risks of infection in the workplace. 2003. Available (September 2015) at http://www.hse.gov.uk/pubns/infection.pdf

8 Environment Agency. Technical Guidance (WM3): Guidance on the classification and assessment of waste (1st Edition). 2015. Available (September 2015) at https://www.gov.uk/government/publications/waste-classification-technical-guidance

9 Water UK. Protocol for the disposal of contaminated water and associated wastes at incidents. 2012. Available (September 2015) at http://www.water.org.uk/publications/water-industry-guidance/disposal-contaminated-water-october-2012

Appendix B Evidence Base

To develop an evidence base for the use of recovery options and to support remediation strategies presented in this handbook, three datasets have been produced:

- recovery options database
- persistence database
- disinfection database

These databases contain the results of comprehensive literature reviews. They provide a source of referenced information which can be assessed to inform the selection of recovery options.

In addition to periodic review of the handbook, the associated databases will also be continually updated when biological incidents are found or are reported, allowing this information to be reflected in the recovery option datasheets. If new information on agent persistence or disinfection efficacy is identified it will be included in the respective database.

B1 Recovery options database

As part of the development of the handbook, a recovery option database containing the recovery options presented in the handbook has been produced using information gathered from past biological incidents.

For the purposes of the handbook, the term recovery option is defined as "an action intended to reduce or avert the exposure of people and the environment to contamination[1]". The purpose of the recovery options database is to detail the effectiveness of the recovery options used in a biological incident as well as any constraints or issues that may have affected the implementation of the recovery option. This includes social, legal, technical, environmental, public health, worker exposure and time constraints. This information forms the evidence base for the handbook and is used to inform the recovery option datasheets and the decision-making framework, allowing users to select appropriate options for their unique incident. The database is searchable in a number of ways that gives users several options to filter and find the required information. The database allows for the search of biological incidents or implemented recovery options that have been identified from previous incidents.

B1.1 Collation of information

Information on recovery options previously employed has been collected in three ways: retrospective questionnaires, literature reviews and official reports.

Retrospective questionnaire

A retrospective questionnaire was made available online for those who have been involved in the management of a biological incident. The questionnaire contained a series of questions about the time and location of the incident, which environment had been affected (food production systems, inhabited areas or water environments), and the type of remediation undertaken. Responses were followed up with a short phone interview to allow expansion on the answers given.

Literature review

An extensive literature review was conducted using peer-reviewed published papers on any remediation work carried out after a biological incident or outbreak of infection.

Using search engines (PubMed[2] and Google Scholar[3]), peer-reviewed papers on remediation were found using the following key words:

'Remediation, incident recovery, outbreak of infection, decontamination'

Papers were excluded if:

- only identification and typing of the contaminating organism was discussed
- only the initial response to the incident was discussed
- the evaluation of decontamination technology used a simulated recovery scenario

Papers were included if:

- a true contamination event/outbreak or infection occurred
- at least one recovery option was mentioned/used
- the paper detailed lessons learned from the incident

Information was also gathered from other literature sources including the ProMED database[4] and the Centers for Disease Control and Prevention (CDC) Morbidity and Mortality Weekly[5].

Official reports

In the case of drinking water, water companies have an obligation to report any water quality event to the Drinking Water Inspectorate (DWI). Those that are considered significant or serious are included in the Chief Inspector's annual report. Significant or serious events as a result of microbiological contamination have been identified and the respective water companies have been contacted for further information.

B1.2 Recovery options database

Information regarding the incident and the recovery options used is entered into the database within the 'Incidents' section (Figures B1 and B2).

Once completed, the database can be used for the generation of individual incident reports, as shown in Figure B3. Furthermore, tailored reports which search the entire database for specific key terms, remediation options and effectiveness can be produced allowing several incidents to be compared.

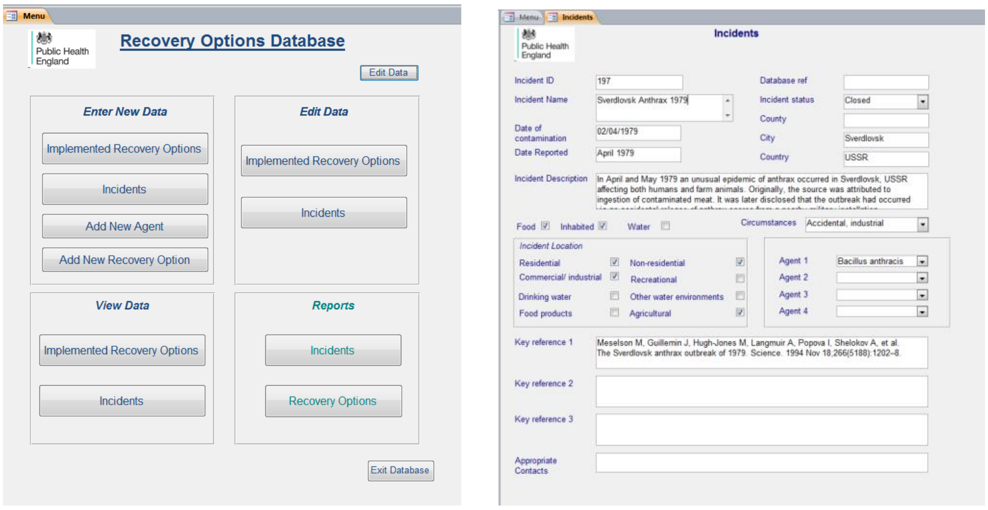

Figure B1: Entry of new incident data into the recovery options database

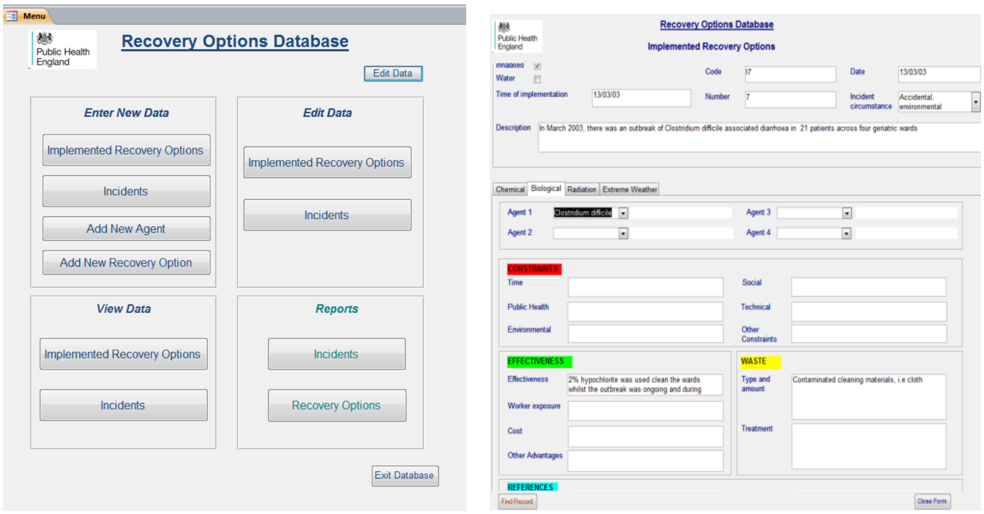

Figure B2: Entry of new recovery options data into the recovery options database

Public Health England

Recovery Options Database Incidents Report

Hepatitis A outbreak in public house, 1999, (Closed)

