Environment Agency

This document is out of date was withdrawn 14/03/2017

Groundwater protection: Principles and practice (GP3)

August 2013 Version 1.1

We are the Environment Agency. We protect and improve the environment and make it **a better place** for people and wildlife.

We operate at the place where environmental change has its greatest impact on people's lives. We reduce the risks to people and properties from flooding; make sure there is enough water for people and wildlife; protect and improve air, land and water quality and apply the environmental standards within which industry can operate.

Acting to reduce climate change and helping people and wildlife adapt to its consequences are at the heart of all that we do.

We cannot do this alone. We work closely with a wide range of partners including government, business, local authorities, other agencies, civil society groups and the communities we serve.

This document is out of date was withdrawn 14/03/2017

Published by:

Environment Agency
Horizon house, Deanery Road,
Bristol BS1 5AH
Email: enquiries@environment-agency.gov.uk.

© Environment Agency 2013

All rights reserved. This document may be reproduced with prior permission of the Environment Agency.

Further copies of this report are available from our publications catalogue: http://publications.environment-agency.gov.uk or our National Customer Contact Centre: T: 03708 506506

Email: enquiries@environment-agency.gov.uk.

Foreword

I am very pleased to be publishing this revised version of *Groundwater protection: Principles and practice*, which has become known as GP3.

With the growing pressure on water resources, the role of groundwater in providing secure water supplies and supporting a healthy surface water environment is becoming increasingly important. In the summer of 2012 England and Wales experienced exceptional rainfall that caused the countries to go from drought to groundwater flooding in less than four months. With future climate change, such extremities of weather are likely to become more common.

This revision of GP3 represents a significant change. We have listened to feedback and reduced the number of documents. We have amalgamated and streamlined GP3 into a single, easy to manage document. We have put everything together in one place, so that it is accessible to all. This will also make it easier for us to update it in the future.

GP3 is intended to be used by anyone interested in groundwater and in particular those wanting to undertake activities which have the potential to impact on groundwater. This document continues to set general requirements for groundwater protection, supporting the drive for better regulation. Our aim is to find the right balance for groundwater protection – a proportionate, risk-based approach that reflects the government's sustainable growth agenda and ensures that our environment is protected.

Our groundwater supports wetland and river ecosystems, provides a third of our drinking water and is estimated to be worth £8 billion. Groundwater is difficult and expensive to clean-up once polluted. We need to look after this valuable resource for future generations.

This document is out of date was withdrawn 14/03/2017

Ed Mitchell

Ed Mitchell

Director of Environment and Business

Executive summary

Groundwater is a hidden asset but a vital resource with many different roles. However, groundwater supplies in England and Wales remain under pressure from pollution and from the ever increasing demand for water. Climate change in future years is also expected to have a major impact not only on the amount of rain that supports river flows and replenishes groundwater, but also on the demand for water.

The Environment Agency is the statutory body responsible for the protection and management of groundwater resources in England and Wales[1]. We seek a consistent approach across England and Wales while recognising the need for flexibility to respond to local conditions and aiming to be a modern regulator whose work and regulation is appropriate to the risks involved.

This guidance document describes our approach to the management and protection of groundwater in England and Wales. It provides a framework within which we can work with others to manage and protect groundwater. This framework takes account of the government's sustainable development strategy and the water strategies of both Defra and the Welsh Government.

Groundwater protection: Principles and practice (GP3) is intended to be used by anyone interested in groundwater and those whose activities may impact on groundwater or could do so. It will be updated as necessary, with the latest version available on the groundwater pages of our website.

Part 1: Groundwater principles

This part of GP3 provides an introduction to groundwater for those new to the subject. It sets out the principles on which our management and protection of groundwater is based.

Groundwater is at risk from both point source pollution (for example, a leak from an oil storage tank) and diffuse pollution (for example, fertilisers leaching from land). Most point sources of pollution arise from activities we can control through permits or the pollution can be prevented by the operator following good practice. Diffuse pollution is much harder to tackle and is the most widespread cause of groundwater pollution. Our priority is prevention through the promotion of good practice and controlling the risks from diffuse sources. The Water Framework Directive provides for a range of measures to protect groundwater quality and has led to the setting up of various protected areas for groundwater such as drinking water protected areas, source protection zones and safeguard zones.

The good quality of groundwater is crucial for water-dependent plants and animals, and for the use of groundwater as a source of drinking water. Nitrate, pesticides, solvents and other pollutants can get into groundwater from surface water and soils. Some pollutants break down readily due to natural processes and some do not. Hazardous substances must be prevented from entering groundwater. The entry of non-hazardous pollutants into groundwater must be limited; though they can be discharged to groundwater under a permit they must not cause pollution.

To manage groundwater effectively, we need to balance abstraction for water supply with the needs of the environment (for example, maintaining adequate river flows). We control how much water is taken with our permitting system. We regulate existing abstraction licences and grant new ones within the framework set out by the catchment

[1] From 1 April 2013, Natural Resources Wales (Wales' single body) took over the functions carried out by the Environment Agency Wales, the Countryside Council for Wales and Forestry Commission Wales.

This document is out of date was withdrawn 14/03/2017

abstraction management strategies (CAMS) for England and Wales. Our water resources strategy considers a range of demand management and water efficiency/reuse options as well as new resource development in terms of financial and carbon cost.

Our networks of boreholes for monitoring groundwater quality and levels provide us with the vital evidence we need to shape the way we protect and manage the competing demands and impacts on groundwater. And help us assess progress.

Part 2: Position statements and legislation

Groundwater protection is long term so our aim is that the principles set out in GP3 will protect and enhance this valuable resource for future generations. The approaches set out in the position statements presented here should ensure wise resource use and bring benefits to land, wildlife, flood risk management and communities. These position statements will be of interest to developers, planners, permitting applicants, operators and anyone whose activities have a direct impact on or are affected by groundwater.

Our position statements also act as a framework to help our staff to make decisions, although still enabling them to use local information to meet flexibly the needs of the local environment and of local communities. The position statements are also intended to help planning authorities and other public bodies appreciate the importance of groundwater, the risks posed by specific activities and the measures that can be taken to mitigate those risks.

Summaries of the key European and domestic legislation under which we operate are provided to supply the context for our position statements and decision-making.

Part 3: Technical information

This part of GP3 contains information primarily of interest to groundwater specialists (hydrologists, hydrogeologists, environmental consultants and academics).

For example, details are given of the risk-based approach we use for permitted activities under the Environmental Permitting (England and Wales) Regulations (EPR) and land contamination issues. Our H1 horizontal guidance provides extensive guidance on environment risk assessment for those applying for a bespoke permit under the environmental permitting regulations (EPR). Our Remedial targets methodology (RTM) is used for land contamination.

Effective risk assessment relies on the use of tools based on sound science. We have developed a range of tools founded on risk-based regulation and conceptual modelling. Some are suitable for a quick risk-screening exercise, while others are complex and provide detailed information on the risks to groundwater.

The technical guidance also includes our interpretation of issues such as the selection of compliance points of use in land contamination risk assessment and the interpretation of the law on groundwater activity exclusions.

This document is out of date was withdrawn 14/03/2017

Contents

This document is out of date was withdrawn 14/03/2017

Introduction

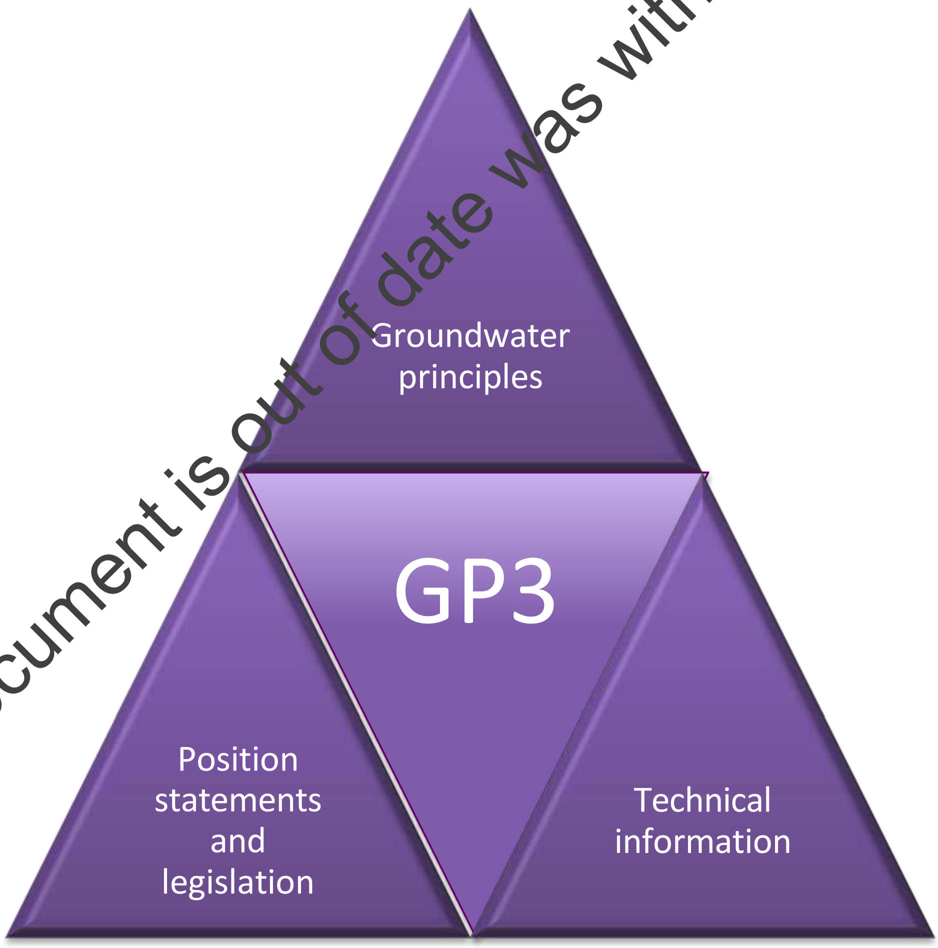
The Environment Agency is the statutory body responsible for the protection and management of groundwater resources in England and Wales. *Groundwater protection: Principles and practice* (commonly referred to as GP3) sets out:

- our aims and objectives for groundwater;
- our technical approach to its management and protection;
- our position and approach to the application of relevant legislation;
- the tools we use to do our work;
- technical guidance for groundwater specialists.

Who should read GP3?

GP3 is intended to be used by anyone interested in groundwater and particularly by those proposing or carrying out an activity that may cause groundwater impacts. You do not have to read all of GP3 – it has been designed for all level of expertise with the guidance presented in three parts (see figure), each focused on a different audience.

This document is out of date was withdrawn 14/03/2017



Structure of GP3

The five chapters forming Part 1 describing groundwater principles are aimed at a wide range of individuals ranging from members of the public to hydrogeological specialists.

The two chapters in Part 2 which present our position statements and describe the legislative framework within which we operate are aimed at anyone whose activities have a direct impact on, or are affected by, groundwater.

The sole chapter making up Part 3 brings together a range of guidance aimed at technically aware specialists and includes topics such as risk assessment.

Structure of this document

Each part starts with a diagram that illustrates the relationship between the three parts and highlights the topics to be covered. At the end of GP3 are some suggestions for further reading, references, a list of abbreviations and a glossary. Sources of practical advice and guidance are highlighted as appropriate throughout.

Part 1: Groundwater principles

Chapter 1 introduces the issues threatening groundwater and our vision for groundwater in England and Wales. To manage and protect groundwater effectively, it is necessary to understand some basic groundwater science. Key concepts are explained in Chapter 2. Chapter 3 describes how we manage groundwater issues in England and Wales and seek to protect it from pollution and over-abstraction. This includes how we monitor groundwater. Chapter 4 deals with groundwater pollution while Chapter 5 explains how to protect groundwater resources.

Part 2: Position statements and legislation

Chapter 6 sets out our approach to the implementation of government policy for groundwater in a series of position statements. Chapter 7 summarises the relevant legislation.

Part 3: Technical information

Chapter 8 sets out our approach to risk assessment – crucial to the cost-effective protection of groundwater and indicates the groundwater tools such as maps, software and numerical analysis we use to support our management and protection of groundwater.

In addition the chapter presents our interpretation within the legislative framework under which we operate of the following technical issues:

- Assessing geological formations permanently unsuitable for other purposes. This section will be used by us and others to assess whether or not an activity (such as shale gas extraction, oil industry, mining and quarrying, civil engineering works, and pump and treat) can take place and how to go about confirming this decision.
- Interpreting 'direct input' into groundwater. This section describes what makes an input 'direct' or 'indirect' and will be of interest to our groundwater and contaminated land teams, those applying for a permit under the Environmental Permitting Regulations (EPR), landfill operators and so on.
- Assessing the 'discernibility' of hazardous substances from discharges into groundwater. This section presents information on hazardous substances and how we assess discernibility.
- Interpreting groundwater activity exclusions. We can decide that an activity is such low risk that it can be excluded from control under EPR, that is, there is no need to register or to have a permit. This section describes possible exclusions under EPR, the basis for our determinations and how we record our decisions.

This document is out of date was withdrawn 14/03/2017

- Selecting compliance points for use in land contamination risk assessments. This important supplement to our guidance on contaminated land and groundwater is expected to be widely used by our groundwater and contaminated land teams and externally by hydrogeological consultants and interested parties.

Interpreting the landfill location position statement is now a part of section E. Landfill

How to use this document

GP3 is intended to be read on-screen as it contains a large number of hyperlinks to other sections within the guidance, and to external documents and websites.

If you have followed a link to another point in the document and wish to return to your previous location, hold down the **ALT key and press the left arrow** on your keyboard.

As well as the short table of contents at the beginning of the document there is a more detailed contents list at the end of this introduction. There is a link at the bottom of each page that brings you back to this detailed table of contents. In addition each chapter begins with a list of its topics with links to each section.

Updating of this guidance

GP3 will be updated and revised as necessary. Please check our website to make sure you are reading the latest version.

You can contact us by email at groundwater.enquiries@environment-agency.gov.uk for further information on GP3.

This document is out of date was withdrawn 14/03/2017

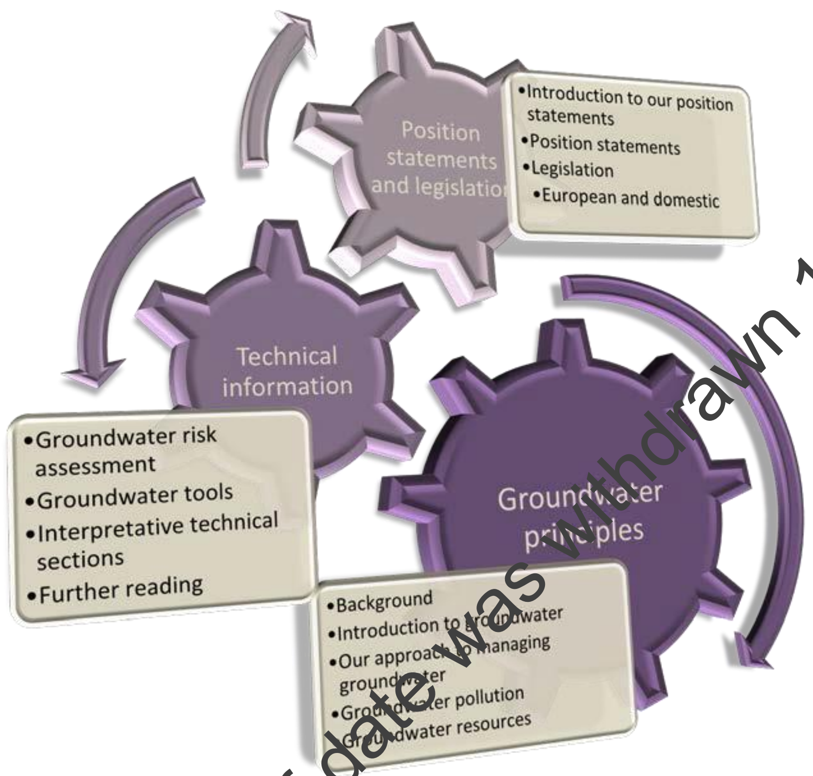
Detailed table of contents

This document is out of date was withdrawn 14/03/2017

This document is out of date was withdrawn 14/03/2017

This document is out of date was withdrawn 14/03/2017

Part 1: Groundwater principles



This document is out of date was withdrawn 14/03/2017

1 Groundwater – underground, under threat

This chapter explains the importance of groundwater and outlines our approach to managing and protecting groundwater in England and Wales.

Topics

This document is out of date was withdrawn 14/03/2017

Why do we need to protect groundwater?

Groundwater is a vital resource. It supplies about one third of mains drinking water in England and up to 10 per cent in Wales. It also supports numerous private supplies. Groundwater has many benefits:

- It provides water that needs little treatment before it can be consumed.
- It provides water for rivers, wetlands and water supplies. All rivers are partly fed by groundwater. Some rivers and wetlands depend on it completely.
- It provides essential water for industry and agriculture.

However, groundwater is a hidden asset, out of sight and all too often out of mind.

The overlying layers of soil and rock mean that groundwater is often relatively well protected from pollution compared with surface water, however, once polluted it can be difficult and expensive to clean up. Water passing through these layers is naturally filtered and many pollutants are degraded during the slow passage to the water table. This helps to maintain the relatively good quality of groundwater.

Protecting groundwater is essential. Any material spilt on or applied to the ground has the potential to reach the water table. Whether it will or not depends on the material involved and the ground conditions at that site. Pollutants introduced by people can overwhelm the natural capacity of the ground to deal with them.

Threats to groundwater

Groundwater supplies in England and Wales are under pressure from pollution and from the ever greater demand for water from an increasing population – all against the background of the threat posed by climate change and its likely effects (including drought).

Groundwater can be contaminated by a wide range of naturally occurring substances as well as by human activities. Pollution only occurs when contamination arising from human activities (by substances or heat) actually harms ecosystems, human health, material property, amenities or other legitimate uses of the environment. Not only is groundwater vulnerable to contamination it is also difficult to clean up.

Over abstraction of groundwater depletes this valuable resource, so we might not be able to rely on it in the future. Many rivers and wildlife also depend on groundwater and may be harmed or lost if groundwater levels become too low.

If too much groundwater is abstracted it may not be replenished by rainfall. This can cause springs and shallow wells to dry up and impact wetlands that depend on groundwater. The flow in rivers may also diminish or cease. Saline or poor quality water can be drawn in from the sea or from deeper in the aquifer and contaminate the groundwater.

Mining, quarrying and civil engineering can also increase the risks to groundwater by removing aquifer material or the overlying protective cover of soil and rock. This can cause changes in groundwater flow and increase the risk from pollution and flooding.

Our vision for groundwater

Our vision for the environment and a sustainable future is a healthy, rich and diverse environment in England and Wales for present and future generations. Clean and sustainable groundwater resources will play a crucial role in achieving this vision.

We aim to prevent damage to groundwater in the first place rather than having to restore it later. In the long term, this is both more cost-effective and better for the environment.

We wish to exert real influence on the problems and threats faced by groundwater in England and Wales. To do this it is important that we are flexible enough to respond to actual situations and able to work with others to achieve our aims.

Our strategy for the future seeks to create a better place for people and wildlife. To achieve this we will:

- act to reduce climate change and its consequences;
- protect and improve water, land and air;
- work with people and communities to create better places;
- work with businesses and other organisations to use resources wisely;
- be the best we can.

These key areas are set out in our corporate strategy, *Creating a better place 2010–2015*, which develops our long-terms goals for the future set out under nine themes.

This is our strategy for 2010 to 2015. It sets out how we – working with others – will bring pace and ingenuity to the challenge of a changing environment.

Our role

We are the statutory body responsible for the protection and management of groundwater resources in England and Wales. To carry out our statutory responsibilities and to meet our aims we need to explain clearly how we believe groundwater should be managed and protected. To put this into practice we need to

This document is out of date was withdrawn 14/03/2017

work with others such as developers, planners, other agencies and those working in industry and agriculture. GP3 provides a framework for this.

We are keen to develop agreements that will give operators on-going support and at the same time give us the assurance that they carry out their activities and decommissioning with minimal risk to the environment using, where possible, Best practicable environmental options.

As part of our regulatory role we issue environmental permits and have enforcement powers. Their main purpose is to prevent harm to protect groundwater. Wherever possible, our decisions and actions relate directly to the likely risks, costs and benefits. We aim to be a modern regulator and as such we must show that our work and regulation is appropriate to the risks involved.

Our position statements focus on where we need to clarify regulatory requirements or explain how we use our discretionary powers. They also describe how we wish to work with others to achieve our aims for the environment where legislation is not in place or direct regulation is not appropriate.

In outlining our approach to groundwater protection, we offer advice and guidance on how to respond to risk in most circumstances rather than a single way of doing things. We seek a consistent approach to groundwater management and protection, but recognise the need for flexibility to respond to local conditions. The principles in GP3 may need to be adapted to local conditions and to take into account the needs of the wider environment. Any deviations from our advice and guidance, which should be the exception rather than the rule, should be clearly explained.

Purpose of this document

This document brings together our understanding of groundwater, our management framework, our positions on key topics, information on legislation, our approach to risk assessment and the tools used to assess risks in a single place. The guidance it contains is intended to:

- help readers to understand the importance of groundwater and what you need to do to protect this hidden resource;
- encourage readers to act responsibly and improve practices to prevent or mitigate impacts on groundwater;
- ensure we use our statutory powers in a consistent and transparent manner;
- encourage co-operation between ourselves and other bodies with statutory responsibilities for the protection of groundwater such as national and local government, water companies, Natural England and the Countryside Council for Wales;
- help land-users and potential developers anticipate how we are likely to respond to a proposal or activity;
- influence the decisions of other organisations on issues we are concerned about but which we do not regulate;
- ensure that groundwater protection and management are consistent with our corporate strategy;
- provide vital information and background on groundwater protection in England and Wales.

This document is out of date was withdrawn 14/03/2017

History of GP3

The first UK groundwater guidance document was produced in 1992 in response to concerns about the deterioration in the quality of groundwater (Policy and practice for the protection of groundwater (PPPG), NRA 1992). At the time there was only limited legislation to control the many activities that threaten groundwater. The document had a major influence on regulators and other interested parties, and provided a focus for developments such as source protection zones and groundwater vulnerability maps.

We first published the guidance known as GP3 in 2006. By then there had been substantial changes in legislation culminating in the Water Framework Directive (2000/60/EC) and the Water Act 2003. 2006 also saw the publication of *The State of Groundwater in England and Wales*, which looked at the condition of groundwater at that time and highlighted the challenges faced and the changes that the Water Framework Directive would make necessary (Environment Agency 2006a). Parts 1 to 3 of GP3 contained our high level policy, the technical background to our work and an introduction to the tools we use. They were joined in 2008 by Part 4 which contained information on legislation and detailed statements on the positions we took in our dealings with those we regulate and wish to influence.