ID No. 219, London, , UK, contaminated 15-31/12/1998 reported 29/1/1999

Accidental, environmental

Agent	Hepatitis A	0
	0	0

Four men became ill with Hepatitis A and investigations revealed that all four cases had visited the same public house between the 15-31 December. They have no other risk factors for Hepatitis A and 6 further cases were reported. The barman at this public house had been ill with jaundice in the first weeks of January and was subsequently diagnosed with Hepatitis A

Recovery Options

Prophylaxis and vaccination

References

Sundkvist et al. 2000. Outbreak of hepatitis A spread by contaminated drinking glasses in a public house. Communicable disease and public health. 3(1):60-62

Figure B3: Example incident report generated from the recovery options database

B2 Persistence database

This database describes the environmental persistence of the agents selected in the prioritisation list. The database is designed to help users of the handbook to rapidly decide on the initial recovery options that are needed to remediate the area in the event of a biological incident. The database is separated into each environment covered by the handbook with relevant agents' persistence colour coded and defined using shading to quickly indicate the persistence range. As with the recovery options database, the persistence database will be continually updated to reflect the latest available information from the scientific literature.

Key information required by decision makers when tasked with developing a recovery strategy following a biological incident is how long the agent is likely to persist in the contaminated environment. The persistence of a biological agent may influence the remediation strategy that will form part of the evaluation of recovery options which may be implemented to return the contaminated environment (food production systems, inhabited areas or water environments) to 'normal'. The persistence database therefore allows for rapid identification and preliminary selection of relevant recovery options that could be implemented to remediate a contaminated environment. As shown in Figure B4, the database presents scientific information in an easy-to-interpret format, supplemented with links to the relevant papers to allow a more informed decision.

	Persistance in inhabited areas						
Pathogen	**Surfaces/fomites***	**s/steel (metal)**	**glass/ceramics**	**carpet**	**wood**	**plastics and/or vinyl flooring**	**soft furnishings/fabrics**
Aspergillus	>30					>30	>30
Avian influenza/ influenza	1-2	1-13	7-66		3	1-2	1-160
Bacillus spp							>3650
Clostridium spp	150	> 7					
Coxiella burnetii							
E. coli 0157	30-480	> 60	1-3		7-294		
Legionella pneumophila							
MRSA	7-210		< 2 -18		90-140	60-140	7- (>) 30
Mycobacterium tuberculosis	1 - 120			19 days	> 88		45
Norovirus	<1-19	7- >42	7->42		16-28	> 42	
Viral haemorrhagic fevers	1-5	1 - 6	1-46			1-26	

Figure B4: Part of the persistence database showing a set of results for inhabited areas

The shading indicates the persistence, with darker shading showing increased persistence. When values have been established for length of survival, these are indicated in the table

As with collation of information for the recovery options database, several sources were searched to gather data for population of the persistence database. This included an extensive literature review in which over 100 peer-reviewed publications were compared for data on the length of organism survival in different environments. The database allows individuals to see the publication associated with the value for a specific organism, thus allowing a more informed assessment to be made.

B3 Disinfection database

In addition to how long the agent will survive in the environment (persistence), it is also crucial to have an understanding of the efficacy of disinfection options against different types of microorganism. As mentioned earlier in the handbook, not all classes of disinfectant are efficacious against all microorganisms due to differences in their mode of action and also in the physiological structure of the target organism. Hence, a disinfection database has been created to show the level of resistance of each microorganism on the prioritisation list against different classes of disinfectant which may be used in a remediation strategy.

The disinfection database has been compiled following an extensive literature review using online search engines and peer-reviewed publications. Generic search terms such as ‘disinfection/decontamination with disinfectant’ were initially used. As additional agents were identified, search terms were widened to evaluate disinfection with the agent or the agents’ genus; during this process over 100 publications were reviewed for the database.

Efficacy data is included in the database if the methodology used evaluated a disinfectant by the ‘suspension assay’ test in sterile water or as dried suspension on filter paper, petri dishes, stainless steel or glass. Where the results show a range of disinfectant concentrations (ie 2–10% solutions) the results have been taken from the concentration recommended by the manufacturer and, in the absence of this data, the results have been taken from the disinfectant concentration that provides the greatest effect. The disinfection database can be read using the following key (Figure B5) and an example of the disinfection database is shown in Figure B6.

No information - Consult PHE
very effective (>4 log kill)
some effectiveness (2-4 log kill)
limited effectiveness (<2 log kill)
* contradicting data available

Figure B5: Colour scheme used in the disinfection database to indicate efficacy of disinfectants against a range of microorganisms

Decon method	Aspergillus	Bacillus spp
Vapour Hydrogen Peroxide		
Hydrogen Peroxide Vapour		
aerosolised Hydrogen Peroxide		
Chlorine dioxide		*
Ozone		*
Ethylene Oxide		
Formaldehyde		*
Dry Heat		
Boiling (liquids)		
Moist Heat		
UV		
Gamma		
FAC (i.e. Bleach)		*
Hydrogen Peroxide		*
Chlorine dioxide (aq)		*
Alcohol	*	
Ammonium compounds		

Figure B6: Example of the disinfection database which can be used to guide selection of recovery options following a biological incident

B4 Agent data sheets

One of the initial steps in the remediation process is identification of the biological agent(s) involved and determination of their characteristics which may influence the nature of the clean-up process. To allow those responding to the incident to have further information, agent data sheets have been produced for each of the identified priority agents and scenarios. As shown in the following example sheet (Figure B7), the information is divided into sections which can be used to guide the responder to the required detail.