A major legislative development in England and Wales since the previous version of GP3 was the introduction of the second phase of the environmental permitting regime in 2010 when The Environmental Permitting (England and Wales) Regulations (EPR) replaced The Groundwater Regulations (1999, 2009). This new regime includes controls to protect groundwater quality by preventing inputs of hazardous substances and limiting pollution from non-hazardous pollutants under the Water Framework Directive (WFD) and the Groundwater Daughter Directive (GWDD).

This new version of GP3 updates and brings together Parts 1–3 published in 2006 together with a revised version of Part 4 (consulted on in 2011) which details the requirements of EPR in relation to groundwater and our interpretation of these requirements. New additional technical guidance has also added to provide clarity and to help us make clear and consistent decisions when protecting groundwater.

GP3 will continue to be updated and revised as necessary, with the latest version made available on our website.

Other complementary strategies

GP3 has been developed in the context of water resources in general and is not intended to be used in isolation. Examples of key related documents include:

- Securing the Future – the government's sustainable development strategy published in 2005;
- Water for Life – government White Paper published in 2011 setting out Defra's vision for future water management in England;
- Strategic Policy Position Statement on Water 2011 – the Welsh Government's strategic direction for water policy in Wales;
- Water resources strategy for England and Wales – how we believe water resources should be managed to 2050 and beyond to ensure integrated planning and enough water for people and the environment;
- Chemicals – our approach focuses on chemicals that may directly affect the environment or human health via environmental exposure.

Return to detailed contents

This document is out of date was withdrawn 14/03/2017

2 What is groundwater?

This chapter deals with groundwater basics and is intended for those new to groundwater.

Topics

This document is out of date was withdrawn 14/03/2017

Groundwater as an essential resource

Groundwater forms the largest available store of fresh water in England and Wales – in fact there is far more groundwater than there is fresh surface water. However, the proportion of drinking water supplied by groundwater varies regionally. Over lowland England, where the pressures on land use are greatest, half our supplies come from groundwater; this rises to more than 70 per cent in the south-east. In rural areas, groundwater may be the only viable water source for isolated properties.

Three-quarters of all the groundwater pumped from boreholes or taken from springs is used for public water supply. Of the remainder, in addition to private domestic use, many hospitals, farms, bottling and food processing plants rely on their own groundwater supplies, as do major manufacturing and other industries. Compared to surface water, groundwater is of relatively high quality and usually requires less treatment prior to use – even for use as drinking (potable) water.

Where does groundwater come from?

Groundwater comes mostly from rainfall or snow (precipitation) that has filtered down through the ground and is an integral part of the water cycle (also known as the hydrological cycle (Figure 2.1) :

- **Precipitation** – water falls as rain or snow onto the land;
- **Run-off** – excess precipitation flows over land to rivers, lakes and the sea;
- **Evapotranspiration** – some is lost back to the atmosphere;
- **Plant uptake and soil moisture** – some is taken up by plants and the soil;
- **Infiltration** – the remainder soaks into the ground and replenishes groundwater;
- **Groundwater recharge** – typically approximately one-third of precipitation (although this varies over the year and depends on the local geology).

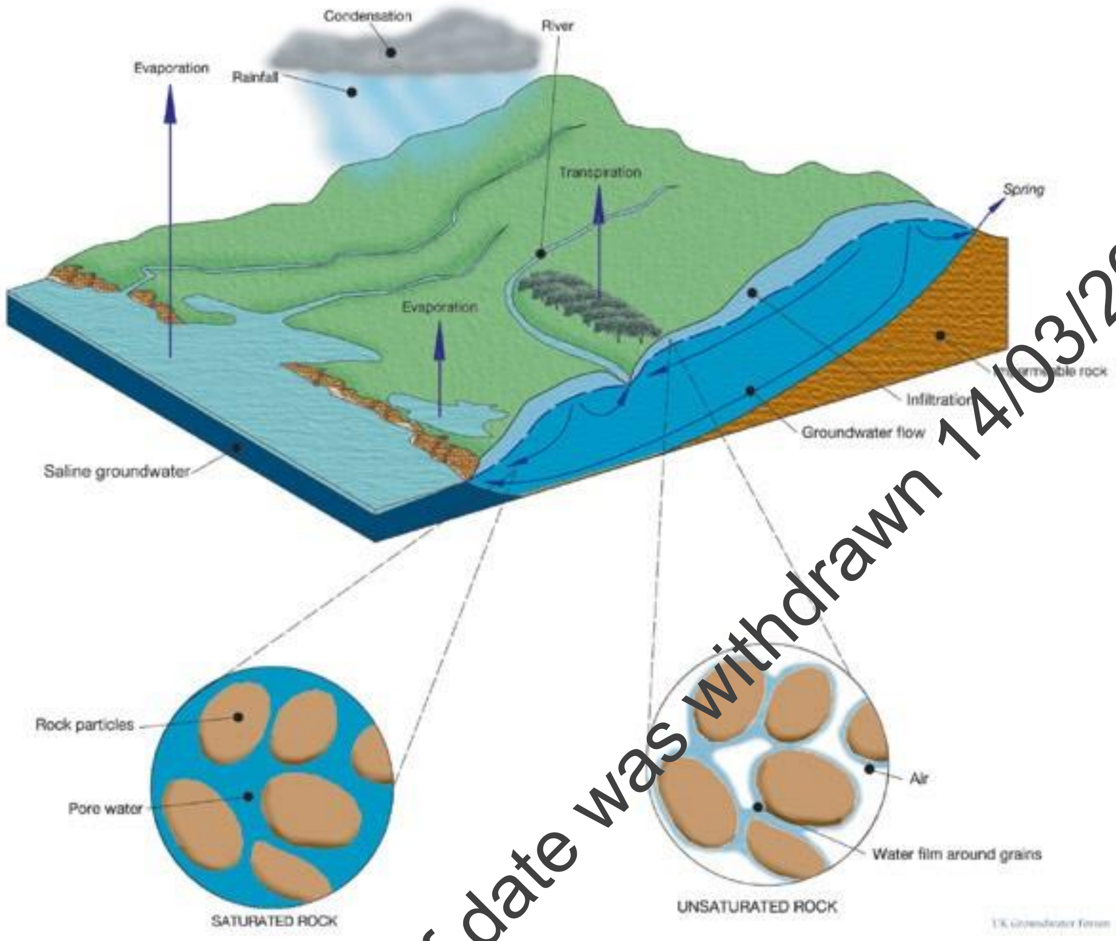


Figure 2.1 Groundwater in the hydrological cycle (UK Groundwater Forum)

The ground above the water table is called the unsaturated zone (Figure 2.2). In this zone some water can be held in storage around soil particles, some flows into drains and into surface water, and some is taken up by plants. The remaining infiltration, known as recharge, eventually reaches the water table and becomes groundwater. There can be a considerable time lag between the fall of rain and recharge to groundwater. Below the water table in the saturated zone, water fills all the fissures and pores. Compared to the rest of the water cycle, the 'residence' time for groundwater can be many thousands of years – this helps to filter and purify it.

Groundwater also discharges into surface waters. Here it supports river flows and maintains ecosystems (such as a wetland). Groundwater is the primary source of water for rivers and lakes in summer or at times of drought, making it vital to wildlife. If groundwater is abstracted or diverted, this can affect river flow and surface water levels (and consequently the associated habitats and ecology).

River water can also flow into the ground, for example through swallow holes in areas of for example limestone rocks. It then becomes groundwater. If the river water is of poor quality, this can pollute the groundwater. We sometimes see the effects of this in groundwater abstracted far from the original river. This underlines the need to manage surface water and groundwater in an integrated way as they are part of the same water cycle.

This document is out of date was withdrawn 14/03/2017

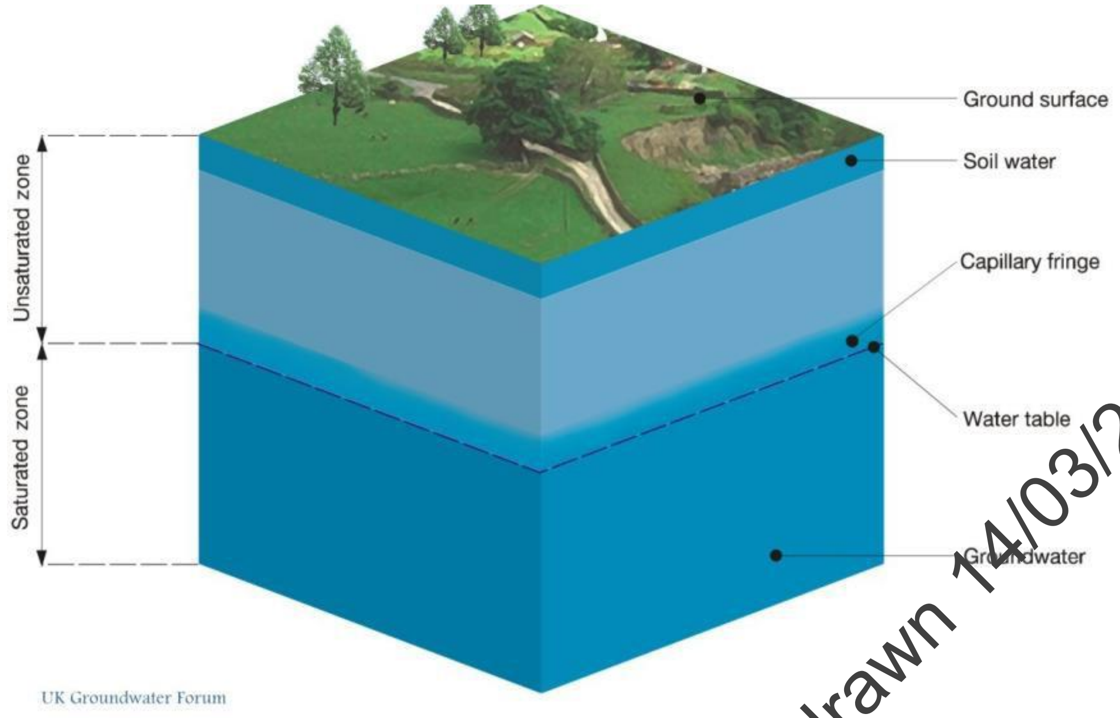


Figure 2.2 Profile of subsurface water (UK Groundwater Forum)

Where is groundwater found?

Groundwater is water stored below the water table in rocks or other geological strata which we call aquifers. Groundwater in aquifers can be exploited via boreholes, wells or springs, or it can support other ecosystems such as rivers and wetlands.

We divide our aquifers into four types based on their geology and the amount and ease with which we can take water from them and the degree to which they support river flows and habitats (Table 2.1).

Table 2.1 Types of aquifer

Type	Description
Principal aquifers	These provide significant quantities of water for people and may also sustain rivers, lakes and wetlands. Formerly referred to as ‘major aquifers’.
Secondary aquifers	These can provide modest amounts of water, but the nature of the rock or the aquifer’s structure limits their use. They remain important for rivers, wetlands and lakes and private water supplies in rural areas. Formerly referred to as ‘minor aquifers.’ Secondary aquifers are subdivided into two types: • **Secondary A –** permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. • **Secondary B –** predominantly lower permeability layers that may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons

This document is out of date was withdrawn 14/03/2017

Type	Description
	and weathering.
Secondary undifferentiated	This designation has been assigned in cases where it has not been possible to attribute either category Secondary A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both 'minor' and 'non-aquifer' in different locations due to the variable characteristics of the rock type.
Unproductive strata	These are rocks that are generally unable to provide usable water supplies and are unlikely to have surface water and wetland ecosystems dependent upon them. Formerly referred to as 'non-aquifers.'

Interactive aquifer maps are available in the 'Groundwater' section of the 'What's in your backyard' pages of our website.

Unconfined and confined aquifers

An aquifer can be unconfined or confined, or can be a mixture of both:

- In an unconfined aquifer the upper surface (water table) is open to the atmosphere through permeable overlying material.
- A confined aquifer is overlain by a low permeability material (for example, clay) that does not transmit water in any appreciable amount.

Figure 2.3 illustrates unconfined and confined aquifers.

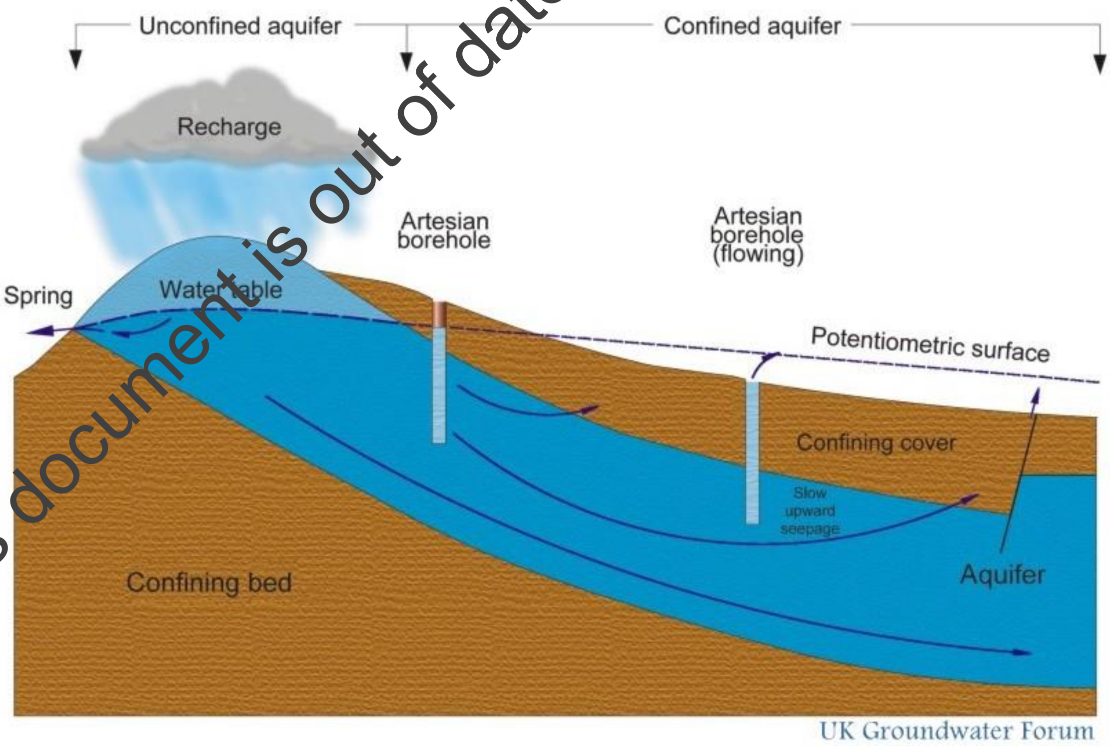


Figure 2.3 Unconfined and confined aquifers (UK Groundwater Forum)

This document is out of date was withdrawn 14/03/2017

How does groundwater flow?

Gravity is the main force behind groundwater flow. However, there is a common misperception that groundwater flows in large subterranean channels, such as in the cave systems within the limestone rocks. In fact, such channels are the exception rather than the rule. Groundwater flows mostly through the interconnected voids in rock. These may be the pore spaces between the grains in a rock, or cracks and fissures. The total volume of the pore space is known as the porosity. This represents the total volume of water that the rock can store. For the rock to be permeable, the void spaces must be interconnected, so that water can flow between them.

Intergranular and fissure flow

Groundwater can flow in different ways depending on the type and structure of the rock. The rate of groundwater flow, from springs or into boreholes, depends partly on the type of rock making up the aquifer. Flows can range from very slow out of sandy clay, for example, to thousands of cubic metres a day from some limestone aquifers. For more information on groundwater flow see Box 2.1.

Intergranular flow occurs when water moves between the grains in rock, for example in sand or sandstone. This is usually fairly slow. However, in limestone, cemented sandstones and many 'hard' rocks such as granites, most flow is along cracks and fissures. This is called fissure flow and is usually significantly faster than intergranular flow. Figure 2.4 illustrates the difference between intergranular and fissure flows.

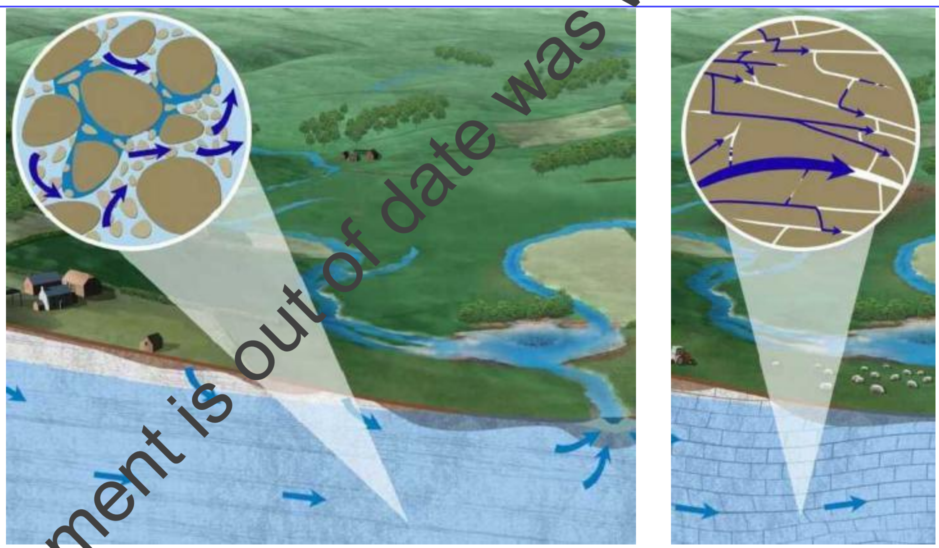


Figure 2.4 Intergranular groundwater flow (left) and fissure flow (right) (www.wfdvisual.com)

In many aquifers there is no simple division between intergranular and fissure flow. Both flow mechanisms can be present and play a greater or lesser part in overall groundwater flow. In dual porosity aquifers, such as chalk, the rock mass between the larger fissures can hold considerable volumes of water. Water flows quickly in the fissures, but intergranular flow in the rock mass is relatively slow.

This document is out of date was withdrawn 14/03/2017

Box 2.1 Groundwater flow concepts

The slope of the water table (that is, the hydraulic gradient) governs the direction of groundwater flow.

The **volume of flow** (discharge) through an aquifer is related to the hydraulic gradient and the hydraulic conductivity or permeability of the rock (a measure of how well pore spaces are interconnected).

Darcy's law relates the volume of discharge through an aquifer to the hydraulic gradient and the hydraulic conductivity.

$Q = k \times i \times a$

where Q = discharge (m^3/d), k = hydraulic conductivity (m/d), i = hydraulic gradient and a = cross sectional area of flow (m^2).

Figure 2.5 illustrates the application of Darcy's law to groundwater.

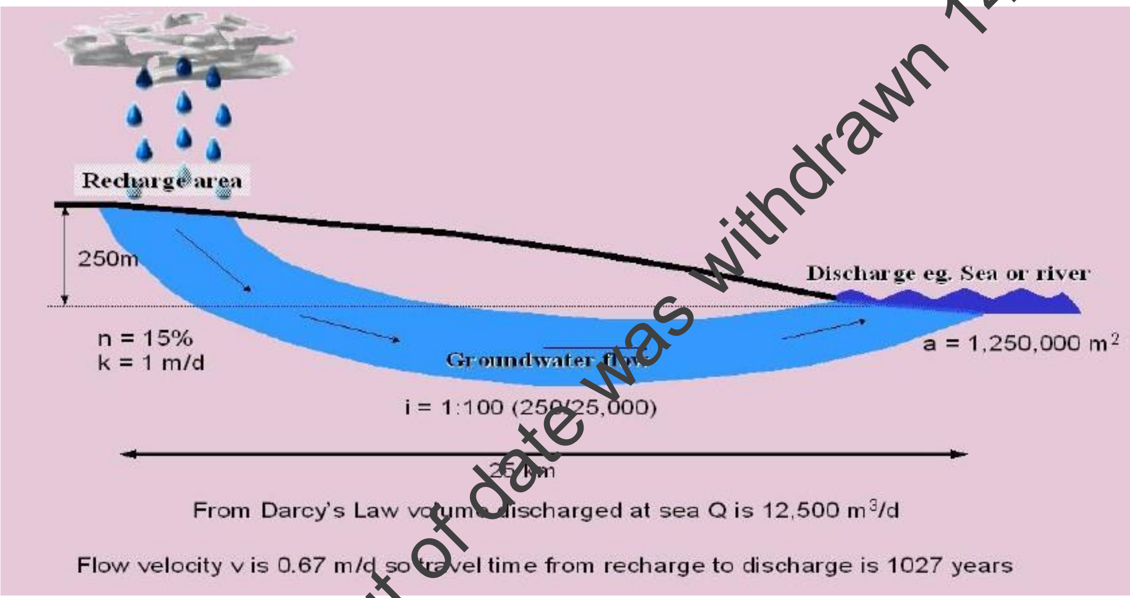


Figure 2.5 Example of the application of Darcy's law to groundwater

The **speed of flow** (flow velocity) is related to hydraulic conductivity, hydraulic gradient and effective porosity (the connected void space in the rock).

$v = (k \times i) / n$

where v = velocity in m/d and n = effective porosity.

In most aquifers, groundwater flow is slow. Speeds range from one metre per year to one metre per day. Occasionally, for example in highly fissured or karstic limestone, flow rates can be similar to those in rivers – of the order of kilometres a day.

More details of these and related hydrogeological concepts are given in *Groundwater – Our Hidden Asset* (Downing 1998) and *Introducing Groundwater* (Price 1996).

This document is out of date was withdrawn 14/03/2017

Seasonal variations

Some rivers, such as those on the chalk downlands of southern England, drain areas that consist entirely of permeable rocks. They obtain virtually all their water from groundwater. Flows are at their highest at the end of winter or in early spring when groundwater levels are high. They decline progressively from late spring to autumn. As the water table falls in aquifers such as chalk, streams may dry up. Such streams – referred to as winterbournes (or simply bournes) – may remain dry for extended periods during droughts.

These are natural seasonal variations. River flow can also be affected by groundwater abstraction. The relationship between the volume and timing of groundwater abstraction and river flows is complex. Inputs to surface water from urban run-off and sewage treatment works further complicate the situation and can hide natural inputs from groundwater. Sewage discharges can also hide inter-catchment transfers of groundwater, with abstraction taking place outside the catchment where the discharge occurs.

Groundwater meets surface water

The zone around a watercourse where surface water and groundwater interact is known as the hyporheic zone (Figure 2.6). In this zone, biological and geochemical activity is often enhanced leading to the attenuation of some pollutants (Environment Agency 2005). The use of attenuation to clean up contaminated groundwater in explained in Chapter 4.