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Agent's species	Agent's taxonomy	Further details about the agent can be determined from literature searches and consultation with experts. For example, *Clostridium difficile* *Genus*: *Clostridium*; *Species*: *difficile* The persistence of and efficacy of disinfection techniques can be determined by agent species, genus or family	*Genus*: *Species*:	
Organism form	Bacteria, bacterial spore, virus, fungi, parasite, oocyte	The form of the organism will help to determine the persistence of the agent and types of disinfection methods that are most effective for decontamination. It is possible that more than one form may be present, in which case the method of disinfection should consider the more resistant form *For example, alcohol-based solutions are very effective for disinfection of some vegetative bacteria; however, they are ineffective against bacterial spores*		
Persistence	How long will the agent survive in the environment?	How long a biological agent can persist in the environment will influence which recovery options should be considered for the remediation strategy (consult the persistence database) An additional factor that should be considered is ***'What is the environment used for?.*** This may also influence which recovery options are selected *For example, protective options (**restrict public access**) could be used if an agent has limited persistence (1–2 days) as **natural inactivation** (natural weathering) would eliminate the agent from the environment. However, this would not be appropriate for persistent agents, more active decontamination or removal options need to be considered*		
Resistance	Is the agent known to be resistant to disinfection processes or methods?	If the biological agent exhibits increased resistance to a disinfection method (eg vapour hydrogen peroxide) then alternative recovery options should be considered (consult the disinfection database) Repeating disinfection with more effective disinfection techniques may result in delays and increase costs for remediation		

Agent characteristics	Description	Interpretation	Biological agent	
			Characteristic	Interpretation
Person to person spread/route of transmission	Can the agent be spread from person to person or animal to human? How is the agent infectious? (gastrointestinal/inhalation) Is the agent zoonotic?	Further recovery options might be necessary to stop the spread of the agent from person to person The route of transmission will affect the prioritisation of recovery from the agent *For example, a scenario where an agent causes gastrointestinal upset but is not infectious through the aerosol route may lend more time to develop a recovery strategy than a scenario with highly infectious or contagious agents that would need to be dealt with as a priority*		
Prophylaxis, vaccination and treatment	Is there medical intervention available with activity against the agent?	The risk to the public and workers will be increased if there is no prophylaxis or treatment available		
Hazard group	What is the ACDP hazard group of the agent?	Agents with a hazard group of 3 or 4 are more likely to cause serious infection and pose a significant risk to public health The recovery from incidents involving hazard group 3 or 4 agents could have increased cost implications, may take longer to remediate, require appropriate levels of worker PPE, and may involve specialist techniques		
Production of toxins	Does the agent produce a toxin? What is the stability of the toxin?	Toxins might persist in the environment after the destruction of the parent agent. Therefore consideration should be given to potential release of harmful toxins from the parent agent. Additionally, they may also be volatile and therefore difficult to contain Recovery options will need to be effective against the parent agent and subsequent toxins (eg mycotoxin). Seek expert advice and guidance for information on toxicology of toxic compounds Some toxins are heat resistant and may not be inactivated by processes used to inactivate microbial agents		
Background level of agent	Are the levels of the agent within the environment before the incident known?	This level will determine the extent of the contamination and the levels that need to be achieved during decontamination. The recovery phase must return the agent's level to at least the background amount.		
Will the agent multiply in the environment?	Is the agent able to replicate in the environment in which it is found?	If the agent has the ability to replicate in the environment in which it is found then the level and spread of contamination could increase. If the agent can replicate in the environment then the decontamination recovery options will need to be employed earlier to limit the growth and spread of the agent. This will be further dependent on the environmental conditions at the time, including the availability of water and nutrients, the relative humidity and the ambient temperature		

Figure B7: Example agent data sheet

The completion of the agent data sheets was undertaken using peer-reviewed journals, published textbooks and other sources including the Public Health Agency of Canada[6] pathogen safety data sheets.

B5 Conclusion

The aim of each of the handbook components discussed in the appendix is to bring together a selection of research data to allow individuals to make an informed, evidence-based decision when selecting a remediation option following a biological incident or outbreak of infection. Systematic literature reviews have allowed collection of this data from a selection of sources, thus building a substantial database which can be readily accessed as required.

B6 References

1 Nisbet A, Watson S, Brown J. UK Recovery Handbooks for Radiation Incidents (and associated publications). PHE. 2015. Available (September 2015) at https://www.gov.uk/government/publications/uk-recovery-handbooks-for-radiation-incidents-2015

2 National Center for Biotechnology Information, US National Library of Medicine. PubMed. Available (September 2015) at http://www.ncbi.nlm.nih.gov/pubmed

3 Google Scholar. Available (September 2015) at http://scholar.google.co.uk/

4 International Society for Infectious Diseases. ProMED mail. Available (September 2015) at http://www.promedmail.org

5 Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report. Available (September 2015) at http://www.cdc.gov/mmwr

6 Public Health Canada. Pathogen Safety Data Sheets and Risk Assessment. Available (September 2015) at http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php

Appendix C Practical Application

Prior to publication of the handbook, data collected has been used in the response to flooding in the UK (winter 2013–14) and the Ebola outbreak (2014–15). This appendix describes how the handbook has been used to provide guidance in these incidences, thus demonstrating its practical application. In addition, this has allowed the decision trees and recovery options to be used and their applicability to be reviewed in a real-life situation.

C1 Flooding

Between December 2013 and February 2014, the UK was hit by severe floods, particularly in the south of the country. The flooding was due to an exceptional level of rain associated with continual winter storms. The weather over the three-month period was highly unusual with the two-month rainfall (December and January) for southeast and central southern England being the highest for any two-month period since 1910, and the overall winter rainfall being the highest in 248 years[1].

Due to the scale of the incident, spanning a wide geographical area, it was deemed that several guidance documents should be produced to allow information to be readily available to those involved, including frontline responders, local authorities and members of the public who had been affected. The information published by Public Health England included the following:

- planning, managing and recovering from a flood
- mental health following floods
- how to clean up homes safely
- questions and answers about health
- essential information for frontline responders

The document 'Guidance on Recovery from Flooding – Essential information for frontline responders'[2] was written to allow public health professionals and frontline responders to react appropriately and in a consistent manner to the flooding, but also to provide guidance on how to deal with the recovery phase including dealing with flood damage.

Section 1 of the guidance document discusses general principles for cleaning up and uses techniques and methodology which have been developed during the writing of this handbook, and allow responders to follow a set process in order to decide upon the best method for remediation. Identification of the surfaces which may have been contaminated allows for an initial cleaning strategy to be confirmed, as shown in Figure C1.

Furthermore, decision trees which allow responders to work through the scenario and arrive at a suitable recovery option were adapted from the handbook as shown in the Figure C2.

As shown in this figure, dependent on the type of contamination and the surface affected, a selection of recovery options are presented to the user. These are detailed in the subsequent pages of the guidance document with information on the process and also safety considerations. The guidance was made freely available by PHE on https://www.gov.uk, thus allowing a wide target audience to access the information readily.