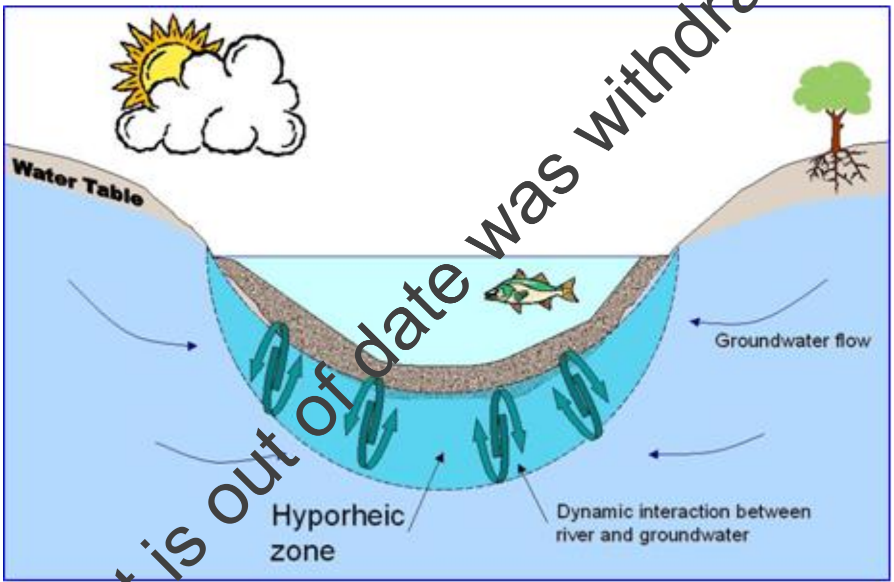


Figure 2.6 Hyporheic zone – a complex area of enhanced biological and geochemical activity at the interface between groundwater and surface water

Wetlands

Wetlands are generally formed in valley floors and low lying areas by flows of groundwater from springs and seepages. Wetland habitats often rely on a complex balance between inflows and outflows to maintain water levels throughout the year. Most wetlands are therefore heavily dependent on groundwater. Water quality is also very important and different plant communities may develop in different parts of the same wetland. Wetland sites of international importance in England and Wales are protected through their designation as Ramsar sites.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

3 Our approach to managing groundwater

This chapter presents the principals on which our approach to managing groundwater is based and the mechanisms we use to protect groundwater quality. Groundwater pollution is dealt with in Chapter 4 and the protection of groundwater resources in Chapter 5.

Topics

This document is out of date was withdrawn 14/03/2017

Our approach

Our priority is to protect water supplies intended for human consumption as well as ensure protection of groundwater quality that supplies dependent ecosystems. We do this under the Water Framework Directive (see Chapter 7). Our position statements (see Chapter 6) seek to apply progressively more stringent controls as the sensitivity of the location increases (for example, applying greater controls the closer an activity is to an abstraction source).

Some activities represent a particular hazard to groundwater due to a combination of the activity type, its duration and the potential for failure of measures taken to mitigate environmental impacts. Depending on the potential severity of the hazard, we will object (through planning or our permitting controls) to such activities in certain areas. Close to sensitive receptors, we are likely to adopt the precautionary principle as even where the likelihood of pollution occurring is not high; the consequences may be serious or irreversible.

Agreements and memoranda of understanding

We encourage operators to enter into agreements with us where these can help both parties to manage and reduce the risks of pollution. We have made agreements, memoranda of understanding and operating codes that include groundwater protection provisions with the following:

- electricity companies;
- Network Rail
- The Coal Authority;
- Southeast Regional Group of Petroleum Licensing Authorities;
- Northwest Regional Group of Petroleum Licensing Authorities;
- The Highways Agency;
- The Fire Service (with SEPA and NIEA) (HM Government 2008).

We are keen to develop agreements that will give operators on-going support and at the same time give us the assurance that they carry out their activities and decommissioning with minimal risk to the environment using where possible best practicable environmental options. In most cases we will promote the use of a risk-based approach.

Precautionary principle

Many of the factors that affect the management and protection of groundwater are subject to uncertainty. This uncertainty arises from physical characteristics and also social values, systems of governance and climate change. While we are seeking to reduce the regulatory burden on industry by simplifying our permitting procedures and adopting a risk-based approach, where appropriate we apply the precautionary principle – first put forward by the UN Conference on Environment and Development at Rio de Janeiro in June 1992. We now adopt the use of Defra's precautionary principle:

> 'Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation' (Defra 2011a).

This means that, if there is uncertainty about the consequences of a decision and there is potential for serious or irreversible harm, we should err on the side of caution and try to clarify the situation. In water resources management, for example, if a proposed abstraction may cause serious environmental damage, our decision on the abstraction should ensure the environment is protected. A precautionary approach may also be warranted if there is a risk of failure to a public water supply – this failure may be unacceptable in terms of its social and economic impacts.

Once groundwater is polluted, it takes many years, decades or even longer for natural processes to clean it up. Human intervention may not reduce these timescales very much. Damage may be serious and perhaps irreversible. For this reason, it is essential to follow the precautionary principle in protecting groundwater quality.

Planning and permitting

Some development and uses of land threaten the quality and availability of groundwater. This means that land-use planning policies and procedures play a significant role in protecting groundwater effectively. The Department for Communities and Local Government is responsible for developing planning policy and wider planning legislation that affect the environment. Full details of the planning system in England are given on its website. Details of the system in Wales are given on the Welsh Government's website.

This document is out of date was withdrawn 14/03/2017

Parallel tracking

A small proportion of developments need both planning permission and an environmental permit. Only a few of these are likely to be complex developments. For these complex developments, we encourage co-ordinated applications for planning permission and EPR permits. This is known as parallel tracking and involves the preparation and submission of the planning application to the planning authority and the environmental permit application to the Environment Agency at the same time.

Parallel tracking provides greater certainty to developers and decision-makers. It is helpful to all as it allows the development of consistent technical details during the processing of the planning permission application. For further information please refer to our guidelines on developments requiring planning permission and environmental permits.

Sustainable development

Sustainable development is important when we make decisions. We will consider not only the environmental benefits and impacts of activities, disposal, discharge and development, but also the social and economic benefits and impacts, including the impacts on natural resources and climate change. We will also seek to take account of short-term and long-term effects, and to avoid decisions that generate short-term economic, social or environmental benefits at disproportionate long-term impact.

The UK's sustainable development strategy (Defra 2005) is based on a set of five principles agreed by the UK Government and the devolved administrations:

- Living within environmental limits
- Ensuring a strong, healthy and just society
- Achieving a sustainable economy
- Promoting good governance
- Using sound science responsibly.

We have two roles in contributing to the achievement of sustainable development:

- To protect or enhance the environment in a way which takes account of economic and social considerations.
- To be an independent advisor on environmental matters affecting policy-making by government and more widely.

Climate change

Climate change will affect the amount of rain or snow (precipitation) that supports river flows and replenishes groundwater. It will also influence the demand for water and its quality, as well as the way land is used – all of which will put pressure on water resources.

As the climate warms, rainfall patterns will change. Summers are likely to get hotter and drier, significantly increasing demand for water, and winters warmer and wetter. More rainfall may come in big downpours. This could lead to droughts and floods, possibly at the same time.

Groundwater has a long 'memory' of past rainfall and recharge, particularly in sandstone aquifers because of the high storage and long residence time. This memory

This document is out of date was withdrawn 14/03/2017

may be a useful indicator of the effects of previous climate change. It may also help us to predict the impacts of future changes.

Our water resources strategy (Environment Agency 2009a) includes actions to reduce existing pressures and to improve resilience to climate change.

Groundwater protection hierarchy

Drinking water protected areas

A key element in the Water Framework Directive is the requirement to set up drinking water protected areas (DrWPAs). The aim in these areas is to manage water resources and to prevent deterioration in water quality that could increase the treatment of water supplied for potable purposes under the Drinking Water Directive (80/83/EEC as amended by Directive 98/83/EC).

All groundwater bodies in England and Wales have been designated DrWPAs.

Tiered approach to drinking water protection

We follow a tiered, risk-based approach to drinking water protection (Figure 3.1).

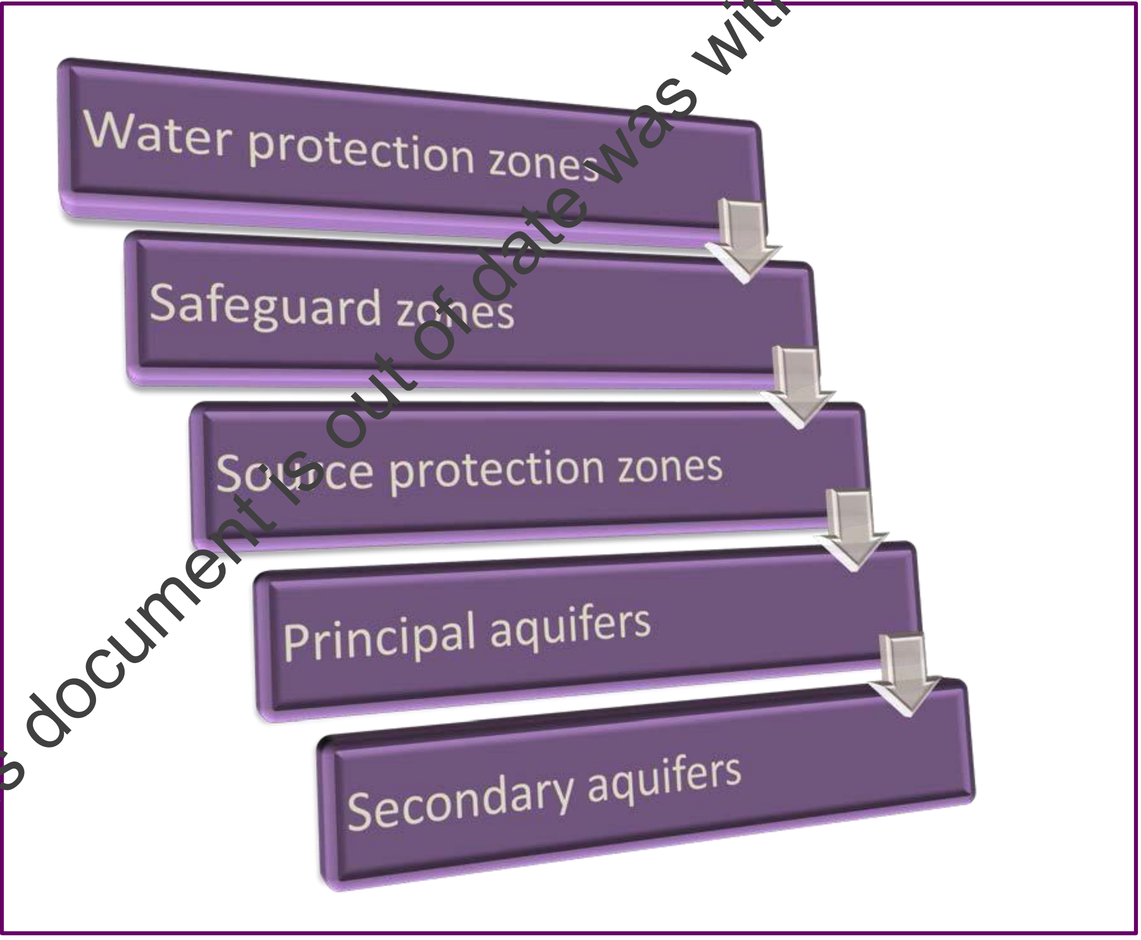


Figure 3.1 Our hierarchy of groundwater protection

This document is out of date was withdrawn 14/03/2017

Water protection zones

Water protection zones (WPZs) are used around sources identified as being at high risk as a 'last resort' when other mechanisms have failed or are unlikely to prevent failure of WFD objectives. Here we are able to apply specific statutory measures over and above existing ones to manage or prohibit activities that cause or could cause damage or pollution of water. This would be for particular pollutants or polluting activities. Nevertheless, although the option of imposing a water protection zone remains, we would need strong evidence to secure approval for it from the Secretary of State.

Safeguard zones

Safeguard zones (SgZs) are identified around sources that are already affected. These are locations where there are known problems with deteriorating water quality, where existing measures should be strictly enforced for particular pollutants and activities, and where there can be a focus on additional new voluntary measures. We will continue to work in partnership with water companies when designating SgZs and implementing actions. We currently have around 200 groundwater SgZs and we plan to review/designate more during the second river basin planning cycle from 2015 to 2021.

Source protection zones

We apply a general level of protection for all drinking water sources through the use of source protection zones (SPZs). SPZs are the basis for other controls within defined safeguard zones. In any specific case, the activity and the particular purpose for which the SPZ, SgZ or WPZ has been designated need to be considered.

SPZs are used to identify those areas close to drinking water sources where the risk associated with groundwater contamination is greatest. SPZs are an important tool for identifying highly sensitive groundwater areas and for focusing control or advice beyond the general groundwater protection measures applied to aquifers as a whole. They also enable us to demonstrate the importance of groundwater intended for human consumption.

We aim to prevent any deterioration in groundwater quality that could harm abstractions intended for human consumption. However, this does not necessarily mean that we apply drinking water standards to untreated groundwater. Such standards are relevant to the quality of water supplied to the consumer and are applied regardless of the natural baseline quality of the water. We can only protect against human influences; preventing deterioration of quality is a major factor in our assessment of the need for protection.

There are approximately 2,000 bespoke SPZs around all major abstraction sources (boreholes and springs) used for human consumption or food use. We assume that all sources intended for human consumption without a bespoke SPZ have at least a default SPZ1 of a 50-metre radius. However, for deregulated small sources (abstraction less than 20 m^3 per day) we do not necessarily know where the sources are. In this case, it is the responsibility of the person undertaking the activity that may impact on an abstraction source to locate the abstraction and decide if it is within 50 metres of a potable abstraction (that is, an SPZ1).

SPZs have three subdivisions (Figure 3.2):

- **SPZ1 inner protection zone** – defined as the 50-day travel time from any point below the water table to the abstraction source. This zone has a minimum radius of 50 metres. SPZ1 represents the immediate area around a

This document is out of date was withdrawn 14/03/2017

borehole where remediation of pollution is unlikely to be achievable within available timescales, such as in less than 50 days.

- **SPZ2 outer protection zone** – defined by a 400-day travel time from a point below the water table. This zone has a minimum radius of 250 or 500 metres around the abstraction source, depending on the size of the abstraction.
- **SPZ3 source catchment protection zone** – defined as the area around an abstraction source within which all groundwater recharge is presumed to be discharged at the abstraction source.

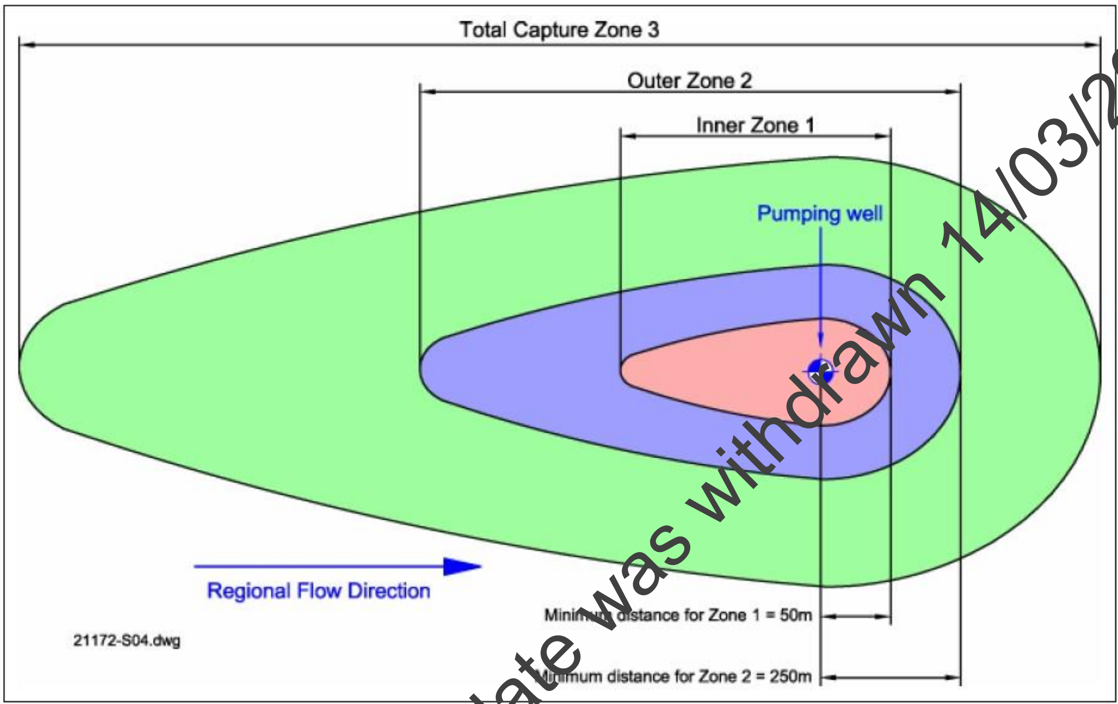


Figure 3.2 SPZ subdivisions

In areas of karstic groundwater flow and recharge we historically defined zones of special interest (SPZ4). SPZ4 usually represented a surface water catchment which drains into the aquifer feeding the groundwater supply (such as a catchment draining to a disappearing stream). In the future, this zone will either be incorporated into one of the other zones (SPZ1, SPZ2 or SPZ3 – whichever is appropriate in the particular case) or become a safeguard zone. Until such time as these zones are reviewed, they will continue to be used, applying local approaches.

Confined aquifers

The default zone for confined SPZ1 is a 50-metre radius; the purpose of this is to provide a buffer protection for the head works around the abstraction borehole. SPZ2 is not generally defined for confined aquifers; SPZ3 is used for the catchment area.

This document is out of date was withdrawn 14/03/2017

Interactive SPZ maps

Our interactive SPZ maps for England and Wales are available in the 'Groundwater' section of the 'What's in your backyard' pages of our website. Figure 3.3 shows an example map covering part of Dorset.

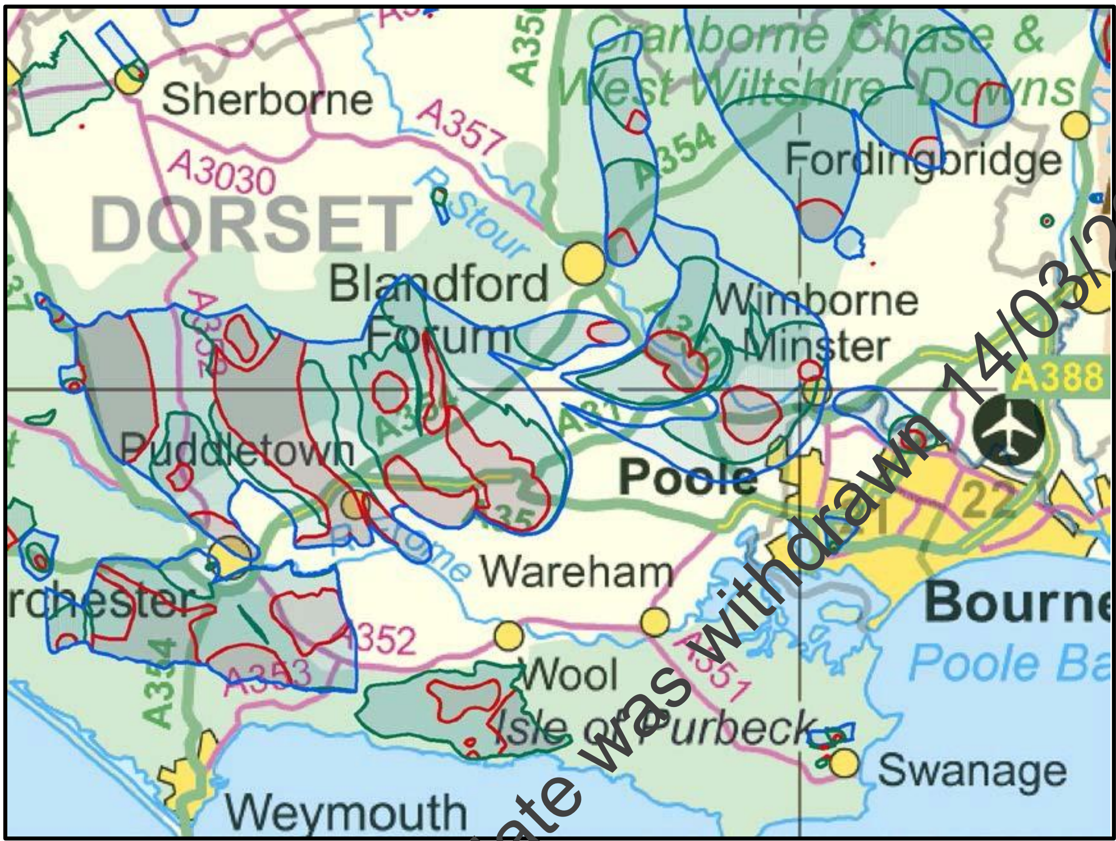


Figure 3.3 Map showing some of the source protection zones in the Poole and Weymouth area

Key: Red = SPZ1; Green = SPZ2; Blue = SPZ3

Private water supplies

Private water supplies are water supplies that are not provided by water companies but instead are the responsibility of the owners and users. Private water supplies are found in a wide variety of settings such as domestic properties, hotels, breweries and hospitals. They supply water to just over one million of the resident population of England and Wales, but many more people are exposed to them when they are travelling through or holidaying in more rural areas of England and Wales (DWI 2011a,b). The source of the supply is most commonly from groundwater (such as a well, borehole or spring), but could also be a stream, river, lake or pond.

The quality and safety of private water supplies is controlled by in England by The Private Water Supplies Regulations 2009 and in Wales by The Private Water Supplies (Wales) Regulations 2010. These regulations implement the Drinking Water Directive.

Private water supplies are regulated by local authorities, which in turn are supervised by the Drinking Water Inspectorate (DWI). The standards and principles of regulation are the same for both public and private water supplies: self-regulation by the owner/user and independent scrutiny. However, it has been recognised for some time

This document is out of date was withdrawn 14/03/2017

that small private or community supplies across Europe are more often of poor quality and linked to illness than public water supplies (DWI 2011a, b).

All private water supplies used for human consumption or food production purposes (but not irrigation of crops) are designated an SPZ1 and have a default radius of 50 metres. Details of these designated private water supplies are held by the local authority concerned and the DWI.

Our SPZ1 position statements (see Table 6.1) apply to all potable groundwater private water supplies.

Groundwater vulnerability

The risks of pollution from a given activity vary from place to place as they depend on the physical, chemical and biological properties of the underlying soil and rocks. These make the groundwater in different areas more or less vulnerable to pollution. Vulnerability maps are one of the tools we use to assess and manage groundwater issues (see Chapter 8).

When we assess the vulnerability of groundwater, our aim is to evaluate how susceptible groundwater resources are to pollution from various activities.

The pollution hazard from an activity will be greater in certain hydrological, geological and soil situations than in others. When we look at the level of risk from any given activity and want to make judgements about its acceptability, we have to assess the total exposure of the groundwater system to that hazard. Vulnerability is usually a significant element of the risk assessment.

We can consider two types of vulnerability:

- Intrinsic vulnerability of a location depends on a number of factors including the soil type, presence of drift and the characteristics of the rock (Figure 3.4). This can be mapped with varying precision depending on the availability of relevant data (soil and geological maps, borehole information and so on).
- Specific vulnerability of a location takes into account additional factors. These include the nature of the activity under scrutiny and the characteristics of the contaminant that is posing a threat to groundwater. In this case we may also consider the removal or bypass of soil or drift and the unsaturated zone.

The key factors that define the vulnerability of groundwater are:

- presence and nature of overlying soil;
- presence and nature of drift;
- nature of the geological strata;
- depth of the unsaturated zone.

This document is out of date was withdrawn 14/03/2017

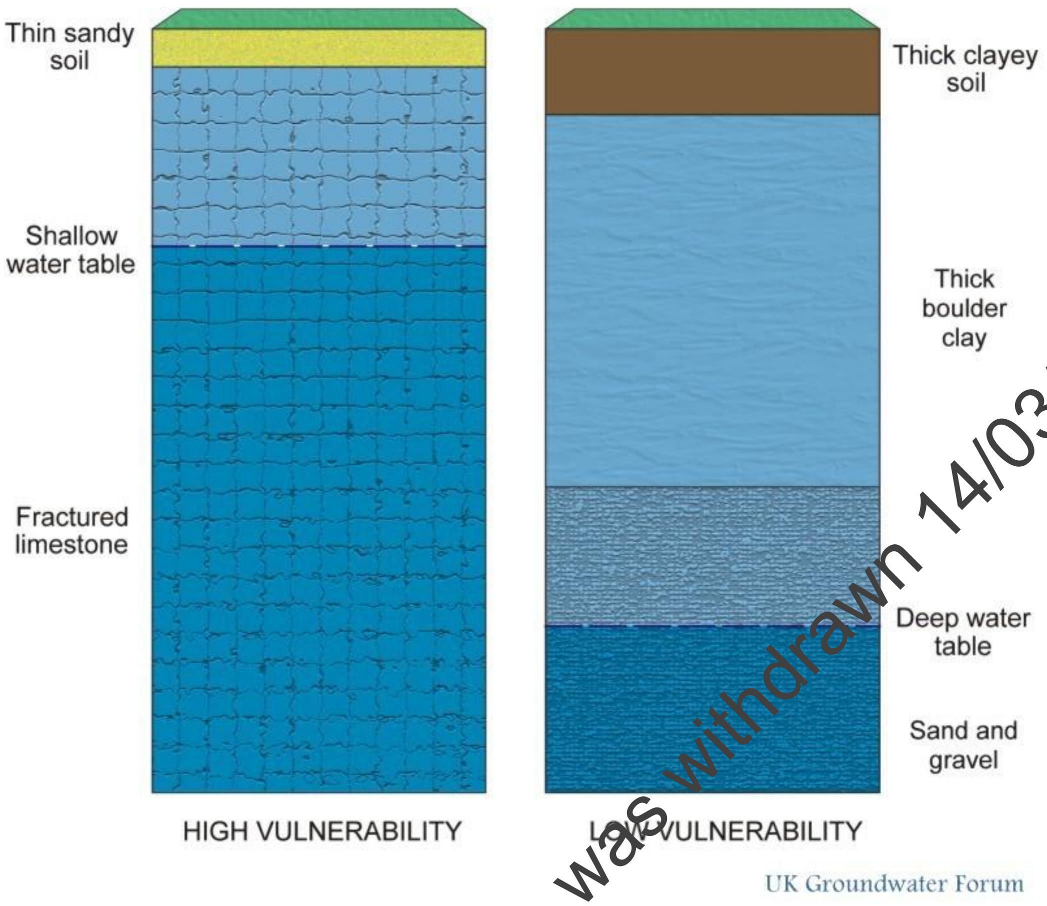


Figure 3.4 Factors controlling the vulnerability of aquifers to pollution (UK Groundwater Forum)

This document is out of date was withdrawn 14/03/2017

Pollution prevention

Pollution prevention guidelines

Our Pollution prevention advice and guidance webpage provides a comprehensive list of pollution prevention guidelines (PPGs). We have produced these short documents in partnership with the Northern Ireland Environment Agency (NIEA) and the Scottish Environment Protection Agency (SEPA) to provide specific guidance on how to minimise the risk to the environment from a wide range of activities. PPGs are used in developing practices to protect both groundwater and surface water.

While every effort should be taken to prevent pollution of groundwater, the benefits of voluntary swift action in an emergency to limit the spread of pollutants while they are in the subsurface is vital in protecting groundwater. Guidance on how to plan your response to accidents and spills is given in:

- PPG21: Incident response planning
- PPG 22: Dealing with spills.

Codes of good practice

Codes of good practice provide useful information on how to prevent pollution from a range of activities where there is no deliberate disposal (and therefore no requirement for an environmental permit).

Groundwater protection codes of practice give practical guidance on steps to take to prevent hazardous substances entering or non-hazardous pollutants causing groundwater pollution. Examples of existing statutory codes include:

- Code of good agricultural practice (CoGAP);
- Code of practice for using plant protection products;
- Groundwater protection codes of practice including
  - Use and disposal of sheep dip compounds;
  - Solvent use and storage
  - Petrol stations and other fuel dispensing facilities involving underground storage tanks.

Storage of polluting substances

The location, volume and nature of the polluting substances will influence the degree of risk. We want to prevent the storage of polluting substances from taking place in the most sensitive locations, where an accidental release could have very serious environmental consequences. However, we recognise that this is not always possible, and in such cases, we look for the very highest standards of pollution prevention to be applied. In other locations, established good practice will be expected as a minimum.

Storage of pollutants is dealt with in more detail in the position statements in Chapter 6.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

4 Groundwater pollution

This chapter describes how groundwater pollution occurs and what causes it.

Topics

- Activities that put groundwater at risk
- Pollutant categories
- Point and diffuse source pollution
- Pollutant phases in groundwater
- Protecting groundwater from the risk of pollution
- Cleaning up groundwater pollution
- Common groundwater pollutants
- Unconventional gas

This document is out of date was withdrawn 14/03/2017

Activities that put groundwater at risk

Groundwater faces many threats and is easily polluted (Figure 4.1).

Pollution of groundwater may be due to deliberate or accidental release of a pollutant. Or it may due to an activity that moves a pollutant so that it becomes a problem. In most circumstances the overlying soils and rocks naturally protect aquifers. However, when groundwater pollution does occur it can go unnoticed for long periods because the pollutants soak into the ground and disappear from view, often becoming 'out of sight and out of mind'.

The risk presented by a pollutant relates to:

- its use;
- how it enters groundwater;
- the degree of harm it may cause;
- its persistence;
- our ability to detect it;
- statutory requirements.

How we assess the risk associated with pollutants in groundwater is explained in Chapter 8.

Leaks, spills and poor maintenance can all release significant volumes of chemicals. Activities that put groundwater at risk include:

- discharge of waste and wastewater (sewage) onto or into the ground;
- use of chemicals such as fertilisers and pesticides;
- poor storage of solvents, petroleum products (oils, petrol, diesel) and other materials;

- spreading of slurry, manure and abattoir wastes.

Figures 4.2 and 4.3 summarise the main threats in urban and rural areas respectively. Information about common groundwater pollutants is given later in this chapter.

Our position statements set out our position on the prevention of groundwater pollution from activities that put groundwater at risk.

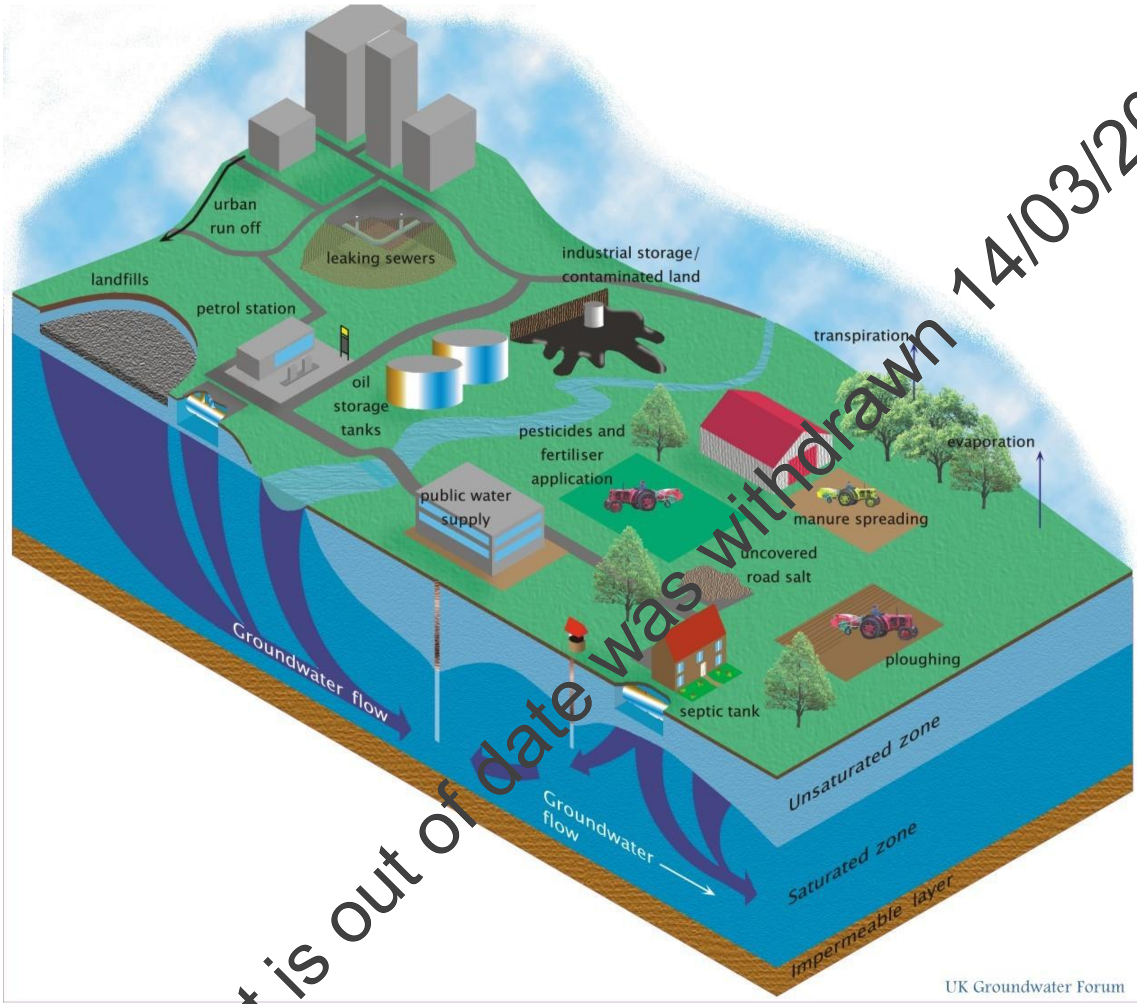


Figure 4.1 Hazards posing a threat to groundwater quality (UK Groundwater Forum)

This document is out of date was withdrawn 14/03/2017

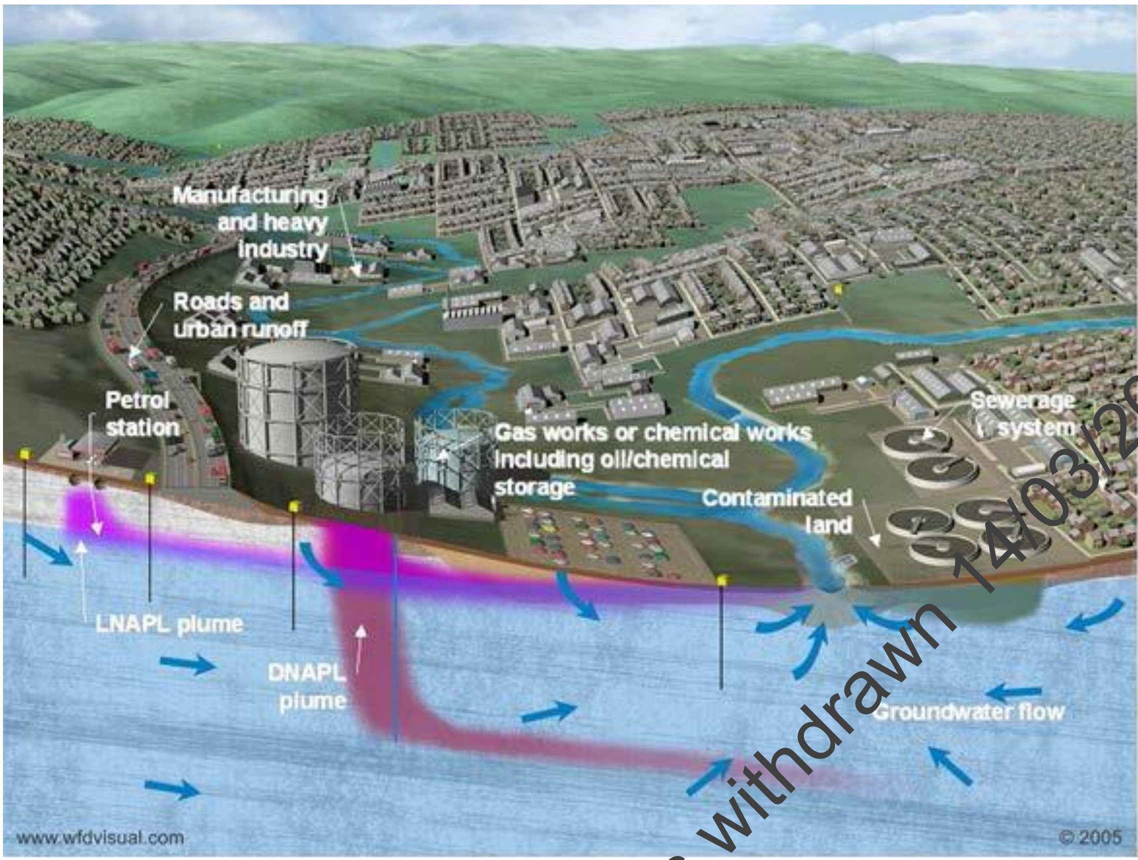


Figure 4.2 Threats to groundwater from the urban environment (www.wfdvisual.com)

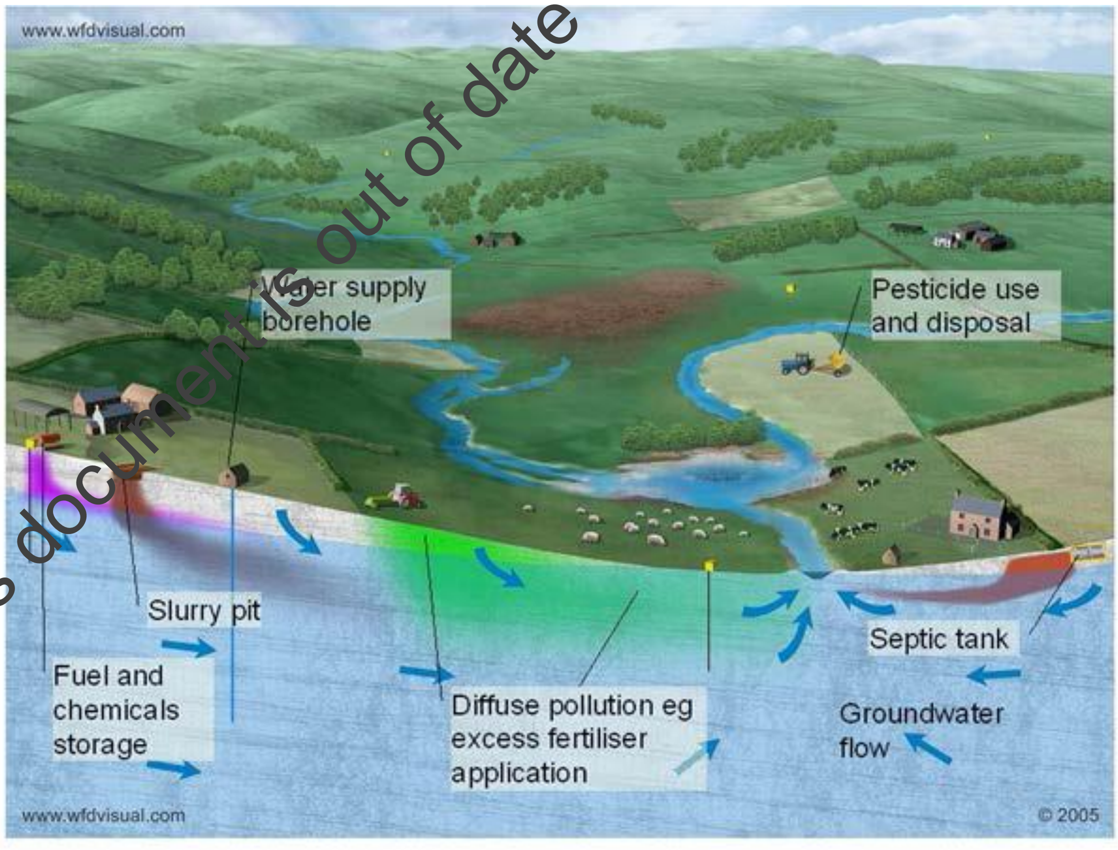


Figure 4.3 Threats to groundwater from rural sources (www.wfdvisual.com)

This document is out of date was withdrawn 14/03/2017

Pollutant categories

Pollutants are substances that can either occur naturally but are concentrated by human activities, or they can be substances that are synthesised by humans and do not normally occur in nature. For example, nitrate, pesticides, solvents and other pollutants can get into groundwater from surface water and soils.

Pollutants can be divided into those that break down easily (degradable pollutants) and those that do not (non-degradable pollutants). The Water Framework Directive introduced the concept of 'hazardous substances' and 'non-hazardous pollutants', which replaced the previous List I and List II of substances considered to pose the greatest threat to the environment.

- **Hazardous substances** are the most toxic and must be prevented from entering groundwater. Substances in this list may be disposed of to the ground, under a permit, but must not reach groundwater. They include pesticides, sheep dip, solvents, hydrocarbons, mercury, cadmium and cyanide.
- **Non-hazardous pollutants** are less dangerous and can be discharged to groundwater under a permit, but must not cause pollution. Examples include sewage, trade effluent and most wastes. Non-hazardous pollutants include any substance capable of causing pollution and the list is much wider than the previous List II of substances. For example, nitrate is now a non-hazardous pollutant whereas before it was not a List II substance.

Point and diffuse source pollution

Point source pollution

Point source pollution is localised and comes mostly from spills, leaks and discharges at a single point or over a small area. Point sources are relatively easy to identify because they are discrete and well-defined events or activities. Examples include:

- leaking underground fuel storage tanks, sewers or septic tanks;
- accidental spillages from the handling of chemicals;
- spills resulting from vehicle and other accidents;
- leaching from landfill sites;
- emissions from industrial plants.

Most point sources of pollution can be prevented by following codes of good practice and the advice given in our pollution prevention guidance notes.

Diffuse source pollution

The distinction between point and diffuse sources of pollution is not entirely clear cut in practice. Some sources described as diffuse are actually made up of multiple small point sources while others are more evenly distributed on the ground. However, the attributes such sources have in common are that:

- they tend to be spread over larger areas and time periods;
- it is often difficult to relate the pollution source to the impact on groundwater.

Diffuse sources cause pollution in two main ways:

This document is out of date was withdrawn 14/03/2017

- spread of pollutants over an area;
- cumulative effect of many individual and ill-defined events:

Sources of diffuse pollution include:

- deposition of atmospheric pollutants (from rain and dust);
- leaching from the land of fertilisers and pesticides (for example, nitrate from the application of chemical fertiliser to farmland is a longstanding problem);
- incorrect handling of farm wastes;
- leaks from the sewerage system;
- run-off from urban areas, highways, etc.

Individually these sources may be small and hard to detect. Together they have a significant impact on water quality.

The distributed nature of diffuse pollution makes it a particular problem for groundwater. Potentially large volumes of pollutants can enter the subsurface and be stored in the unsaturated zone or within the aquifer before the pollution has been detected, linked to a particular activity and made subject to controls.

Diffuse pollution is the most widespread form of groundwater pollution in England and Wales. Unlike point source pollution, we cannot easily control diffuse pollution using mechanisms under EPR. Diffuse pollution also tends to arise from sites or activities we do not regulate directly. Our priority is therefore prevention through the promotion of good practice and controlling the risks from diffuse sources.

The Water Framework Directive sets new objectives which will require measures to reduce diffuse pollution. An effective combination of innovative regulatory and non-regulatory measures in partnership with others will be needed to meet these objectives.

Nitrates and pesticides

In England and Wales we identify nitrate vulnerable zones (NVZs) where action plans are used to limit the amount of fertiliser, manure and slurry that farmers can apply.

EU controls restrict the marketing and use of substances such as pesticides and herbicides. As existing and new products are reviewed for their pollution risks, this has become an increasingly effective way of protecting groundwater. The regulation of plant protection products and biocides (including pesticides) in the UK is the responsibility of the Chemicals Regulation Directorate (CRD), a directorate of the Health & Safety Executive (HSE). CRD maintains the Pesticides Register of UK Authorised Products. The Voluntary Initiative is a voluntary programme promoting responsible pesticide use in the UK.

Information about the properties of nitrate and pesticides and why they are of concern is given later in this chapter.

Pollutant phases in groundwater

Polluting substances in groundwater can occur as a gas (gaseous phase) or dissolved in water (aqueous phase), or as a non-aqueous phase liquid (NAPL).

Methane, often derived from degrading organic matter, is an example of a gaseous pollutant that may be present in the unsaturated zone and below the water table. Below the water table in the saturated zone, the methane is dissolved in the groundwater and

This document is out of date was withdrawn 14/03/2017

therefore could move with it as it flows, with the potential to be released some distance from its source. If the methane mixes with air on its release from groundwater, this can result in an explosion, especially in confined spaces below ground.

Some pollutants include substances that dissolve readily in water. These are said to have high solubility. Salt is a good example. Other examples are MTBE (methyl tertiary butyl ether – the anti-knock ingredient used unleaded petrol), bromate, nitrate or ammonium. Although only generally readily soluble under acidic conditions, metals such as lead and zinc also fall into this category. Details of these and other common groundwater pollutants are given in the final section of this chapter.

Substances that have low solubility (such as oil) are referred to as non-aqueous phase liquids (NAPLs). Some NAPLs are only sparingly soluble but this is often enough to result in groundwater pollution, Many NAPLs are highly toxic, mobile and can migrate down through the ground and result in groundwater pollution.

NAPLs behave differently in groundwater depending on whether they are lighter or heavier than water. Light non-aqueous phase liquids (LNAPLs) may float on the water table (Figure 4.4) whereas dense non-aqueous phase liquids (DNAPLs) may sink through the aquifer until they reach an impermeable layer (Figure 4.5). They may then generate plumes of contamination. In both cases, the slowly dissolving pollutant may form a plume of dissolved contamination which moves with the groundwater flow. Some NAPLs such as chlorinated solvents also present a risk due to the release of toxic gases from natural breakdown processes.