What types of surfaces are there?[7]

Surface types	Examples	How can they be cleaned?
External building surfaces	Walls, roofs, windows, garages and paved areas	External building surfaces are usually quite robust, so active cleaning (ie household detergents or bleach) or pressure hosing are efficient and effective methods for cleaning.
Internal hard building surfaces	Walls, ceilings, hard floors	Internal hard building surfaces are also quite robust, so active cleaning (ie household detergents or bleach) are efficient and effective methods for cleaning.
Soft furnishings	Carpets, curtains, sofas, bedding	Soft furnishings are porous and absorbant and can be extensively damaged by floodwater, deciding on whether or not to throw them away or get them cleaned (ie steam cleaning or a hot 60°C machine wash) will have to be decided by the homeowner. Remember ask your insurer before discarding items if they cannot be cleaned (eg mattresses and carpets).
Personal (precious objects)	Photos, jewellery, books and CDs etc	Personal (precious objects) can be gently cleaned once they have dried out.
Vehicles	Cars, motocyles, bicycles	The outside of vehicles are quite robust, so active cleaning (ie household detergents or bleach) and pressure hosing are efficient and effective methods for cleaning. However, the inside of vehicles should be considered in the same way as soft furnishings.
Recreational areas	Parks and open spaces, gardens, allotments and playing fields	How soil and vegetation is remediated will depend on what it is used for. The first priority will be to remove obvious signs of contamination once the floodwater has receded. Natural weathering (and drying out) may be the most appropriate approach for recreational areas as sunlight and natural UV radiation are effective at killing micro-organisms[8].

Figure C1: Examples of cleaning strategies for different surface types following a flood

C2 Viral haemorrhagic fevers

In March 2014 the World Health Organization (WHO) confirmed Ebola cases in Guinea for first time. This turned out to be the beginning of an extensive outbreak, much larger than any previously seen with Ebola, and spreading to several countries. By August 2014, the WHO had declared the Ebola outbreak a public health emergency of international concern, with three countries in West Africa being heavily affected and a number of other countries reporting imported case(s) and/or limited local transmission.

With the ease of international travel there was the potential for individuals infected with the virus to move between countries. Additionally, many nationals from countries outside West Africa travelled to the affected areas to assist with the international relief efforts, and their health status required assessment prior to return to their home country. In August 2014 the Royal Free Hospital in London treated the first case of Ebola in a British national related to this

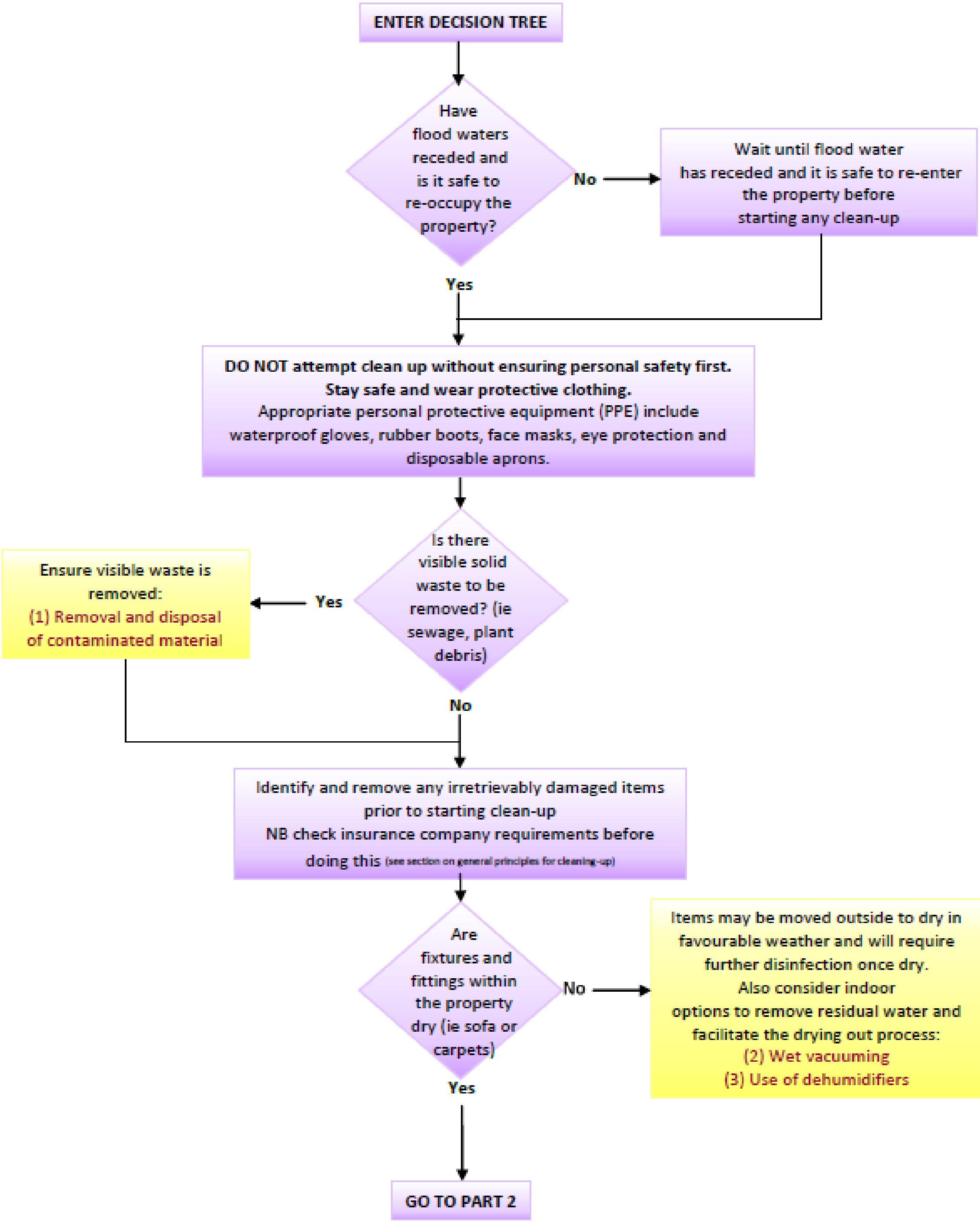

Figure C2: Decision tree for clean-up process following a flood (Part 1)

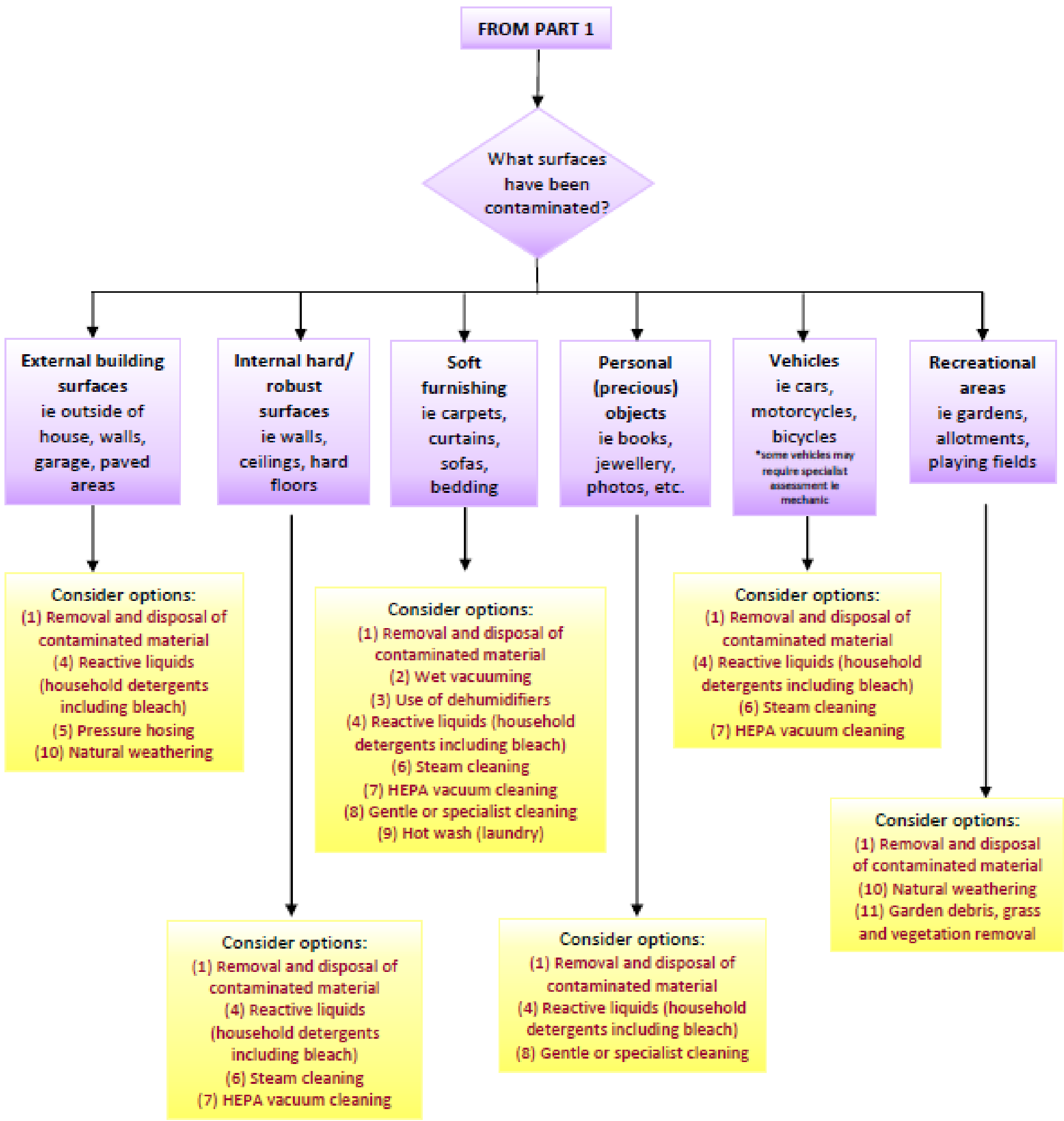

Figure C2 *(continued)*: Decision tree for clean-up process following a flood (Part 2)

outbreak. This was subsequently followed by two further cases of the disease in UK health care workers. Two of the health care workers were diagnosed with Ebola on arrival in the country; the third did not develop symptoms until after arriving home. This demonstrated the potential for an individual to return while carrying the infection and to pass through border control.

As part of the response to the outbreak, several guidance documents have been published by PHE, which are freely available on https://www.gov.uk. The guidance covers areas including, but not limited to, diagnosis, risk assessment, primary and secondary care, education and public awareness resources.

Additionally, this led to significant research to establish the efficacy of disinfectants against the Ebola virus outside the laboratory setting, with several new peer-reviewed papers being published in response to the outbreak. The document 'Environmental Cleaning and Decontamination of an Aircraft Following a Suspect Case of Ebola'[3] uses aspects of the handbook to provide an evidence base for the report. A significant amount of information based around the agent data sheets (Figure C3), persistence database and decontamination database developed for viral haemorrhagic fevers has been used in establishing recommended guidance on decontamination following an incident.

Furthermore, the additional research has allowed aspects of the handbook databases to be more extensively populated for this specific area, thus demonstrating the importance of regular review of the contents of the handbook in line with the most recent development in scientific evidence.

Important physiological characteristics of biological agents			**Agent name:** ***Ebola virus.***	
Agent characteristics	**Description**	**Interpretation**	**Characteristic**	**Interpretation**
Agent's species	The agent's taxonomy	Further details about the agent can be determined from literature searches and consultation with experts. For example *Clostridium difficile* Genus: *Clostridium* Species: *difficile* The persistence of and efficacy of disinfection techniques can be determined by agent species, genus or family.	Genus: *Filoviridae* Species: *Ebolavirus*	
Organism form	Bacteria, bacterial spore, virus, fungi, parasite, oocyte	The form of the organism will help to determine the persistence of the agent and types of disinfection methods that are most effective for decontamination. *For example, alcohol based solutions are very effective for disinfection of some vegetative bacteria; however they are ineffective against bacteria spores.*	Single stranded RNA viruses	Single stranded RNA viruses are generally susceptible to sodium hypochlorite (bleach), glutaraldehyde, formaldehyde and alcohol is also likely to have some efficacy

Figure C3: Section of the agent data sheet written for Ebola

These two examples demonstrate the applicability of the handbook in response to two very different biological incidents.

C3 References

1 Slingo J, Jenkins A et al. The Recent Storms and Floods in the UK. Met Office. Centre for Ecology and Hydrology. 2014. Available (September 2015) at http://www.metoffice.gov.uk/media/pdf/n/i/Recent_Storms_Briefing_Final_07023.pdf

2 PHE. Guidance on Recovery from Flooding: Essential Information for frontline responders. 2014. Available (September 2015) at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/348917/Guidance_on_Recovery_from_Flooding_essential_info_from_frontline_responders.pdf

3 PHE. Environmental Cleaning and Decontamination of an Aircraft Following a Suspect Case of Ebola. 2015. Available (September 2015) at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/404479/Environmental_cleaning_and_decontamination_of_an_aircraft_following_a_suspected_case_of_Ebola_v2.pdf

Appendix D Decontamination Technologies in Development

The technologies described here may be specific to a single organism species or applicable to a range of organisms, but as of yet do not have proven efficacy in the field or are lacking extensive scientific data to demonstrate they can be used effectively during recovery from a biological incident. This appendix will review a number of technologies that have not been considered for use in the main body of the handbook but show potential for use in the future, with more evidence from field trials.

D1 Emulsions

Nanoemulsions have been developed for several purposes, including the need for less toxic decontaminating agents which can be safely applied on a range of surfaces. Nanoemulsions are formed by combining oil and water to make an emulsion and passing the product through a high speed mixer resulting in a high energy state particle[1]. The nanoemulsion can then be stabilised using surfactants and can be further modified by the addition of biocidal agents[2].

Several programmes have assessed the use of nanoemulsions as a remediation strategy following a biological incident. Results have been promising, with studies showing the efficacy of the nanoemulsion against different classes of microorganisms to be high[3]. Furthermore, the addition of germinants to the nanoemulsions may promote the germination of endospores, increasing the activity of the nanoemulsion and thus providing a remediation strategy against endospore forming bacteria.