Cleaning up NAPL pollution is expensive and technically challenging. Clean-up techniques can deal successfully with some of the lighter liquids, but cleaning up contamination from DNAPLs is often more problematic.

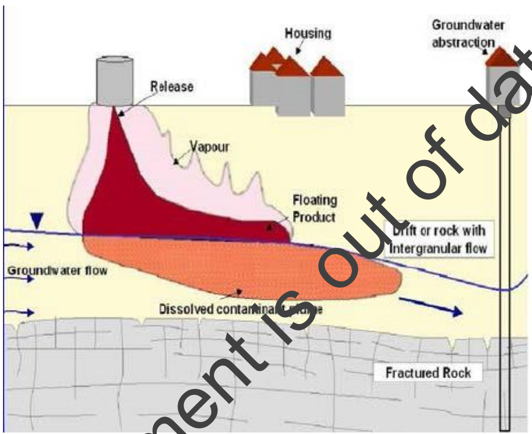


Figure 4.4 LNAPL behaviour in groundwater

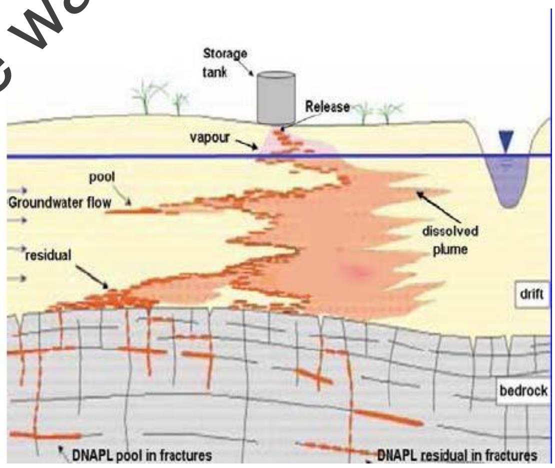


Figure 4.5 DNAPL behaviour in groundwater

In Figure 4.4, the NAPL is less dense than water so it floats on the top but can still cause significant groundwater contamination. In Figure 4.5, the DNAPL sinks down through the soil and causes groundwater contamination. The contamination is difficult to clean up as the DNAPL can form discrete layers and pools of contamination that can be difficult to find.

This document is out of date was withdrawn 14/03/2017

Protecting groundwater from the risk of pollution

The good quality of groundwater is important for water-dependent plants and animals, and for the use of groundwater as a source of drinking water. Implementation of the Water Framework Directive will help to protect and enhance the quality of groundwater and groundwater-dependent ecosystems. The WFD requires us to strive to ensure that all groundwater bodies (GWBs) are of 'good' status in terms of water quality. This status is based on thresholds for the chemical constituents of groundwater and their impact on ecosystems.

Preventing pollution is by far the most sustainable and cost-effective way of maintaining good groundwater quality. We are committed to the 'prevent or limit' approach reflected in EU and domestic legislation and described in detail in our position statements. Wherever possible, we use risk-based methods to control releases of pollutants.

Permits, guidance and codes of practice play a key role in our efforts to prevent and control groundwater pollution.

We protect groundwater quality under EPR through the issuing of permits designed to prevent or limit the inputs of polluting substances into groundwater. Our H1 horizontal guidance will help you to assess the risks to groundwater when applying for a permit under EPR. You can visit our website to find out if your facility needs an environmental permit to protect groundwater by preventing or limiting the discharge of polluting substances.

Many pollution incidents are avoidable and we take enforcement action for serious offences. Our pollution prevention guidance notes (PPGs) produced jointly with SEPA and NIEA give advice on the law and good environmental practice to help reduce environmental risks from business activities.

Pollution may only become apparent much later when, for example, the groundwater quality at an abstraction borehole is affected, or when contaminated baseflow has a noticeable effect on the chemical quality or ecology of a watercourse. This time lag means that a large volume of aquifer can become polluted before the impacts are readily noticeable. The potential for groundwater pollution increases greatly if the overlying layers are removed or bypassed, for example, by quarrying or sinking a poorly constructed borehole for private water supply. Good practice for the construction of boreholes is detailed in Environment Agency (2001).

Cleaning up groundwater pollution

Groundwater pollution can be very difficult to detect and may not become evident until a water supply or spring is affected. Pollutants may take months or years to migrate from the source to a receptor or to a point where they can be detected.

Once groundwater has become polluted, it is very difficult to return it to its original condition. Processes that take days or weeks in surface water systems may take decades to centuries in groundwater. This is because of the relatively slow rates of groundwater flow and the reduced microbiological activity below the soil zone due to the general lack of oxygen and nutrients.

Other reasons for the difficulty in cleaning up groundwater include:

- inaccessibility of pollutants;
- difficulties in defining the exact nature and extent of the pollution;
- retention of the pollutants within the rock matrix;

This document is out of date was withdrawn 14/03/2017

- difficulties in controlling the spread of pollution.

The costs are therefore very high (Environment Agency 1999). They are met not just by the polluters but by users such as water companies, and through their bills, householders and businesses.

Attenuation

Soils and aquifers can do much to purify polluted groundwater. Naturally occurring subsurface processes can reduce the mass, toxicity, volume or concentration of organic and inorganic contaminants in both the unsaturated and saturated zones. Specialists often refer to this as natural attenuation and it is often applied in the context of restoring groundwater quality. An assessment of the vulnerability of groundwater at a specific site can take account of these processes in the unsaturated zone.

A remediation technique called monitored natural attenuation (MNA) is considered a viable, cost-effective option for managing the risks from contaminated groundwater (see Box 4.1). However, MNA needs to achieve the remedial objectives in a reasonable time.

Box 4.1: What is natural attenuation?

Natural attenuation in groundwater refers to the naturally occurring physical, chemical and biological processes, or combinations of these processes, which reduce the load, concentration, flux or toxicity of polluting substances in groundwater. For natural attenuation to be effective, the rate at which these processes occur must be sufficient to prevent polluting substances from entering identified receptors and to minimise expansion of pollutant plumes into currently unpolluted groundwater. Dilution within a receptor, such as in a river or borehole, is not natural attenuation.

Monitored natural attenuation (MNA) is a remedial technique that monitors groundwater to confirm whether natural attenuation processes are operating. The monitoring must also demonstrate that natural attenuation is acting at a rate that ensures the wider environment is unaffected and that remedial objectives will be achieved within a reasonable timescale. This will typically be within one generation or less than 30 years.

For further information on natural attenuation see Environment Agency (2000a).

Common groundwater pollutants

This section gives some basic information on the most commonly detected pollutants in groundwater.

Nitrate

Nitrate, a soluble compound of nitrogen and oxygen, occurs naturally in the soil and is the main form of nitrogen taken up by plants as an essential nutrient. Farmers maximise crop yields by applying nitrogen and other nutrients in the form of chemical fertilisers or livestock manure. Nitrate is also produced when soil processes break down the organic matter left over from crops such as potatoes or when grassland is ploughed up. Whatever the source, any nitrate not used by the plants is particularly vulnerable to leaching from the soil into groundwater. This usually happens during autumn and winter rainfall. Nitrate is classed as a non-hazardous pollutant.

There are two main concerns about nitrates in groundwater:

This document is out of date was withdrawn 14/03/2017

- High nitrate concentrations in drinking water can cause a serious blood condition in young babies. However, this is extremely rare and no cases have been recorded in the UK since 1972. To protect against this and other potential health problems, water companies must not supply drinking water with more than 50 mg per litre of nitrate. This is the drinking water limit.
- High nitrate concentrations are believed to contribute to the eutrophication of some surface waters, that is, the over-enrichment of waters with mineral and organic nutrients. These can promote a proliferation of plant life (especially algae), which reduces the dissolved oxygen content and often causes the extinction of other organisms. The action level set by the Nitrates Directive for the designation of NVZs and the implementation of action plans to prevent the eutrophication and pollution of surface waters and groundwater is again 50 mg per litre.

The increase in nitrate concentrations in many aquifers across England and Wales is a major concern. If farmers and others applying nitrates to the ground do not substantially change their current land use practices, we estimate that the drinking water limit of 50 mg per litre will be breached in many more aquifers in the coming decades. The Nitrates and Water Framework Directives require the UK government to reverse such rising nitrate trends.

Ammonia

Ammonia is a nitrogen and hydrogen compound. It is very soluble in water and toxic, especially to fish. In water ammonia exists as two species – un-ionised ammonia NH_3 and the ammonium ion NH_4^+. Ammonia is the more toxic form. Ammonia is classed as a non-hazardous pollutant and so it must be limited in groundwater so as not to cause pollution.

The drinking water limit for total ammonia (ammonia and ammonium) is 0.5 mg per litre. This level is indicative of generally low quality or polluted water. In addition, the reaction between ammonia and chlorine can reduce the disinfecting action of the chlorine when used for safeguarding drinking water. The toxic effects of ammonia on mammals only happen at a concentration significantly higher than 50 mg per litre – hence the 50 mg per litre drinking water limit. However, fish begin to show problems when ammonia is present even at sub 0.1 mg per litre concentrations (the Fresh Water Fish Directive guideline value is 0.005 mg per litre un-ionised ammonia).

Most animals, plants and bacteria produce ammonia as a result of metabolic processes including the breakdown of organic matter. Ammonia is present at significant concentrations in sewage, manure, farm slurries, silage liquors and in the leachate (complex solution of water and other substances) found in landfill sites. Waste disposal (landfill in particular) needs controls to ensure that water quality standards are not breached. Landfill leachate can have ammonia concentrations in excess of 2,000 mg per litre. This may cause groundwater pollution and seriously compromise drinking water quality or harm fish if it discharges into a stream.

If ammonia is oxidised (or nitrified) in the ground, it often becomes an additional source of nitrate.

Hydrocarbons

'Hydrocarbon' is a general term for a large family of organic compounds that consist solely of carbon and hydrogen atoms. Hydrocarbons include common substances such as benzene, petrol, paraffin, diesel, lubricating oil, greases, naphthalene and asphalt. They are in widespread use. They often exist in a great variety of complex mixtures,

This document is out of date was withdrawn 14/03/2017

which can break down into other mixtures or single substances. Hydrocarbons are classified as hazardous substances and many persistent hydrocarbons are classed as priority substances under the Water Framework Directive. The direct discharge of such hydrocarbons to groundwater is not permitted.

Some hydrocarbons frequently contaminate groundwater. Examples include petrol from leaking tanks at filling stations and polycyclic aromatic hydrocarbons (PAHs) in the run-off from roads. Petrol and diesel leaks are usually point source pollution problems. PAHs represent a serious threat of diffuse pollution to the water environment.

In theory, microbes can degrade many hydrocarbons to carbon dioxide and water under aerobic conditions. However, suitable conditions are often not present in groundwater.

Although not strictly hydrocarbons, fuel additives such as MTBE have recently attracted considerable attention. MTBE and other ether oxygenates – for example, *tert*-amyl methyl ether (TAME) and ethyl *tert*-butyl ether (ETBE) – were developed to enhance the performance characteristics of unleaded petrol. However, they also represent a significant threat to groundwater quality due to their solubility, mobility, poor biodegradability and low taste threshold. MTBE is a good example of a substance that is not a particular issue in surface water because of its degradability but is an issue in groundwater.

Motor fuels are undergoing rapid evolution. New additives may present as yet unforeseen risks to groundwater. These include biofuels and additives (ETBE can be produced from non-oil sources) and ethanol.

Pesticides

Pesticides are chemicals used to control or destroy pests. They include insecticides, herbicides, fungicides and substances such as timber preservatives. The bulk of pesticides are used in agriculture and horticulture, but they are also widely used in industry, in transport (to keep roads and railways weed-free) and in the home. By their very nature pesticides are toxic to living organisms.

Although their chemical and physical characteristics vary greatly, many pesticides can easily pollute water. Part of the risk from pesticides is the level of their persistence in the environment. Some pesticides are highly persistent. Although others readily degrade, the breakdown products may occasionally be toxic.

Serious incidents of groundwater pollution due to pesticides are rare (they make up less than one per cent of recorded pollution incidents). However, when they do occur they can cause severe environmental damage. As we become better at detection, we are identifying a wide range of pesticides in many groundwater supplies prior to treatment. In order to meet drinking water standards, water companies in many parts of England and Wales now face substantial costs from removing pesticides.

The Chemicals Regulation Directorate's responsibilities include the regulation of plant protection products and biocides (including pesticides). The Biocides Directive and the Plant Protection Products Directive (and Regulation) require companies that currently produce or develop new pesticides to submit them to an approval process. The risk of groundwater pollution is a factor in the approval process and may mean that conditions on use are applied or, in high-risk cases, lead CRD to refuse approval.

We have evidence that over time the approvals process and the restrictions on use are reducing pollution by pesticides. However, there remains a risk of groundwater pollution and work needs to continue in this area. Our main concern now is dealing with pesticides such as sheep dip that are still causing problems. These compounds are not

This document is out of date was withdrawn 14/03/2017

subject to the approvals process described above and are still involved in too many pollution incidents that mainly result from inappropriate use or disposal practices.

Solvents

Solvents are liquid chemicals that are good at dissolving other substances. They are widely used in industrial processes, for example, in the extraction or purification of other chemicals, for degreasing metal components, and as the fluid in dry cleaning. They are also the basis of many paints, varnishes, adhesives and cleaning products (many have the ability to dissolve oils, greases and fats).

With respect to groundwater pollution, the word ‘solvent’ often refers to chlorinated hydrocarbons (Figure 4.6). These are denser than water (DNAPLs) so that, if they are present in sufficient quantity, they may migrate vertically downward through an aquifer. However, they are also soluble to varying degrees in groundwater and can therefore migrate as a dissolved phase with flowing groundwater.

Many solvents are persistent in groundwater. Their toxicity and complex behaviour in groundwater make this class of pollutants particularly difficult to assess and clean up.

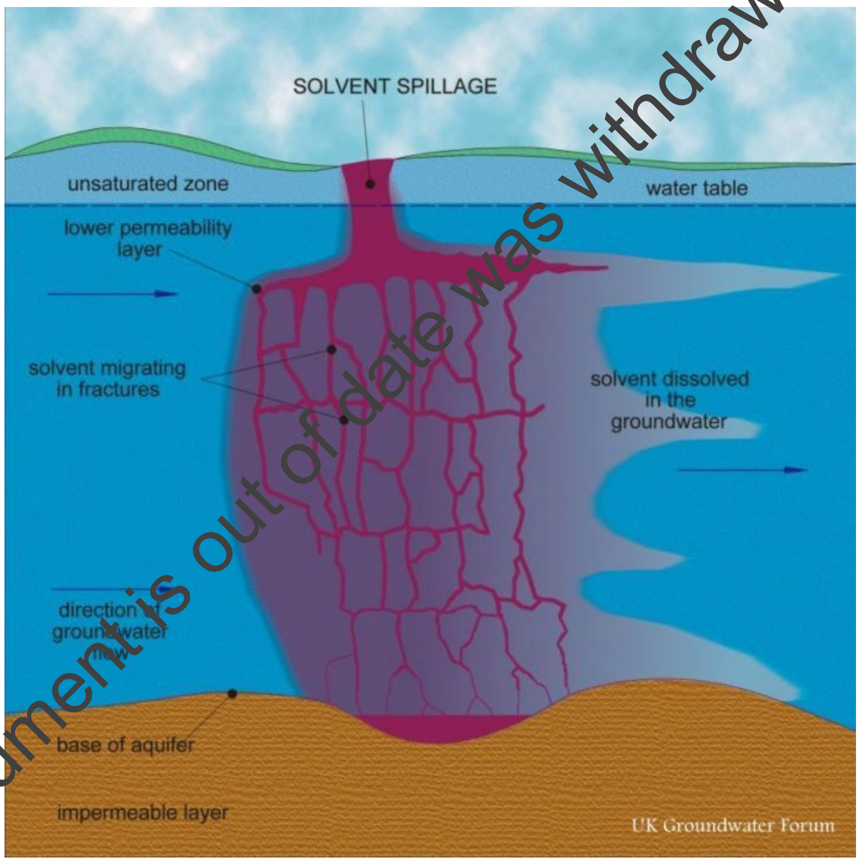


Figure 4.6 Pollution of the Chalk by the solvent tetrachloroethylene (UK Groundwater Forum)

Pharmaceuticals and endocrine disrupters

Pharmaceuticals represent a large and ever increasing number of substances. This group of substances also includes veterinary medicines such as sheep dip and antibiotics. They can reach groundwater via industrial discharges from manufacturing or research facilities or from animal wastes, or via on farm disposal. They are also present in sewage effluents, septic tank discharges and domestic waste. They are

This document is out of date was withdrawn 14/03/2017

difficult to detect routinely, partly because of the large number of substances and the generally low concentrations. With the possible exception of those substances that are also approved pesticides, the effects of their presence in groundwater are poorly understood.

Some pharmaceutical substances and chemicals used in industry are endocrine disrupters. These are natural and synthetic substances that can affect the normal functioning of the endocrine (hormone) systems. One affect is the feminisation of the males of certain fish species. Endocrine-disrupting substances include steroids, alkylphenols, some pesticides and polychlorinated biphenyls (PCBs). Sources include:

- agricultural pesticide use;
- industrial processes such as timber treatment;
- improper disposal of electrical transformers;
- surfactants.

One of the most common routes of these substances into the environment is through discharges to sewers. If these sewers leak, these substances could end up in groundwater.

Our approach to these substances is based on preventing releases to the environment.

Microbiological contaminants

It is only relatively recently that attention has focussed on microbiological contamination by pathogens. As a result there is relatively little published work on this subject.

Most microbiological pollutants derive from land-based activities and are filtered out or die off as groundwater passes through the soil, unsaturated and saturated zones. Some types of geology are more at risk from microbiological pollution; for example, fissured strata are more at risk due to rapid flow to and within the saturated zone.

Possible sources of pollution by microbes include:

- septic tanks;
- disposal of farm waste;
- municipal landfills;
- sewage sludge handling;
- leaking sewers;
- recharge from rivers containing sewage effluent.

Viruses are much smaller than bacteria and are not so readily filtered out. Some can be persistent and could potentially travel a considerable distance in groundwater. Some research is taking place into viruses and groundwater.

Cryptosporidium is relatively common in the natural environment and represents a routine risk to water quality. The bacterium, Escherichia coli, is also an important contaminant. The bovine spongiform encephalopathy (BSE) prion and foot and mouth disease (FMD) virus could be a risk to water supplies in an emergency such as an epidemic that resulted in the need for mass burial of infected carcasses. However, there is little evidence of their routine presence in groundwater.

This document is out of date was withdrawn 14/03/2017

Radioactive substances

Radionuclides from human activities can enter the environment by several means, such as through discharges during the nuclear fuel cycle, from weapons production, or from research. Examples include plutonium-239, americium-243, strontium-90 and caesium-137. They can potentially pollute groundwater if there are leaks or spills from nuclear facilities, or as a result of radioactive waste disposals. These activities are closely regulated and covered by radioactive substances legislation.

Some radionuclides have become widely dispersed around the world. One example is tritium (hydrogen-3). This radionuclide has a low radiotoxicity and a relatively short radioactive half-life (12.3 years). It is commonly found in low concentrations due to its production during atmospheric nuclear weapons testing in the 1950s and 1960s. It is also released from some nuclear facilities. Atmospheric levels of tritium increased sharply in about 1953, allowing concentrations in groundwater to be used to determine whether groundwater had been recharged before or after then. Tritium concentrations are now returning to background levels making groundwater dating using tritium difficult. Radioactive sources are also commonly used in some domestic items such as smoke detectors and exit signs. Many such items have been disposed of to landfill. As a result, low levels of radioactivity are found in some landfill leachates.

Radioactive isotopes of many elements exist naturally and can present a risk to people. In groundwater, the best known is radon-222. Radon-222 is a daughter product of the breakdown of uranium-238. Naturally occurring uranium 238 is found most commonly in granite and in a variety of other minerals found in many different types of rock. This means that radon-222 can be found in many different areas, not just those underlain by granite as in Devon and Cornwall. Radon is a gas and can dissolve in groundwater flowing through relevant source rocks. The groundwater can then release the gas in confined spaces such as houses, where the gas may accumulate if no precautions are taken to vent it; however, in many cases this is not the major source of radon build up. Radon degasses easily from water and therefore it is not usually considered to be a problem in terms of drinking water.

Thermal pollution

The temperature of liquids people discharge to groundwater can cause pollution. This factor is in addition to the chemical and microbiological composition of the discharge. Water that is otherwise clean can cause pollution if it is hot as heat is a pollutant under the Water Framework Directive.)

One impact heat can have is to cause extra growth of indigenous organisms that are potentially pathogenic when otherwise the temperature would have been too low for them to survive. A well-known example is *Legionella pneumophila*, the cause of Legionnaires' disease.

The most common sources of heat pollution in groundwater are the discharge of cooling water and hot industrial effluents. Ground source heat pumps are also now increasing in popularity. These either extract heat from groundwater for space heating or heat it up by using groundwater for cooling. The cooling of groundwater by heat pumps can also cause problems. The groundwater may freeze or cold water may impact on other users or environmental receptors.

Our position on ground source heating and cooling (GSHC) and deep geothermal schemes is set out in Section R..

This document is out of date was withdrawn 14/03/2017

Metals

Impact of mining on groundwater

Mining activity is now minimal in the UK. However, the legacy from the past mining of coal and metals still poses a threat to groundwater and surface water. The main sources of pollutants from mining are:

- metal-contaminated water from the rebound of groundwater depressed by pumping;
- leaching of metals from spoil heaps (waste rock piles) into surface and groundwater.

The main pollutants include iron, zinc, lead, cadmium, manganese, copper and acidity (low pH). These contaminants are released when oxygen in the air reacts with minerals in the rock found near coal seams and mineral veins. The metals are then dissolved in the returning groundwater, or by rain in the case of spoil heaps.

Mining has taken place in the British Isles since the Bronze Age and has always been associated with pollution. This long history is reflected in place names such as Redruth and the Red River in Cornwall, and Afon Goch Amlwch (red river) on Anglesey, Wales.

Pollution from mining activities is particularly difficult to deal with because of the length of time over which discharges can persist. Also, because mining invariably disturbs land on a large scale, it causes diffuse pollution – irrespective of whether it is opencast, deep mining or spoil dumping.

The dewatering of deep mines to allow mineral extraction lowered groundwater levels, sometimes by hundreds of metres and groundwater in many of the coalfields has been depressed since the 19th century. However, when mining stops the pumps used to keep the mines dry are turned off. The subsequent rise in groundwater (rebound) can cause flooding. Oxidised minerals dissolve into the groundwater as it rises back into the dewatered levels. This leads to high concentrations of metals (particularly iron) and sulphate in the rising groundwater. The result is the pollution of large areas of groundwater. This can subsequently discharge to surface waters or overlying aquifers.

Our position on mining-induced pollution is set out in Section K.

Other sources of metals

Metals may also enter groundwater from other sources. The use of inorganic fertilisers such as rock phosphate can introduce cadmium into the soil. This may leach into groundwater. Cadmium concentrations in phosphate fertilisers are lower now than in the 1980s but still remain a concern.