Their long shelf-life also means they can be stored and transported over prolonged periods of time. These properties of nanoemulsions make them an interesting prospect for surface decontamination following an incident.

Advantages

- disinfectant content can be modified to provide disinfection against several classes of microorganisms
- lower toxicity to humans compared to conventional technologies, resulting in a reduction in the level of PPE required during their application
- chemical stability – therefore can be stored for many months
- easily dispersed (without requirement for complex technology) so can be used in a wide range of environments
- proven efficacy over long periods
- potentially lower cost

Disadvantages

- The mechanism for the sporicidal action has not yet been defined
- may be restricted to indoor use due to potential effect of weather, eg rain will decrease the concentration and disperse the nanoemulsion

- potential for large volumes of liquid waste
- questions regarding efficacy on absorbent surfaces; studies demonstrating efficacy have been on non-porous surfaces
- difficulty of use on vertical surfaces due to a reduced contact time
- may not easily penetrate organic material

D2 Non-thermal plasma

Non-thermal plasma is still a relatively new antimicrobial process that is being developed for use in the laboratory and food production industry. Plasma is a neutral ionised gas, where the particles are in constant interaction with each other; and are composed of neutrons, electrons, photons and free radicals[4]. The non-thermal name refers to the temperature at which the plasma is generated during operation, rather than thermal plasmas that are generated using a high amount of energy and at high temperatures (>4000°C for arc plasmas), non-thermal plasmas are generated at or close to room temperature[5].

Generally, high voltage electricity or other energy inputs are used to ionise gas molecules, thereby imparting reactive properties. Non-thermal plasma is waterless, uses no antiseptic chemicals and is contact free[6]. Given the reactive nature of non-thermal plasmas, they been used for surface treatment of thermolabile materials as electronics, polymers and metals[7].

This technology has shown promise in the direct treatment of fresh and fresh-cut fruits and vegetables, as well as nuts and other foods. Therefore non-thermal plasmas could be applicable for the decontamination of food contact surfaces contaminated with human pathogens[7].

Non-thermal plasmas are also used in conjunction with other antimicrobial agents, eg hydrogen peroxide vapour is injected into small vacuum chamber where a radiofrequency signal is used to break the hydrogen peroxide molecules apart and create hydroxyl radicals[4]. This approach has been used in the medical and space industries for decontamination of equipment that can be placed within the vacuum chamber.

Advantages

- non-thermal plasmas are rapid acting due to the large number of free radicals produced
- active against a wide range of microorganisms, including bacterial endospores
- can be used for targeting ‘hot spots’ of contamination on surfaces
- may be used on thermolabile surfaces and pieces of equipment
- small items can be decontaminated using a chamber based system
- can be used for the decontamination of some more robust personal items

Disadvantages

- non-thermal plasma needs to be generated close to the surface on which it is being used and the field of use can be quite narrow
- may be time consuming to decontaminate large areas

- limited efficacy of non-thermal plasmas against biofilms
- if the technology is used within a vacuum chamber then items larger than the chamber cannot be decontaminated

D3 Phages

Bacteriophages (phages) are viruses that are specific for a bacterial species. Lytic phages will infect the bacteria, then replicate within it and finally lyse the bacterial cell to release the multiplied phages[8]. Phages bind to the bacteria by proteins that are specific to the host cell, which means they will only infect that species. Due to their specificity and antimicrobial nature they have been studied for their ability to control bacterial populations in humans, animals and the environment[9]. Phages are widely seen in the natural environment and are one of the more abundant biological entities[9].

Phages have been used in the control of spoiling and pathogenic bacteria in the food production industry, but it has been found that a high concentration was needed to reduce the bacterial load[10]. Some phage treatments have been successful enough that they have been granted US Food and Drug Administration (FDA) approval for use on ready-to-eat foods[11], but phage treatment has not been approved for use in the UK at present. They have also been shown to be effective with bacteria on surfaces when the phage is applied in high concentrations[12].

Advantages

- phage are specific to bacterial species and even specific strains, so only the targeted bacteria will be affected
- due to replication within the host bacteria phage treatment can last for a prolonged period of time as they will replicate in the environment
- the phage suspension used can contain a number of phage types so multiple bacterial strains/species can be targeted

Disadvantages

- phages will only lyse vegetative bacteria; if a bacteria is in spore form they will not be affected and will persist in the environment
- phage solutions generally need to contain a high number of phage particles to ensure success in decontamination
- if the contaminating bacteria is naturally occurring, phage treatment could remove it from that environment and allow other bacteria to take its place
- the phage can be readily inactivated by decontamination chemicals (eg sodium hypochlorite), therefore problems may arise if the area has previously been treated with a chemical
- the phage will take a different amount of time to work depending on the bacteria it is targeting. This could mean that the treatment takes an extended period of time to be completed

D3 Strippable coatings

Strippable coatings are a technology that has been investigated for use in the radiation industry since the Chernobyl accident[13]. Polymers have been developed that can be applied to surfaces as a liquid, either by pouring and then spreading over the surface or by using a spray of the liquid to deposit over the surface. The polymer is then allowed to dry and be peeled off the surface. This method has three mechanisms of action when used against radiation contamination: (a) the coating will cover the contamination and therefore stop any spread or any potential further release to the environment, (b) it will absorb the contamination thereby removing it when it is peeled away from the surface, and (c) it can remove the top layer of the surface that might have been contaminated[14].

The technology is being trialled for use in biological contamination settings[15]. It is possible to mix a biocidal agent into the polymer so when it is applied the coating will decontaminate the microorganisms with which it comes into contact. Strippable coatings can also be used to prevent contamination from contacting a surface. An uncontaminated surface can have a coating applied and therefore any contamination that would have touched that surface will land on the coating which can then be peeled and removed. This could be useful for vehicles (eg emergency) entering a contaminated area, reducing the need for stringent decontamination procedure on their exit.

Advantages

- the coating can capture the contamination and/or decontaminate the area if a biocidal agent has been added to the polymer
- it can 'seal' in the contamination so it can be remediated later
- it will harden into a solid form that will be easier to handle as waste than a liquid
- it can be applied over a wide area using a spray device
- it could be applied prophylactically to prevent contamination on other surfaces

Disadvantages

- little evidence for the use of coatings against biological agents
- the coating's efficacy can be dependent on the surface to which it is applied and environmental factors. For instance, some polymers are water based so solidify as water evaporates from them; if rain is present then the coating can become liquid again and be removed
- if loose material is present over the contamination then the coating may have difficulty penetrating/accessing under that material during decontamination or may remove the loose material exposing contamination underneath
- peeling/removal of the coating may produce aerosols, therefore spreading the contamination
- depending on the thickness of coating required to cover a surface, a large volume could be required

D4 Germinants

Bacterial endospores are more resistant to decontamination techniques than their vegetative forms. Alternative decontamination approaches are being investigated to increase the efficacy of the traditional techniques against spore-forming bacteria. Chemical agents are being explored to germinate bacterial spores and therefore expose less resistant vegetative bacterial cells to the decontamination. Examples of germinants for use against *Bacillus* species are the amino acid L-alanine and the nucleoside inosine[16–18]. The use of this technique does not lead to the inactivation of the biological organism, but is a preliminary step to be used before a decontamination technique. The use of germinants helps to reduce the need for long exposure periods and/or a high concentration of the decontaminant. The reduction in the decontamination parameters required will also potentially reduce any damage that might occur to surfaces in contact with the decontaminant, by reducing the contact time and duration[19]. This could also make the decontamination approach more environmentally friendly, eg a liquid decontaminant may be acceptable for use in an environment where it was previously prohibited because a smaller volume is necessary for the inactivation of vegetative cells in comparison to endospores.

Germinants will often be applied in a liquid form to the contaminated area, if on a surface or in a suitable substrate (eg soil), as this presentation allows better penetration and better coverage over a wider area. Powdered germinants can be added to contaminated water environments, allowed to disperse and act on the spores.

Advantages

- germinants can be used to increase the efficacy of chemical and physical decontamination techniques
- can be applied to a number of different surfaces and substrates where contamination is present
- may be applied over a large area using simple methods such as backpack sprayers

Disadvantages

- penetration of germinants can be reduced in substrates like soil
- they will need to be applied in advance of the decontamination technique to allow the spores to germinate
- costs can be increased by the need for two applications (germinants and decontaminants)

D5 Sprayer application of lactic acid solution

Acids have been used in food production systems for the fermentation of carcasses prior to their rendering[20]. Lactic acid fermentation involves the animal carcasses being ground up and some carbohydrate, protein sources and a lactic acid producing bacterium (such as *Lactobacillus acidophilus*) added to the mixture. This mixture is then kept under conditions that will allow the fermentation process, which in turn will produce lactic acid and reduce the mixture’s pH, destroying many harmful bacteria.

Lactic acid has also been used in the decontamination of meat carcasses prior to consumption, rather than disposal[21]. This method can be used in the same manner for the decontamination of carcasses before they are disposed of, whether this requires disposal on site or transport to a different site. This process allows the carcasses to be handled and moved more easily than if they were not treated, by reducing the contamination levels on their surfaces.

The carcasses are sprayed with a solution of lactic acid for a period of time then left at a predefined temperature for the acid to work. Studies have shown that the application of lactic acid solutions by spraying reduces the number of microorganisms on the exterior surfaces of the carcasses. The level of microorganism reduction varies with temperature, contact time and lactic acid concentration. Antimicrobial effect was seen with an increase in temperature of the solution, increased temperature of the meat, longer contact time and an increased lactic acid concentration[22,23].

Advantages

- quick method for a reduction in surface microbial load
- sprayer application means large numbers of carcasses can be treated
- stronger acids could be used if necessary as meat tainting would not matter
- can be applied while disposal options are considered

Disadvantages

- will reduce contamination but may not kill all microorganisms
- waste liquid run-off will need to be collected
- does not reduce any internal contamination
- contact time can be limited, a second application might be necessary
- will form part of a disposal option, not a decontamination option itself

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Appendix E Agencies Involved in Recovery

E1 Objectives of recovery

To understand how the recovery phase of an incident is dealt with, it is important to appreciate the different groups that are involved in the response and how they fit within an overarching hierarchy. The response phase is usually managed at the lowest appropriate level across multiagencies (ie police, fire and rescue and ambulance) and may also include local authorities. The immediate multiagency response to the crisis or acute phase of an incident will be coordinated by the police service, with the fire and rescue service taking responsibility for safety management within the inner cordon. The response phase may involve implementing urgent measures such as evacuation to protect individuals from short-term, relatively high risks. These measures may include restricting the spread of contamination by decontamination and transferring casualties to hospital for acute medical treatment. Equally, the recovery phase for the majority of incidents will be overseen by local authorities, with a more limited input from regional or national levels unless this is deemed necessary, depending on the scale of the incident[1].

However, irrespective of the nature and scale of the incident, there is a need to consider recovery-related issues from the outset of the incident response, even though there are no exact boundaries between these two phases. For large-scale incidents, the amount of resources required during the recovery and remediation stage may be greater and required for longer than during the initial acute response.

The information below (Figure E1) is taken directly from the ‘Strategic National Guidance: The decontamination of buildings, infrastructure and open environment exposed to chemical, biological and radiological substances or nuclear (CBRN) materials’ (4th edition, January 2015)[2].

Objectives of recovery

15. The aim of the recovery process is to rebuild, restore and rehabilitate the community following an emergency. Additionally, in the event of an incident leading to contamination, the key objectives for decontaminating buildings, infrastructure and the open environment are:

- ensuring that risks to people and to the environment are kept to a minimum;
- facilitating criminal and other investigations;
- ensuring that further contamination is avoided or kept to a minimum;
- considering what is an acceptable level of remaining residual hazard to declare the area "clean" and then setting target levels for the decontamination process accordingly;
- ensuring, where possible, the preservation of personal items of high personal value to the owner;
- ensuring that the most appropriate method of decontamination or remediation is used;
- returning buildings, infrastructure and the open environment to normality as soon as practicable;
- ensuring that waste is legally and safely disposed of;
- ensuring the co-operation and co-ordination of all site owners into the decontamination strategy and process, including agreement of payment and cost accountability;
- ensuring that effective and co-ordinated communication messages are given to the public, recognising the need during recovery for two-way communication and engagement.

Figure E1: Objectives and regional/governmental response to recovery[2]

Co-ordinating the decontamination process

16. The immediate multi-agency response to the response or emergency phase of an incident will be co-ordinated by the police. Irrespective of the nature and scale of the release, there is a need to consider recovery-related issues from the outset of the incident response.

17. Local co-ordination will be handled through a multi-agency Strategic Co-ordinating Group (SCG) set up to take strategic decisions in relation to the response to the incident and providing information to the public and media. The SCG, which will normally comprise of senior representatives from the key organisations involved, will initially be chaired by the police. The SCG will not be in operation once the handover to the recovery phase is complete. The transition from response stage to recovery, and so the change in lead authority, will be determined on a case-by-case basis.

18. The LAs in England, Wales and Scotland will normally be responsible for co-ordinating the recovery phase (usually as chair of the Recovery Co-ordinating Group (RCG))[5]. LA planning is carried out in close co-operation with the emergency services, utilities, other industrial and commercial organisations, government departments and agencies.

19. The recovery co-ordination arrangements in Northern Ireland are different and are detailed from paragraphs 104 to 114.