Land contamination is another potential source of metal pollution. Industrial activity is the usual reason for the presence of metals in land. Examples of such activity include steel works, foundries, lead smelters and similar heavy industries.

Metal pollution is difficult to deal with sustainably. Metals do not degrade naturally. For example, copper oxide may react and become copper sulphate but the copper is still present. However, many metals become bound to material in the soil or rock. This means that they do not move and pollute groundwater. The risk of groundwater pollution does increase if the ground is disturbed (for example, during redevelopment).

This document is out of date was withdrawn 14/03/2017

Other pollutants

There are other substances that can threaten groundwater quality. Some examples of those that have caused groundwater pollution or are of concern include:

- industrial chemicals such as bromate;
- fire-fighting foams containing hazardous substances;
- naturally occurring substances that are mobilised by human activity (for example, arsenic) and so present a hazard.

Unconventional gas

This section gives an overview of the emerging resource of unconventional gas and the potential risks to groundwater.

Underground coal gasification, coal bed methane and shale gas extraction may liberate a range of polluting by-products including:

- ammonia;
- hydrogen cyanide;
- carbonyl sulphide;
- polycyclic aromatic hydrocarbons (PAHs);
- methyl mercaptan;
- heavy metals;
- dioxins and furans.

This document is out of date was withdrawn 14/03/2017

Shale gas

Shale gas is the natural gas methane held in fractures, pore spaces and adsorbed onto the organic material of shale. Its extraction involves drilling wells/boreholes to considerable depth (usually more than 1,000 m) and in some cases horizontally.

Where there is insufficient natural permeability in the formation for the gas to escape, this may be enhanced by hydraulic fracturing (often referred to as fracking or hydrofracturing) at multiple levels, whereby a fluid is pumped into the well bore at pressure to create and propagate fractures in the surrounding rock formation. The fluid is then pumped out to release gas and in some cases oil. The process can involve the injection and return of large volumes of water.

The injected fluid is mainly water (99.5 per cent). It contains sand or ceramic beads to 'prop' open the fractures and maintain the enhanced permeability. Small amounts of other substances may be added including:

- bactericide to inhibit growth of organisms that might clog the well or lead to contamination of the methane gas;
- substances to reduce the viscosity of the fluid so that it can fully access the fractures.

Only non-hazardous chemicals, including those found in household products, have been used in 'frack fluids' in England and Wales.

The water that returns to the surface consists of frack fluid along with minerals released from the shale (for example, chloride and metals) and very small amounts of naturally occurring radioactive materials (NORMs). The level of NORMs is similar to that found in many other rocks in the UK such as granite.

The methods used in hydraulic fracturing have been developed and established over some 60 years, primarily in the USA. Sophisticated geophysical methods allow the fracturing to be targeted and controlled, and the detection of problems with the installation. Drilling and installation is carried out to oil and gas industry standards, overseen by HSE and the Department of Energy and Climate Change (DECC).

The recent advances in technology, mainly through directional drilling and hydraulic fracturing, have greatly extended the application, particularly in the US. A study by the US Environmental Protection Agency (US EPA) of the widespread use of hydraulic fracturing for coal bed methane concluded that there was no significant evidence that the drinking water found in aquifers was being affected (US EPA 2004). However, shale gas production in the US has been developed extensively and there has been a corresponding increase in public concern based on reports of pollution problems in groundwater. It is difficult to verify whether these are the direct consequence of the extraction processes or some other pre-existing issue. Further studies are being carried out by the US EPA and ourselves – and in other countries where shale gas is potentially a significant resource – to understand better the long-term risks and mitigation needed.

Coal bed methane

Coal bed methane (CBM) is held within the coal by adsorption. The methane is released when the coal seam is depressurised. Boreholes are drilled to dewater the coal seam. The decrease in pressure allows methane to escape from the coal and flow up the well to the surface. Hydraulic fracturing may also be used to open up the coal seam to help release methane.

Extraction may generate other hydrocarbons in addition to methane. Over time, wells may be spaced more closely in order to extract the remaining methane. The produced water may contain undesirable concentrations of dissolved substances. Water withdrawal may depress the level of water in aquifers over a large area and affect groundwater flows.

Underground coal gasification

Underground coal gasification (UCG) and extraction is an in situ process carried out in coal seams. It involves the injection of oxidants to ignite the coal, bringing the resulting mixture of gases to the surface through separate production wells drilled from the surface. It produces a mixture of gases known as syngas (mostly carbon monoxide, carbon dioxide, hydrogen and methane) that can be processed to provide fuels for power generation, diesel fuels, jet fuels, hydrogen, fertilisers and chemical feedstock.

Coal has considerable variation in its resistance to flow depending on age, composition and geological history. Where there is insufficient natural permeability, this may be enhanced by high pressure break-up of the coal with water (hydraulic fracturing), electric linkage and reverse combustion. Hydraulic fracturing for the UCG process would not normally be expected to include any additives in the water.

UCG can be applied to resources that are otherwise unprofitable or technically complicated to extract by traditional mining methods. Contamination of aquifers is a potential environmental concern. Pollutants (such as phenol) remain in the underground chamber after gasification and, without the appropriate controls, these could leach into groundwater.

This document is out of date was withdrawn 14/03/2017

Regulation

In view of the potential risks associated with unconventional sources of gas, it is essential to ensure that we apply the appropriate regulatory controls and encourage high standards of environmental protection through communication with the industry and influence at the planning stage. Our use of permits, together with the controls available to other regulators (DECC, HSE and local planning authorities) helps to provide the framework for this.

See our position statement C6 on UCG, CBM and shale gas extraction.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

5 Protecting groundwater resources

This chapter explains how we work to ensure there is sufficient water for people, industry and the environment.

Topics

- **Abstraction management strategies**
- **Options for developing resources**
- **Groundwater storage**
- **Saline intrusion**

Abstraction management strategies

We need to make sure there is enough water for people (public water supply, industry and agriculture) and a healthy environment. We control how much water is taken with our permitting system. We regulate abstractions by a licensing system. Note that, following the Water White Paper (Defra 2011b); the whole approach to managing abstractions is being reviewed by government to reflect the increasing pressures on scarce water resources.

Our catchment abstraction management strategies (CAMS) set out the available water resources in each catchment area in England and Wales (Figure 5.1).

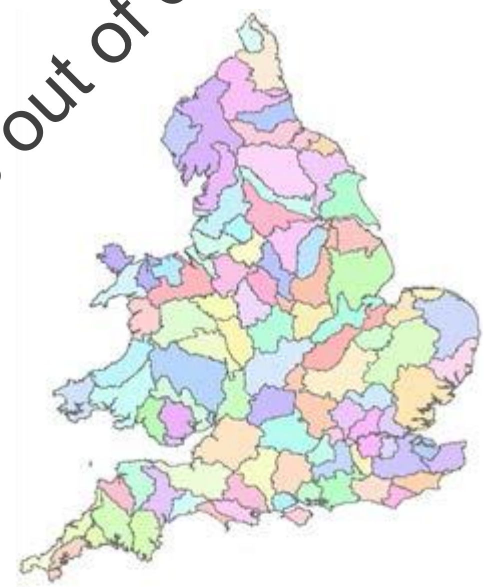


Figure 5.1 CAMS areas in England and Wales

This document is out of date was withdrawn 14/03/2017

The aims of CAMS are to:

- make information on water resource availability and the abstraction licensing strategy within the catchment more readily available;
- provide a consistent and structured approach to local water resource management;
- recognise both environmental needs and the abstractor's reasonable need for water;
- provide mechanisms to assess water resources availability;
- provide results which ensure relevant Water Framework Directive objectives are met;
- provide tools to aid licence decisions – particularly the block replacement and management of time-limited licences.

The CAMS process considers the impact of abstraction at all flows. This allows us to grant licences where there may be, for example, impacts at low flows but not at higher flows. These licences will be issued with conditions restricting abstraction at lower flows – known as the 'hands off flow' (HoF). Similarly, groundwater abstraction licences may also have conditions such as cessation of pumping when a certain groundwater level has been reached – a 'hands off level' (HoL).

Most new licences in a CAMS area will be time-limited and have a common end date (CED). This will allow periodic review and changes to abstractions within an area where circumstances may have changed since licences were granted. Licences that are likely to have an impact may still be issued, but for a period less than the CED in order to allow monitoring of the potential impact.

A groundwater body defined under the Water Framework Directive can be classed as either 'good' or 'poor' based on its chemical status and groundwater abstraction pressures. In CAMS we assess the quantitative status (abstraction pressures) based on the current groundwater abstraction impacts on each groundwater body. This includes the impact of groundwater abstraction on surface water flows.

The Water Framework Directive requires that all groundwater bodies achieve good status by 2015 unless alternative objectives are justified. For most of the groundwater bodies at poor status we have justified an extended deadline (2027) on the basis that premature action to modify abstractions will be disproportionately costly. This will allow time for investigations to be completed and appropriate measures implemented.

In areas where principal aquifers are classed as being at poor status due to abstraction pressures we may seek to reduce groundwater abstraction. However, in some cases rising groundwater (rebound) is such that it could potentially affect property and infrastructure. We may need to encourage new abstraction. This approach is consistent with the Water Framework Directive and is reflected in the CAMS for a particular area.

Where it would be disproportionately expensive to achieve good status, we may set less stringent objectives. For example, in the case of mine water rebound, allowing groundwater levels to recover so that good quantitative status is achieved might threaten the good chemical or ecological status of water bodies. In this case a balance between competing demands must be struck.

The aim and principles of CAMS and links with other initiatives are detailed in Managing water abstraction (Environment Agency 2010a).

The latest CAMS for England and Wales can be viewed on our website. The abstraction licensing strategy for each CAMS is reviewed annually and updated if necessary.

This document is out of date was withdrawn 14/03/2017

Over-abstraction

Sustained abstraction from an aquifer in excess of the long-term rate of recharge can result in depletion of the groundwater storage. This is sometimes called groundwater 'mining' and can result in:

- loss of springs;
- reduced river flows;
- falling water levels beneath wetlands;
- dried up boreholes;
- damage to the aquifer system.

Our use of CAMS will help to prevent over-abstraction occurring in the future and identify solutions where problems already exist. We are also seeking to reduce certain abstractions that are adversely affecting sensitive rivers and wetland sites under our Restoring sustainable abstraction (RSA) programme.

Options for developing resources

To manage groundwater effectively, we need to balance abstraction for water supply with the needs of the environment (for example, maintaining adequate river flows). Our water resources strategy (Environment Agency 2009a) considers a range of demand management and water efficiency/reuse options as well as new resource development in terms of financial and carbon cost.

Demand management options include:

- metering and tariffs;
- smart metering;
- conventional metering;
- efficient showers and baths;
- spray taps;
- water audits;
- low flush toilets;
- community rainwater harvesting;
- individual rainwater harvesting;
- community greywater reuse;
- individual household greywater reuse.

New supply options include:

- direct groundwater abstraction;
- aquifer storage and recharge;
- river intake;
- indirect effluent reuse;
- reservoir;
- desalination of brackish water or saline water.

This document is out of date was withdrawn 14/03/2017

Groundwater storage

Groundwater storage is more difficult and sometimes more costly to access than surface water. However, the potential storage is vast and there may be cost, technical and political advantages in using groundwater storage rather than building a major reservoir.

There is a complementary relationship between the recharge of surface and groundwater 'reservoirs' due to the time lag between rainfall filling conventional reservoirs and the recharge to aquifers. Surface water resources are often plentiful in the spring and early summer. In contrast, plentiful groundwater supplies may be available during late summer and early autumn, when rainfall and surface water flows are low. The lag time in groundwater systems usually means that groundwater resources are lowest in late autumn or early winter. Most groundwater recharge takes place during winter.

The different storage characteristics for groundwater and surface water reservoirs are also helpful. For example, groundwater abstraction in summer may only impact on a river in winter when surface flows are higher. In addition, high storage sandstone aquifers are far more resilient during drought in terms of security of water supply and the impact of abstraction on river flows.

There are a number of 'conjunctive use' schemes in operation where groundwater and surface water sources are used together, at different times of the year, to meet seasonal demand and minimise environmental impact. Where feasible, this approach is likely to become increasingly important to help us to adapt to climate change.

In some places, operators (usually water companies) make use of aquifers for water storage as in Thames Water's North London Artificial Recharge Scheme. During periods of surplus, water treated ready for supply to customers is instead recharged to the Chalk aquifer via wells and boreholes. The water is then stored in the rock for later abstraction. Our position on managed aquifer recharge (MAR) and recovery schemes is detailed in section Q..

A different approach is aquifer storage and recovery (ASR). This is a more localised scheme where excess surface water is taken and injected into an aquifer, often where the groundwater quality is naturally poor. This technique uses the storage capacity of the aquifer to store good quality water by displacing the natural poor quality water. The stored water is re-abstracted when surface water flows are low or the local demand for water is high. This can help to reduce pressure on surface water systems when the environment is most stressed and therefore reduces damage to ecosystems.

In certain parts of the country, river augmentation schemes pump groundwater into surface watercourses to enhance flow. River augmentation is generally carried out to either support surface water abstractions further downstream or for environmental protection (for example, to alleviate low flow). Small schemes may use a single borehole to maintain flow in a small stream with a high amenity or ecological value. The largest schemes may have 20 or more boreholes supporting large-scale downstream surface water abstraction for public water supply. Our position on river augmentation from groundwater is detailed in section P.

Saline intrusion

Sea water is denser than fresh water due to its salt content. As a result, fresh water floats on top, with a mixing zone at the interface. The intrusion of denser saline groundwater can occur naturally where aquifers meet the coast where the discharging fresh waters ride over a wedge of denser, salty water (Figure 5.2). Ancient saline

This document is out of date was withdrawn 14/03/2017

groundwater is also present in certain deep aquifers and in natural spas. This saline groundwater is unrelated to coastal intrusion and in some cases is many times more salty than the sea. The balance between fresh groundwater and the denser saline water is a delicate one, being highly dependent on the local groundwater flow regime and the geology.

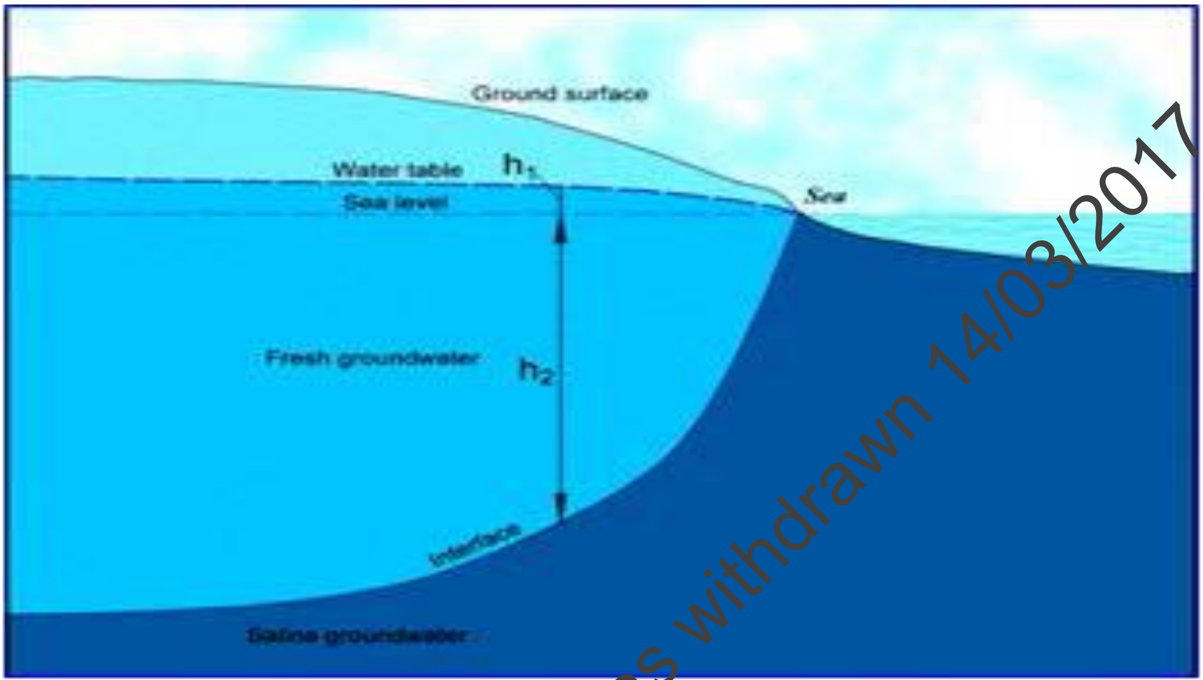


Figure 5.2 Relationship between fresh and saline groundwater in a coastal aquifer

Abstraction from the overlying fresh waters can cause saline waters to intrude inland into an aquifer from the coast or upwards from depth. In sandstones (where the flow is mainly intergranular), saline intrusion moves more slowly and on a broader front. In fractured aquifers, such as the Chalk, intrusion can move rapidly and extend inland for a considerable distance.

Some abstractors have developed practices to control saline intrusion which allow them to make the optimal use of the groundwater resource. However, in some cases, excessive abstraction has resulted in the progressive migration of saline fronts inland or upwards from depth. This threatens high-quality groundwater resources.

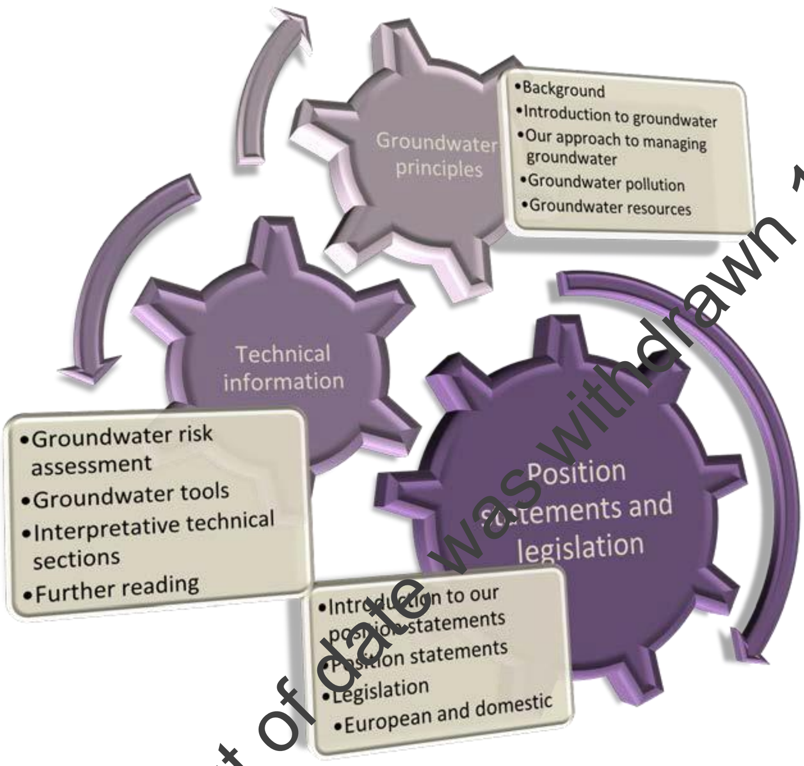
Saline intrusion is complex and unpredictable. As a regulator, we need to act with caution when we consider new, increased or changed abstraction regimes in estuarial or coastal settings, or in inland areas where deep saline groundwater is present.

Some areas have had saline groundwater for a long time. This does not mean that the groundwater has no potential use. It is possible to utilise brackish groundwater for industrial and manufacturing purposes. With the increased focus on the effective use of water resources, more companies are using these waters. In addition, suitable treatment enables brackish groundwater to be used for higher grade purposes. This use of poorer quality groundwater can reduce the pressure to abstract more environmentally sensitive groundwater and surface water.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

Part 2: Position statements and legislation



This document is out of date was withdrawn 14/03/2017

6 Position statements

This chapter presents a series of position statements that detail how we deliver government policy for groundwater and put it into action with reference to relevant legislation (see Chapter 7) where we have freedom in the exercise of our powers and duties.

Topics

This document is out of date was withdrawn 14/03/2017

Introduction to the position statements

The position statements set out in this chapter provide you with information about our approach to managing and protecting groundwater and help you to understand the environmental decisions we take.

The position statements act as a framework for Environment Agency staff to help them make decisions, though still enabling them to use local information to be flexible in meeting the needs of the local environment and local communities. They can also be used as an aid for other public bodies, such as planning authorities in understanding:

- the importance of groundwater;

- the risks posed by specific activities;
- measures that can be taken to mitigate those risks.

This clear approach aims to remove uncertainty and potentially inconsistent decision-making.

This chapter contains a series of sections containing position statements that detail how we regulate and manage groundwater, each focused on different activities or sectors. Our position statements are within the overarching government policy framework.

General approach to groundwater protection covers a wide range of activities that are also an integral part of the activities described in later position statements. **The position statements set out in this first section should be referred to before consulting sector-specific position statements.**

Many of the approaches set out in our position statements are not statutory but may be included in, or referenced by, statutory guidance. Some position statements seek to influence the activities of others that can or do affect groundwater where there is no specific legislative requirement or where other responsible bodies implement the legislation. We recommend that you consider these early in the planning and design of any project. This will help to identify any constraints necessary to protect groundwater and allow you time to investigate and agree proposals.

Sustainable development is important when we make decisions. We will consider not only the environmental benefits and impacts of activities, disposal, discharge and development, but also the social and economic benefits and impacts, including the impacts on natural resources and climate change. We will also seek to take account of short-term and long-term effects, and to avoid decisions that generate short-term economic, social or environmental benefits at disproportionate long-term impact.

We balance this approach with the need to comply with environmental legislation and to prevent or remedy pollution where possible. We also need to consider how climate change may impact existing and planned activities that could influence groundwater resources and quality. We also need to ensure our position statements align with approaches to reduce greenhouse gas emissions and adapt to climate change.

Important note

Under the right circumstances, we may consider a relaxation from a position statement if this is supported by suitable evidence and a risk assessment. Any local decision would not set a precedent for the general application of the position statements. You should always discuss any proposals that conflict with a position statement with us first.

The legislation and tools for managing and protecting groundwater do change and our approaches evolve, so we may in the future add other position statements to those set here or on our website. We will regularly review and update GP3 where relevant. Our definitive approach is that given in the current version of GP3 or any separate position statements that we may put on our website.

This document is out of date was withdrawn 14/03/2017

A. General approach to groundwater protection

Introduction

The primary aims of all of our position statements is the prevention of pollution of groundwater and protection of it as a resource.

We apply common principles to many activities that can affect groundwater. These are set out here and are used together with the sector-specific position statements in the following sections.

We adopt a risk-based approach to environmental protection where legislation allows, following the principles recommended in Green Leaves III: Guidelines for environmental risk assessment and management (Defra 2011a). Our experience may lead us to adopt a robust approach to the most potentially polluting activities and/or activities in sensitive locations. On occasion legal requirements may oblige us to follow a prescriptive approach.

Our role

We have a duty to maintain and protect the quality and quantity of groundwater resources for current and future abstraction, dependent ecosystems and indirect uses.

The issue of permits for abstractions and discharges to water and land is an important part of our regulatory role. We can refuse permits if, for example, we consider they would interfere with another abstraction or harm an aquifer, river, lake or wetland. We can also serve notices on anyone carrying on any activity (or proposing to) on or in the ground that may result in hazardous substances entering groundwater, or it becoming polluted by non-hazardous pollutants. We also have the necessary powers to enforce these permits and notices.

General groundwater protection position statements

A1 - Risk-based approach
Wherever legislation allows, we will use a tiered, risk-based approach to our regulation of activities that may impact groundwater resources and to the prevention of pollution.

A2 - Precautionary principle
Development must be appropriate to the sensitivity of the site. Where the potential consequences of a development or activity are serious or irreversible we will adopt the precautionary principle to the management and protection of groundwater, particularly in the absence of adequate information with which to conduct an assessment.

A3 - Groundwater protection hierarchy
We encourage planners, developers and operators to consider our groundwater protection hierarchy in their strategic plans and when proposing new development. Our aim is to avoid potentially polluting activities being located in the most sensitive locations from a groundwater protection viewpoint.

This document is out of date was withdrawn 14/03/2017

A sensitive location with respect to groundwater would depend on the hazard and importance of the receptor.

A4 - Responsibility for assessments
We expect developers and operators to assess the area of influence of their activities and to take account of groundwater uses and dependent ecosystems within this area during planning, construction, operation, and decommissioning.

A5 - Supply of adequate information
We expect developers and operators to provide adequate information to statutory bodies including ourselves when submitting their proposals, so that the potential impact on groundwater resources and quality can be adequately assessed. In particular, where new techniques, operations, products or substances are involved, developers or operators should be prepared to supply specific relevant data to allow the risk to groundwater to be assessed.

A6 - Compliance with good practice
We expect site owners, developers and operators to comply with any relevant statutory codes of good practice and to have due regard to our advice and guidance, and to other reputable standards and guidance*. This applies particularly to the handling, use, storage and treatment of substances that can potentially result in an unacceptable input to groundwater. * For example, British Standards, International Organization for Standardization (ISO).

A7 - Enforcement
If necessary, we will use our powers to serve notices to prevent or stop unacceptable inputs to groundwater arising from an activity that is not subject to a permit. In the event of actual pollution, we will take into consideration whether the operator is complying with a statutory code of good practice before taking further action.

A8 - Building and decommissioning of structures
We expect best practice regarding the development or backfilling of any shaft, well, borehole, tunnel or adit in order to prevent pollution or loss of water resources. We expect operators to adopt appropriate engineering standards and comply with our publication, Good practice for decommissioning redundant boreholes and wells (Environment Agency 2012). Any contamination that is discovered during decommissioning or otherwise should be dealt with in accordance with our position statements on land contamination.

This document is out of date was withdrawn 14/03/2017

A9 - Delay in recovery
Where existing groundwater conditions have been adversely affected by human activity so that pollution has occurred, we aim to ensure that any new development or discharge will not significantly delay the restoration of groundwater quality to an unpolluted condition.

Legal framework

An overview of the legislation that covers the general protection of our groundwater resources is given in Chapter 7. For general groundwater protection there are a number of relevant pieces of legislation to protect the quality of drinking water.

Water Resources Act 1991

Section 93 of the Water Resources Act 1991 allows for the designation of statutory water protection zones (WPZs) (for groundwater or surface waters). These may be designated to prohibit or restrict the carrying out of activities that are giving rise to the entry of poisonous, noxious or polluting matter into ground or surface waters and which present a risk of pollution. They may also be used to impose requirements on persons who carry out activities in the zone to take such steps as may be specified or described by the defined WPZ.

Water Framework Directive (2000/60/EC)

Article 7.1 of the WFD requires member states to formally delineate water bodies that are used for the abstraction of drinking water, called drinking water protected areas (DrWPAs). All groundwater bodies in England and Wales are classified as DrWPAs due to the low abstraction thresholds set in the WFD. Article 7.2 stipulates that the requirements of the Drinking Water Directive must be met; in England and Wales this is the responsibility of the Drinking Water Inspectorate. Article 7.3 requires the protection of these water bodies 'with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water'. We can establish safeguard zones for this purpose if we wish.

Although the Article 7 objectives apply across a groundwater body, the point of compliance for Article 7.3 is at the point of abstraction. This means that applying protection measures equally over the entire land area of the DrWPA is not necessary to meet this objective.

There are some common elements with the requirements of Article 7 of the WFD and we encourage collaboration between water companies and ourselves to achieve these common goals.

REACH Regulation (EC 1907/2006)

REACH is the European Community regulation on chemicals and their safe use (EC 1907/2006). It deals with the registration, evaluation, authorisation and restriction of chemical substances. The regulation entered into force on 1 June 2007.

The aim of REACH is to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. At the same time, REACH aims to enhance the innovation and competitiveness of the EU chemicals industry.

This document is out of date was withdrawn 14/03/2017

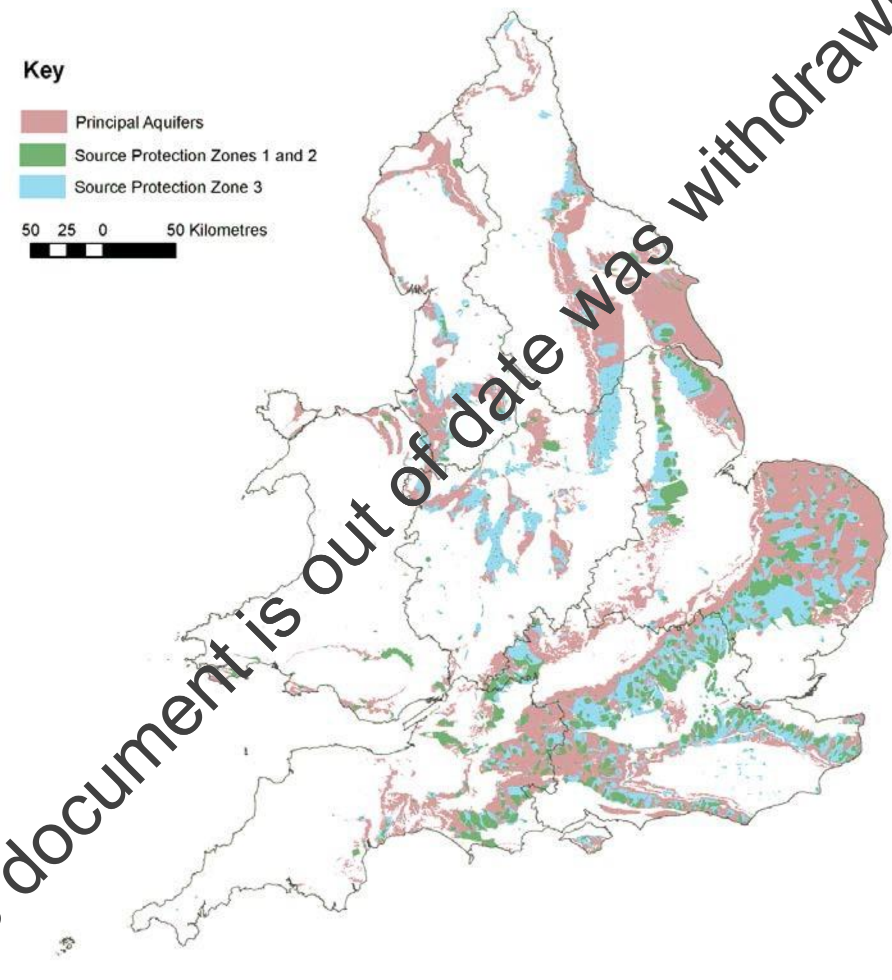
B. Protection of water intended for human consumption

Introduction

This section contains our position statements on source protection zones (SPZs).

Our role

We will give consistent advice on development proposals based on the groundwater risk as shown by the SPZ designation or aquifer designation (principal and secondary aquifers – see Figure 6.1) at the site in question using the general groundwater protection hierarchy shown in Figure 6.2. In order to protect groundwater, we may object in principle to, or refuse to permit, some activities. However, SPZs and the use of aquifer designation should not be taken as a substitute for site-specific risk assessment (see Chapter 8).



This document is out of date was withdrawn 14/03/2017

Figure 6.1 Principal aquifers and source protection zones in England and Wales

Note: This map provides a strategic view and should not be used for site-specific risk assessment.

Aquifer designation		Within an SPZ
Principal aquifer	↑	SPZ1
Secondary aquifer		SPZ2
Unproductive strata	Increasing sensitivity	SPZ3

Figure 6.2 General groundwater protection hierarchy

Position statements

B1 - Screening tool
We will use SPZs as initial screening tools to show: • areas where we would object in principle to certain potentially polluting activities, or other activities that could damage groundwater resources; • areas where additional controls or restrictions on activities may be needed to protect water abstracted for human consumption; • how we prioritise responses to incidents. Note: For some high risk activities, the presence of an SPZ will be a deciding factor in our response. For other activities, additional investigation may show that a proposal is or is not acceptable regardless of the requirements of the SPZ position statements.

B2 - Designation of SPZs around groundwater abstractions
Our SPZ position statements apply to any groundwater abstraction of water intended for human consumption as defined in the Drinking Water Directive (98/83/EC). However, for production of bespoke SPZs we have prioritised: • public drinking water supplies; • other commercial potable supplies (including mineral and bottled-water); • groundwater abstractions used in commercial food and drink production;* • other sources where we believe additional protection is required. * Groundwater abstractions used in commercial food and drink production does not mean water that is used for the irrigation of crops.

B3 - Default source protection zones for small abstractions and private water supplies
All other groundwater abstractions intended for human consumption will assume a default SPZ1 and in cases depending on volumes abstracted an SPZ2.

This document is out of date was withdrawn 14/03/2017

The default SPZ1 will be a circle of radius 50 metres with the centre at the abstraction point.

The default SPZ2 is a circle of radius 250 metres centred on the abstraction point for sources with a protected yield of less than 2,000 m^3 per day or 500 metres for sources with a protected yield of more than 2,000 m^3 per day.

In some circumstances, we may use a more appropriate simple shape (for example, an ellipse) for either or both zones which may depict groundwater flow more accurately than the default circle.

Table 6.1 indicates restrictions or extra control in a SPZ1. If you wish to undertake a specific activity you are recommended to refer to the relevant section of GP3.

This document is out of date was withdrawn 14/03/2017

Table 6.1 Position statements that apply specifically to SPZ1

Topic	Position statement
Infrastructure	C2 - Non-nationally significant infrastructure schemes C4 - Transport developments C5 - Pipelines and high voltage fluid filled cables C6 - Underground coal gasification, coal bed methane and shale gas extraction C7 - Oil and conventional gas exploration and extraction
Storage of pollutants	D2 - Underground storage (and associated pipework) D3 - Sub water table storage
Landfill	E1 - Landfill location
Other waste activities	F1 - Non-landfill waste activities
Discharge of liquid effluents into the ground	G2 - Sewage effluent discharges inside SPZ1 G4 - Trade effluent and other discharges inside SPZ1 G6 - Cesspools and cesspits G8 - Sewerage pipework G12 - Discharge of clean roof water to ground G13 - Sustainable drainage systems
Diffuse sources	H6 - Landspreading H7 - Livestock housing H8 - Storage of organic manures on farms
Cemetery developments	L1 - Siting cemeteries close to a water supply used for human consumption L2 - Mass casualty emergencies L3 - Cemeteries: Protecting groundwater in highly sensitive locations
Burial of animal carcasses	M1 - Burials close to water supply used for human consumption or farm dairies M2 - On-farm carcass burials M3 - Risk-based approach M4 - Animal carcasses: Protecting groundwater in highly sensitive locations
Managing groundwater resources	N8 - Physical disturbance of aquifers in SPZ1
Ground source heating and cooling	R4 - Good practice

Note: Applies to both modelled and default zones including private water supplies around potable abstractions.

This document is out of date was withdrawn 14/03/2017

Legal framework

Private water supplies

The Water Supply (Water Quality) Regulations 2000 (as amended in England) and 2010 in Wales and Private Water Supplies Regulations 2009 (England) and Private Water Supplies (Wales) Regulations 2010 require water companies and local authorities to adopt a risk-based drinking water safety planning approach to public and private water supplies respectively.

Source protection zones

SPZs are not statutory. However, SPZ1 has been noted in statutory guidance as the minimum area under the former Groundwater Directive that is identified for the protection of drinking water. SPZs are also recognised within the Environmental Permitting Regulations (EPR) as a zone where certain activities cannot take place (for example, in certain standard rule permits).

This document is out of date was withdrawn 14/03/2017

C. Infrastructure

Introduction

This section focuses on developments (that is, new facilities, extensions to existing facilities, change of use and refurbishments) that represent a particular hazard to groundwater due to the type of activity, its duration or the potential for failure of controls. These can potentially lead to serious or widespread pollution of groundwater.

The position statements in this section are specifically tailored to cover the infrastructure developments listed below but we will apply them to any new infrastructure or technologies not specifically identified here where there is a significant potential for groundwater pollution.

Specific infrastructure developments are as follows:

- transport infrastructure such as major roads, railways, airports, industrial parks and large parking areas for commercial vehicles;
- tunnels;
- oil and other pipelines, fluid-filled electricity cables, substations and infrastructure;
- oil industry facilities associated with oil exploration, production, manufacturing (including refineries), distribution (including pipelines) and storage;
- industrial activities storing and handling significant quantities of hazardous substances;
- petrol and/or diesel retail filling stations;
- large-scale agricultural developments;
- underground coal gasification (UCG), coal bed methane (CBM) and shale gas exploration and extraction.

Our aim is to protect existing water supplies and to avoid the situation where possible future development of important groundwater resources is constrained by the presence of groundwater contamination or potentially contaminative land-uses. This will help to ensure our groundwater resources are available for future generations. The development of these activities should therefore be directed towards less sensitive locations.

Car parking has historically been regarded as having the potential to cause significant contamination. However, with the improvement in vehicle standards in recent years, this is no longer routinely the case. There is therefore no need for a specific position in relation to car park location, but we would encourage the use of sustainable drainage systems (SuDS) (see section G - discharge of liquid effluents into the ground and section N - management of groundwater resources) as the best means of managing the quality and quantity of run-off. However, it remains vital to pay close attention to commercial parking and hard standing areas where contaminated run-off could cause pollution of surface or groundwater.

Our role

All the development types identified in this section present a potential pollution hazard to groundwater. In areas where groundwater is of less concern, the risks to surface water are likely to be greater. Therefore it is vital that good pollution prevention practice is applied.

This document is out of date was withdrawn 14/03/2017

We can influence the siting and construction of many activities through our role as a consultee to the development planning process and our role in permitting these activities. Our involvement in the planning process can be crucial in preventing pollution from major infrastructure and to help direct such development to areas where groundwater is less vulnerable. If national need for the provision and location of major developments overrides our objections we will raise our concerns and make every use of environmental impact assessment in addition to other measures to achieve environmental protection. Where developments receive approval against our advice we will apply section A - general protection position statements.

Planning may not always be able to give the level of control over land use necessary for a high standard of groundwater protection. Many infrastructure developments also require a permit from us under EPR or may be eligible for an exemption from the need for a permit. Where this is the case, groundwater protection would normally be achieved via these controls and we will apply a risk-based approach. Within SPZ1 we have a presumption against development that involves activities posing an inherent hazard to groundwater; where appropriate, we will oppose such new developments via the development planning system or refuse a permit application.

Where developments involve discharges to ground, please refer to G11 - discharges from areas subject to contamination and G12 - discharge of clean roof water to ground.

Sites regulated under EPR are also required to implement pollution prevention measures that must meet the requirements of best available techniques (BAT) and should set a standard of good practice. Where developments pose comparable levels of risk outside this regime, we will expect BAT principles to be applied. Under EPR we are able to serve a notice to prohibit an activity altogether where the risks and consequences of failure of good practice are unacceptable. This process runs in parallel to any planning response for new developments or change of use.

We are keen to develop agreements with specific sectors to prevent pollution from their activities. This aims to provide operators with the best information on how to carry out their activities with minimal risk to the environment. This also gives us assurance that good practice is being applied. In some circumstances, we will also issue external guidance on good practice for specific developments or activities.

This document is out of date was withdrawn 14/03/2017

Position statements

C1 - Nationally or regionally significant schemes
We will encourage the promoters of schemes of national or regional significance to follow the principles of groundwater protection in choosing locations. In the cases where this is not possible due to national or regional interests we expect to be fully involved in the scheme development to mitigate groundwater risks via EPR where applicable. We expect promoters (via the environmental impact assessment process) to identify all the potential pollution linkages and apply best available techniques to mitigate the risks.

C2 - Non-nationally significant infrastructure schemes
In SPZ1 and SPZ2 we will only agree to proposals for infrastructure developments of non-national significance where they do not have the potential to cause pollution or harmful disturbance to groundwater flow or where these risks can be reduced to an acceptable level via EPR if applicable.

C3 - On-going groundwater monitoring
Where a new infrastructure development presents a significant risk to groundwater we may require a programme of groundwater monitoring to be designed, agreed, installed and undertaken to give early warning of developing groundwater pollution and/or interference to groundwater flow. This programme may include off-site locations if necessary to identify pollution and to allow monitoring in the event that the site becomes inaccessible. Where appropriate, we will use our powers to require this at existing sites.

C4 - Transport developments
When planning proposals are brought forward for major new road, rail or airport developments we will require that: • drainage is via sustainable drainage systems (SuDS) designed and maintained to current good practice standards, including the provision of suitable treatment or pollution prevention measures. The point of discharge should normally be outside SPZ1 and, ideally outside SPZ2; • where there is an existing or unavoidable need to discharge in SPZ1, we require a risk assessment to demonstrate that pollution of groundwater will not occur. See also our position statements G11 and G12.

This document is out of date was withdrawn 14/03/2017

C5 - Pipelines and high voltage fluid filled cables
We will object to pipelines or fluid filled cables that transport pollutants, particularly hazardous substances that: • pass through SPZ1 or SPZ2 where this is avoidable; or • are below the water table* in principal or secondary aquifers. Where there is an existing or unavoidable need for pipelines or fluid filled cables to pass through SPZ1 or SPZ2 we expect operators to adopt BAT and operate in accordance with the sector guidance (Energy Networks Association and Environment Agency 2007). Where existing pipelines or fluid filled cables are already below the water table or if the water level subsequently rises, we will work with operators to mitigate the risks. We will only agree to any redevelopment scheme with sub water table pipelines or fluid filled cables for the transport of hazardous substances where there are substantial mitigating factors. When the opportunity to replace existing fluid filled cables in SPZ1 and SPZ2 arises we will work with the operators to agree the best environmental option. We would expect operators to carry out a site specific risk assessment prior to the decommissioning of pipelines or fluid filled cables in SPZ1 and SPZ2. We will then work with operators to agree the best available environmental option. Please note that this position statement applies to underground and on ground cables but not aerial cables. * For the purposes of this position statement we would include in the term 'water table' any laterally continuous groundwater in these aquifers including perched groundwater. Operators should consider the lifetime of the pipeline or cable in their assessment of the depth to groundwater.

Hydraulic fracturing (fracking) may be used in underground coal gasification (UCG), coal bed methane (CBM) and shale gas extraction to increase the reservoir permeability and thus increase gas production. Groundwater may under some circumstances be impacted by:

- pollutants in the injected fracture fluid;
- the introduction or displacement of natural and introduced pollutants (including gas);
- effects on groundwater flows.

The withdrawal of water may depress water levels in overlying aquifers over a large area and affect groundwater flows. Works at the surface may lead to inputs to groundwater (for example, via lagoons) and there is the potential issue of re-injection of waters arising from the processes. Where the activity requires a permit, this will cover the associated surface works. Where a permit is not required, we will work with the relevant planning authority during the planning consultation process to deliver the necessary controls within the planning consent.

This document is out of date was withdrawn 14/03/2017

C6 - Underground coal gasification (UCG), coal bed methane (CBM) and shale gas extraction
We wish to facilitate development of sustainable sources of energy, working in partnerships on initiatives where appropriate. However, we will object to UCG, CBM or shale gas extraction infrastructure or activity within SPZ1. Outside SPZ1, we will also object when the activity would have an unacceptable effect on groundwater. Where development does proceed, we expect BAT to protect groundwater to be applied where any associated drilling or operation of the boreholes/shafts passes through a groundwater resource. Elsewhere, established good practice should be followed. Groundwater that is currently used as a resource or provides flow to surface waters and wetlands, or may be used as a resource in the future must be afforded a high degree of protection. A high level of protection will also extend to some deep formations that contain groundwater that would be suitable for use following treatment if necessary, or that may be used for artificial storage and recovery. For other formations groundwater must also be protected but we would not seek to apply the same degree of protection.

C7 - Oil and conventional gas exploration and extraction
We will object to such hydrocarbon exploration, extraction infrastructure or activity within SPZ1. Outside SPZ1, we will also object when the activity would have an unacceptable effect on groundwater. Where development does proceed, we expect BAT to protect groundwater to be applied where any associated drilling or operation of the boreholes passes through a groundwater resource. Elsewhere, established good practice for pollution prevention should be followed. Where such activities already exist we will work with operators to assess and if necessary mitigate the risks. We will object to any redevelopment scheme involving retention of oil exploration, extraction infrastructure or activity within SPZ1 unless there are substantial mitigating factors.

This document is out of date was withdrawn 14/03/2017

Legal framework

Environmental Permitting Regulations (EPR)

See Chapter 7.

Town and Country Planning Acts and Regulations (various dates)

The town and country planning acts and regulations influence the location of developments through development plans and specific planning applications.

Town and Country Planning (Environmental Impact Assessment) Regulations 1999

These regulations require an impact assessment to ensure that the likely effects of (certain) new development(s) on the environment are fully understood and taken into account before the development is allowed to go ahead.

Water Resources Act 1991

The Water Resources Act 1991 gives us powers under section 161A and the Anti-Pollution Works Regulations 1999 to serve works notices to prevent or remedy pollution of controlled waters.

Conservation of Habitats and Species Regulations 2010

See Chapter 7.

Control of Major Accident Hazards Regulations 1999 (COMAH)

COMAH requires measures to prevent a major accident to the environment (MATTE) when certain thresholds are exceeded.

This document is out of date was withdrawn 14/03/2017

D. Storage of pollutants

Introduction

The position statements in this section apply to:

- industrial activities storing and handling significant quantities of hazardous substances;
- petrol and/or diesel retail filling stations;
- fuel storage and dispensing facilities used for public transport infrastructure (for example, associated with airports, railways or ports) or large machinery or plant (for example, at mines and quarries, road haulage/bus and coach depots);
- storage and handling of pollutants that present a significant and on-going potential for groundwater pollution through accidents, vandalism, poor practice, and the deterioration of storage vessels and associated infrastructure such as pipelines.