20. Further details about planning and recovery management are set out in the CO's National Recovery Guidance (NRG)[6], in the Preparing Scotland[7] section of the Scottish Government website and in "The Release of CBRN Substances or Material: Guidance for LAs"[8]. Decontamination work will normally take place in the recovery phase however the immediate work of containing and evaluating the extent of the contamination is likely to begin in the response phase.

5 There are two types of LA structure in England: single-tier and two-tier. Two-tier systems divide responsibility for services between county councils and district councils. In single-tier areas, one authority is responsible for all LA functions. Wales has a single tier structure of local government with 22 unitary authorities. More detail on services provided at each level can be found here: www.gov.uk/understand-how-your-council-works/typesofcouncil

6 www.gov.uk/national-recovery-guidance
7 www.readyscotland.org/ready-government/preparing-scotland
8 www.gov.uk/government/publications/the-release-of-chemical-biological-radiological-or-nuclear-cbrn-substances-or-material-guidance-for-local-authorities

Figure E1 *(continued)*: Objectives and regional/ governmental response to recovery[2]

21. Where an incident affects one building or more, significant parts of infrastructure or the open environment, the SCG may consider setting up subgroups. During the response phase of an incident the RCG should be set up to report to the SCG, so that recovery issues can be considered in detail. The RCG can set priorities for the recovery phase and for the decontamination work, and/or co-ordinate the work of specialist decontamination contractors. The Science and Technical Advice Cell (STAC) will provide strategic advice, co-ordination and assessment of health, and scientific and environmental protection issues to support the SCG and RCG. The chairs of the RCG and the STAC would normally attend, advise and report back to the SCG. The basic structure for command and control is set out in the following diagram:

22. When an incident requires national strategic co-ordination and support, the UK Government's dedicated crisis management facilities at the Cabinet Office Briefing Rooms (COBR) will be used. This group will be supported by the Scientific Advisory Group in Emergencies (SAGE). The SAGE group of scientific and technical experts is used to provide a common source of advice to inform central government's decisions on response and recovery. The document "Scientific Advisory Group for Emergencies (SAGE)"[9] was published in October 2012 and provides guidance on the role of SAGE in an emergency.

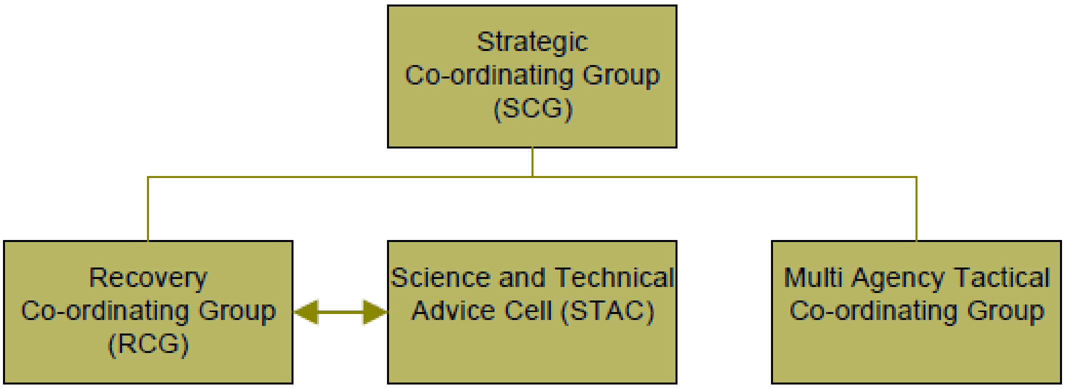

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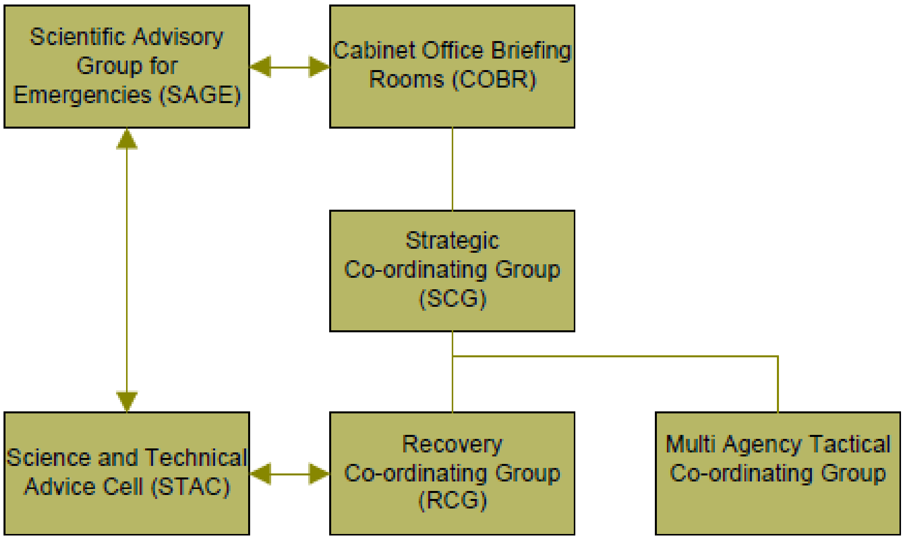
Figure E1 *(continued)*: Objectives and regional/ governmental response to recovery[2]

23. SAGE and COBR interaction with the local level in England is shown in the following diagram:[10]



24. GDS are able to give to give advice and guidance on the decontamination of buildings, infrastructure, transport assets and the open environment. As such, it is highly recommended that they be invited to attend these multi agency groups. The team can also facilitate access to the GDS Framework of specialist decontamination service providers. Further details on accessing CBRN remediation services are set out in Appendix C.

25. All contractors, whether drawn from the GDS Framework or engaged independently, will work as required within the command and control arrangements established for the incident.

10 If an incident occurs in a devolved area and is not terrorist related, the relevant devolved administration will come between COBR and the SCG on the diagram.

Figure E1 *(continued)*: Objectives and regional/ governmental response to recovery[2]

E2 Contact details of agencies involved in recovery

Public Health England

Emergency Response Department and Preparedness Duty Officer: 0207 811 7058 (in hours) 01980 612100 (out of hours)

For chemical incidents call the specialist team on 0344 892 0555

For radiation incidents call the specialist team on 01235 834590

National Poisons Information Service 0344 892 0111

Press Office (out of hours), only to be used by journalists and media: 0208 200 4400

Government Decontamination Service (GDS)

Emergency contact in relation to CBRN or major HazMat incident GDS duty officer: 0300 1000 316

Department for Environment, Food and Rural Affairs (Defra)

Duty Room contact: 0345 051 8486

Food Standards Agency (FSA)

Out of Hours Incidents contact: 0345 051 8486

Drinking Water Inspectorate (DWI)

Water quality enquiries should be directed to the relevant water company; however, the DWI can be contacted during office hours: 0300 068 6400

E3 References

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