Our role

We expect statutory codes of practice to be complied with as a minimum – for example in relation to petrol stations and other fuel dispensing facilities involving underground storage tanks and solvent use and storage.

While underground and sub water table storage and associated pipework systems as specified in the Association for Petroleum and Explosives Administration (APEA) and Energy Institute (EI) *Guidance for Design, Construction, Modification, Maintenance and Decommissioning of Filling Stations* (APEA/EI June 2011) are effectively subject to continuous inspection through monitoring systems, they represent a particular hazard to groundwater due to the difficulty of dealing with any leaks that may occur. Single wall systems or those which do not meet the requirements of APEA/EI (2011) could lose fuel directly to ground without any detection.

Operators should be aware that other non-statutory guidance is available from a variety of sources, including our pollution prevention guidelines.

Despite this good practice advice, higher standards may be needed in more vulnerable groundwater locations.

Important note

We recognise the concerns regarding our position on underground storage tanks and above ground storage tanks and remain in discussion with the Energy Institute about how to most effectively compare the hazards from each. When this work has been completed we will consider updating GP3.

This document is out of date was withdrawn 14/03/2017

Position statements

D1 - Principles of storage and their transmission
Where we judge there to be an unacceptable risk to groundwater from the storage of pollutants or their transmission through associated pipework, we will oppose such storage or transmission. If other priorities determine that the development should proceed, we expect BAT to be applied. Elsewhere, established good practice should be followed. Where such storage already exists we will work with operators to assess and if necessary mitigate the risks to groundwater, with an aim to meet this position. Re-use of existing facilities for new applications must be accompanied by a thorough assessment to demonstrate that there will be no unacceptable input of pollutants to groundwater.

This document is out of date was withdrawn 14/03/2017

The principles of storage and their transmission is an overarching approach covering all forms of pollutant storage (specific risks arising from underground storage are referred to in D2 - underground storage and D3 - sub water table storage). However, any storage and transmission facility such as tanks, lagoons and pipework must be designed and maintained in such a way that that the risk of inputs of pollutants to groundwater is minimal.

Facilities that leak and result in inputs of pollutants to groundwater should be decommissioned, replaced or effectively repaired at the earliest opportunity. They may also require a permit under EPR or may be subject to a prohibition notice if the input is unacceptable.

A particular concern is the re-use of existing facilities that are not designed or fit for purpose for the proposed new use.

A new development involving large-scale above ground storage of hazardous substances as may occur at a chemical works or at a petrol filling station would be opposed within SPZ1. However, our position statement D2 - underground storage does not specifically object to all storage of hazardous substances in SPZ1 as this would eliminate common practices such as the storage of domestic heating oil by householders with their own private water supplies. Judgement is required in the light of the nature of the substance, the volumes stored and the pollution prevention measures proposed.

Judgement is also required where there is existing storage; hazardous substances in SPZ1 are again of particular concern. In order to reduce the risk of groundwater pollution, as far as practicable and reasonable we expect operators to make improvements necessary to:

- minimise the likelihood of a release;
- be able to identify and stop a release immediately it occurs;
- adopt good practice standards in design, construction and operation (APEA/EI 2011);
- have effective environmental management systems in place.

D2 - Underground storage (and associated pipework)
We will object to the new and increased underground* storage of hazardous substances in SPZ1. We will agree to such storage on principal and secondary aquifers outside SPZ1 only if there is evidence of overriding reasons why: (a) the activity cannot take place on unproductive strata, and (b) the storage must be underground (for example public safety), in which case we expect the risks to be appropriately mitigated, as noted below. Where such storage already exists we will work with operators to assess and if necessary mitigate the risks, including an aim to change to above ground storage. We will object to any redevelopment scheme involving retention of underground storage of hazardous substances in SPZ1 unless there are substantial mitigating factors. For all storage of pollutants underground we expect operators to adopt appropriate engineering standards, meet the requirements of PPG 27: Above ground oil storage tanks as a minimum standard and have effective management systems in place. These should take into account the nature and volume of the materials stored and the sensitivity of groundwater, including the location with respect to source protection zones. * Underground storage constitutes storage whereby the tank is not wholly visible on a permanent basis and/or is not accessible from ground level; any tank that is partially set in the ground in a secondary containment and is totally accessible and wholly visible will be considered to be an above ground tank. However, any oil storage tank that is not wholly underground will need to comply with the Oil Storage Regulations (in England); in Wales, we expect similar standards.

This document is out of date was withdrawn 14/03/2017

We adopt the precautionary principle to protecting groundwater because of:

- the difficulties associated with observing and remediating leaks from underground storage and transmission facilities;
- the previous history of pollution from such facilities.

Our position on underground storage may encourage the development of above ground storage, which may pose different environmental or health and safety issues. Both operators and the Environment Agency need to have regard to the overall level of risk. We are aware of industry concern with respect to the screening requirements for above ground tanks. These are primarily matters for the planning authority but we recognise that such requirements may influence the site risk assessment.

In principal and secondary aquifers we prefer to see storage of hazardous substances to be placed above ground in tanks with suitable secondary containment. We recognise that this may not always be reasonable when other risks are taken into account. Our position statement D2 - underground storage therefore allows for underground storage of hazardous substances outside SPZ1 where there is sufficient evidence to justify such an approach. This should include both site-specific and generic data on the performance of installations (providing this is appropriate to the materials being stored). We also recognise that some sectors such as petrol retailing have made considerable improvements to the standards of underground storage and we will reflect that in our approach. However, we retain the objection for all new underground storage within SPZ1.

In situations where redevelopment or refurbishment of underground storage at sites is unavoidable, we will review the risks and any contamination history and take account of the proposed improvements. We encourage improvements which reduce the risk of contamination of groundwater. We will not object to below ground storage in such situations provided there is evidence that:

- there are no suitable alternatives to below ground storage;
- redevelopment will maintain a low risk or significantly reduce an existing risk to groundwater;
- proposals comply with appropriate engineering standards (APEA/EI 2011);
- effective management systems are or will be in place;
- redevelopment does not bring the below ground storage nearer to any groundwater abstraction source.

Substantial mitigating factors would be required for any retention of underground storage of hazardous substances in SPZ1.

We would expect proposals for underground storage of pollutants in principal and secondary aquifers to be accompanied by a risk assessment appropriate to the volume and type of pollutants being stored and the hydrogeological situation. More detailed risk assessments and an infrastructure design method statement that meets BAT would be expected for storage within source protection zones or close to other vulnerable receptors.

Sub water table storage of hazardous substances is more problematic as any leak would potentially contravene legislation. By implementing the position statement D3 (below) we are trying as far as possible to minimise the perpetuation of below water table storage facilities.

This document is out of date was withdrawn 14/03/2017

D3 - Sub water table storage

We will object to storage of hazardous substances below the water table* in principal or secondary aquifers.

Where such storage already exists or where the water level subsequently rises, we will work with operators to mitigate the risks, with an aim to change to above ground storage (notwithstanding the position statements above and in particular D2).

We will object to any redevelopment scheme involving retention of sub water table storage of hazardous substances unless there are substantial mitigating factors.

* For the purposes of this position statement we would include any laterally continuous groundwater in these aquifers including ‘perched’ groundwater. Operators should consider the lifetime of the storage in their assessment of the depth to groundwater.

D4 - Use of notices

Where we consider that other forms of control or voluntary action do not give sufficient protection to groundwater, we will serve EPR groundwater activity notices to avoid or restrict inputs of pollutants to groundwater including from, for example, underground storage and distribution facilities.

Storage of radioactive substances

The storage of radioactive substances on sites licensed under the Nuclear Installations Act 1965 is regulated by HSE's Office for Nuclear Regulation (ONR) and not the Environment Agency. Therefore, this guidance does not apply to such storage. ONR will expect licensees for those sites to protect groundwater by complying with the relevant nuclear site licence conditions.

Under these circumstances we would require the operator to take all necessary and reasonable measures to prevent inputs of hazardous substances to groundwater.

Legal framework

Environmental Permitting Regulations (EPR)

See Chapter 7.

Water Resources Act 1991

The Water Resources Act 1991 gives us powers under section 161A and the Anti-Pollution Works Regulations 1999 to serve works notices to prevent or remedy pollution of controlled waters.

Control of Major Accident Hazards Regulations 1999 (COMAH)

COMAH requires measures to prevent a major accident to the environment (MATTE) when certain thresholds are exceeded.

This document is out of date was withdrawn 14/03/2017

E. Landfill

Introduction

Our main concern for groundwater protection is in the location of landfills and their operation through post-closure to surrender of the permit. Sites may also be re-examined at regular intervals as part of re-permitting under the Landfill Directive and permit reviews.

Groundwater can be at serious risk from landfill activities unless they are located in the right place and subject to the right operational controls. The nature of the hazard to groundwater from landfill will depend on the types and quantities of pollutants in the waste. Unless the whole of the waste mass is inert, landfills represent a store of pollutants some of which will inevitably find their way into the environment.

Our approach is to therefore steer the development of landfills with the potential to pollute groundwater into less sensitive locations. Our aim is to protect our existing water supplies and to avoid the situation where the presence of a landfill constrains future development of our most important groundwater resources for future generations.

Landfill leachate is a mixture of chemicals and water from rainfall, waste and waste breakdown and can be highly polluting. For example, the leachate from domestic waste may be similar in composition to sewage, but is potentially many times stronger. Even very high standards of engineering cannot totally prevent leachate seepage into the environment.

We need to provide an internal framework to give risk-based advice to waste planning authorities (WPAs) and developers to ensure that, in vulnerable areas, groundwater protection measures will be viable for the entire duration that the landfill remains a pollution risk. Permit surrender is not possible unless a landfill meets specific criteria to our satisfaction.

Our role

We are responsible for issuing permits to regulate landfill construction, monitoring, operation and aftercare. We will rigorously apply the E1 - landfill location position statement in our consultee role and in our permitting role. To assist with this process, we will work with planners and landfill developers at the appropriate stage to provide advice on geology and hydrogeology and the significance of water resources. We will also work with landfill developers and operators to help improve understanding of the issues between industry and us and look for practical solutions.

This approach will complement our strong role in promoting the government's waste hierarchy of prevention, preparing for re-use, recycling, other recovery and finally disposal so as to reduce the need for landfill. It should also influence the appraisal of options for new landfills. Waste local development documents should include or be based on an evaluation of:

- sustainable waste strategies;
- the locations chosen for landfills – these must satisfy the terms of E1 - landfill location so that environmentally sensitive locations are avoided.

Planners have a number of ways to identify acceptable environmental locations for landfill sites. These may include criteria based on location and therefore would encourage consistency with our E1 - landfill location position statement.

This document is out of date was withdrawn 14/03/2017

Parallel tracking is helpful to us and the developer. It means we can use the hydrogeological risk assessment (usually a detailed quantitative risk assessment; Environment Agency 2011a) submitted with the permit application to determine how our E1 - landfill location position statement applies to the planning application. This should include an assessment of the risk with its managed reduction through engineering and management controls. Such assessment must address the long-term viability of pollution control measures over the whole life of the proposed site. This includes any aftercare period and the consequences of site-specific failure scenarios.

Background information

To control the rate of leachate escape to a level that is acceptable to the environment, modern landfill sites are built on a philosophy of containment. This is achieved initially using a mineral barrier, either the natural geology where suitable, or an engineered layer, or both. Where leachate needs to be extracted, the mineral layer works in conjunction with a sealing liner and a drainage system. Modern sites also have sidewall liners and when completed are capped with low permeability materials to reduce rainfall infiltration. These and other measures also help to reduce other environmental risks from landfill such as the migration of landfill gas and allow the gas to be collected and re-used to create energy and reduce greenhouse gas emissions.

The need for a geological barrier is an absolute requirement of the Landfill Directive. It must provide sufficient attenuation between the landfill source and any potential groundwater receptor in order to protect groundwater and ensure compliance with the Groundwater Directive.

The practicalities of constructing and laying liners and the variability of natural materials make some leakage inevitable. During the time it will take for the waste in some sites to fully break down (many decades in most cases), the artificial liner and drainage systems will degrade. The waste will therefore represent a hazard well beyond the active operational phase of the landfill, that is, beyond closure and capping. While we normally require operators to design active site management systems with longevity in mind, the long-term impact from the site will ultimately depend on the capability of the geological barrier and the sensitivity of the underlying groundwater.

When the waste hierarchy has been applied and where disposal is inevitable we favour sites where any long-term potential for pollution is kept away from strategic groundwater resources and groundwater dependent receptors. We therefore favour areas of unproductive strata or, if this is not possible, of secondary aquifer and outside the catchments of water supplies or other sensitive locations. For sites below the water table there may be an increased risk to both surface and groundwater. The risk is increased due to removal of the unsaturated zone and soils where attenuation of pollutants can occur prior to infiltrating to the water table. Sub water table landfill can have a direct link to surface water or other groundwater dependent receptors because of the lack of unsaturated zone and the links that often exist between groundwater and surface water receptors. Wherever possible, waste sites should not be sub water table. This will help to avoid long-term risks to sensitive surface waters that depend on inputs from groundwater.

Specific technical requirements to ensure landfills are properly engineered to protect groundwater should be followed as set out in our regulatory guidance, Understanding the Landfill Directive (Environment Agency 2010b), and our suite of landfill engineering guidance (documents LFE1 to LFE10).

The application of risk assessment to the development of landfills is set out in our H1 technical guidance document on hydrogeological risk assessments for landfills and the derivation of groundwater control and compliance limits.

This document is out of date was withdrawn 14/03/2017

Position statements

E1 - Landfill location
(i) We will object to any proposed landfill site in groundwater source protection zone 1. (ii) For all other proposed landfill site locations, a risk assessment must be conducted based on the nature and quantity of the wastes and the natural setting and properties of the location. (iii) Where this risk assessment demonstrates that active long-term site management is essential to prevent long-term groundwater pollution, we will object to sites: • below the water table in any strata where the groundwater provides an important contribution to river flow or other sensitive surface waters; • within source protection zones 2 or 3; • on or in a principal aquifer.

E2 - Extension of landfill location position statement to radioactive wastes
Whilst recognising that radioactive waste disposal sites are not landfills as defined under the Landfill Directive, we consider that the principles in our E1 – landfill location position statement should be applied equally to proposals for new surface and near-surface disposals of radioactive waste and we will apply this position to such proposals.

Interpreting the landfill location position statement

The following is intended to supersede similar text in regulatory guidance series No. LFD 1 Understanding the Landfill Directive.

Our E1 - landfill location position statement will guide our advice and comments on planning proposals for landfill. Where the designation for aquifers has changed, we will not retrospectively apply the landfill location position statement to any development for which there is written evidence of agreement by us prior to the new aquifer designation maps being issued. All new developments and extensions to existing facilities, for which there has been no such prior agreement, should comply with E1 - landfill location.

This document is out of date was withdrawn 14/03/2017

E1 - landfill location has the following general objectives:

- to provide a risk-based framework for waste planning authorities and developers that steers landfill developments that require active long term site management into less sensitive locations;
- to ensure that groundwater protection measures will be viable for the entire duration of the pollution risk from landfilling.

E1 - landfill location applies to all stages of seeking permission to develop a new landfill. It does not apply to landfills that were already in operation on 15 June 2002 or had not been brought into operation by that date, but the permit was granted before that date. Any new areas (that is, not already permitted on 15 June 2002) will not benefit from the transitional arrangements and therefore the position statement will be applied to applications for an environmental permit for those areas.

Decision framework

The starting point for the decision framework for the position statement is whether or not a site poses a potential hazard to groundwater based on consideration of the waste types and the natural geology.

If an inert landfill does not pose a potential hazard to groundwater (and hence it is not necessary to collect leachate and no drainage system is required), we will not object in principle on the basis of the location position statement unless the site falls within a SPZ1.

If a site does pose a potential hazard to groundwater, leachate collection will be required and so we must consider whether these active controls will be needed over the long term to prevent pollution. If so, unless mitigating factors apply, we would object where the site meets any one of the following criteria:

- site is below the water table in any strata where the groundwater provides an important contribution to river flow or other sensitive surface waters;
- site is within source protection zones 2 or 3;
- site is on or in a principal aquifer.

Mitigating factors such as the presence of substantial drift overlying the aquifer are considered in Box 6.1

Source protection zone 1

Where a conceptual model or risk screening identifies that the proposed landfill is situated inside a SPZ1, then E1 - landfill location will apply whether the site is for inert, non-hazardous or hazardous wastes.

Note that this interpretation guidance refers to the deposit of landfill waste and that the CL:AIRE definition of waste: development industry code of practice is entirely separate and therefore covered by its own specific guidance.

Source protection zones 2 and 3 and principal aquifers

As well as the nature and quantity of the wastes, the risk assessment must be based on the natural setting and the properties of the location. Designated source protection zones and principal aquifers represent those areas of our groundwater resources critical to existing or future public water supplies. In these areas, we would normally

This document is out of date was withdrawn 14/03/2017

wish to preserve the high quality of the groundwater immediately under a proposed landfill site. Risk screening should identify the aquifer and SPZ designation.

Many sites may need to be dealt with on a case-by-case basis using evidence to support the decision. A site where active long-term management is not needed is one example. In this scenario, we will require a high degree of confidence that the developer can achieve this for any proposal that falls within a SPZ2. This is especially so if the site lies within a travel time of 400 days from the abstraction. In practical terms, this is likely to mean that we will resist developments within this time of travel zone unless they contain wastes types presenting only a short-term risk of generating polluting leachate.

Box 6.1 Circumstances where an SPZ3 or principal aquifer may be a suitable landfill location

There may be cases where substantial, natural low permeability geological barriers overlie a SPZ3 or principal aquifer and where these would be sufficient to prevent long-term pollution and satisfy the requirements of the legislation, after taking account of uncertainties in the longevity of artificial liners, leachate collection systems and other active long-term site management. This might occur, for example, where a principal aquifer designation is shown on the aquifer designation bedrock maps but the aquifer is actually known to be overlain by a significant thickness of low permeability clay drift. We will only take such circumstances into consideration where:

- the site is located outside any designated SPZ2; and
- it can be demonstrated that the presence of the natural low permeability geological barriers, where necessary by site specific investigation; and
- the site is above the water table where groundwater provides an important contribution to river flow or other sensitive surface waters.

Where it can be shown that such natural geological barriers exist, it will need to be demonstrated (where necessary by quantitative risk assessment) that the groundwater vulnerability can be lessened by compensating for the risk of long-term degradation of artificial sealing layers, leachate collection systems and other active management control systems. In some cases it may be appropriate to consider for this purpose the natural geological barrier in conjunction with any artificial enhancement of the mineral barrier; however, there must be a predominant natural component to the barrier – 'substantial' cannot be based just on the use of an artificially placed mineral barrier.

It is a site-specific judgement whether or not an overlying geological barrier is 'substantial' for the purposes of dis-applying the position statement in this way. Thickness and permeability need to be taken into account in combination and the properties of the barrier need to be reasonably predictable. A barrier would not be substantial if unpredictable variability in the lithology or presence of natural or artificial by-pass routes could compromise its overall protective integrity. There should be a minimum of several metres of natural material such that:

- any variations in its thickness over a site are insignificant in terms of the performance of the barrier;
- any construction/excavation activity at the site poses no risk of breaching the integrity of the barrier;
- it is clear that the geological barrier is substantial from a basic assessment of the site, which may include confirmatory site investigation data but without the necessity of very detailed site investigation or detailed quantitative risk assessment.

Note: We will not normally regard the aquifer materials themselves as forming part of a

This document is out of date was withdrawn 14/03/2017

low permeability geological barrier when considering a proposed landfill on within an SPZ3 or a principal aquifer. A landfill in these locations is only potentially suitable where there is a separate, natural, low permeability geological barrier which is acting to protect the aquifer.

In our E1 - landfill location position statement, a simple distinction has been made between SPZ2 and 3, a principal aquifer and all other groundwater. However, there could be areas shown on the aquifer designation maps as a principal aquifer where we judge that circumstances of poor natural groundwater quality or geological structure mean that local significance to water resources is very limited. For example, this might include areas of natural saline intrusion or where the strata involved only occupy a small isolated faulted block. These local circumstances in a principal aquifer may be taken into consideration providing there is adequate evidence to justify the decision – where necessary supported by a quantitative risk assessment.

Note: We will only consider the location of a landfill on a principal aquifer due to poor groundwater quality on the basis of the natural hydrogeochemistry and not poor quality due to existing land use such as landfill.

This document is out of date was withdrawn 14/03/2017

Secondary aquifers and unproductive strata outside SPZs

Our E1 - landfill location position statement does not apply to sites on secondary aquifers or unproductive strata (unless either our D3 - sub water table position statement also applies or the site also falls within a source protection zone). E1 - landfill location takes account of the fact that these formations are variable in terms of their local significance for water supply and occur in a wide range of strata with differing natural groundwater quality, hydraulic properties and ability to attenuate contaminants. In these locations it may be possible to place greater reliance on natural geological barriers and/or artificial mineral barriers for long-term protection of groundwater, depending on the particular geological and hydrogeological circumstances. Sites on secondary aquifers or unproductive strata should be considered on the basis of tiered risk assessment. This should take into account the long-term degradation of artificial sealing layers and management control systems, and ensure protection of groundwater in accordance with the legislation.

Sites below the water table in any strata where groundwater provides an important contribution to river flow or other sensitive surface waters

Groundwater forms an integral part of the water cycle and to varying degrees it supports the baseflow of rivers – in some cases having a dominant influence on flows and quality, particularly in dry periods. Groundwater may also support sensitive ecological sites such as wetlands where small changes in quality or level could be detrimental.

The decision as to whether the proposed landfill is below the water table and whether groundwater provides an important contribution to river flow or other sensitive surface waters should generally be achieved at a risk screening level.

Our E1 - landfill location position statement uses the terms ‘important contribution’ and ‘sensitive surface waters’. The identification of such sites is necessarily a matter of site-specific professional judgement but in general we would only identify sites as falling within these categories where the reasons for doing so are clear and transparent.

The relevant factors to be considered in ‘important contribution’ and ‘sensitive’ include:

- proximity of the surface water;

- directness of the hydraulic connection;
- quality and quantity of both the groundwater and the receiving surface water;
- the consequences of the potential impact on the surface water quality;
- the consequences of the potential impact on the ecology of the surface water due to changes in quality or level.

For example, some cases may arise from the close proximity to ecologically sensitive sites such as wetlands or rivers where there is direct continuity and sensitivity to quality or water level changes. In other cases, the close proximity of a river may raise concern about the potential for rapid or high volume flow connection or impacts on the headwaters to important, high-quality catchments. We would not wish to raise objections to sub water table landfill developments on the basis of small-scale, distant or trivial hydraulic connections or where natural geological barriers mitigate against the risk.

Where geological barriers or other factors mitigate against the contribution of the groundwater to surface water, we are likely to require more detailed risk assessment based on site-specific information.

For simplicity, the general term 'water table' has been used in E1 - landfill location. This should apply equally to a piezometric head within a confining layer where there is sufficient connectivity to the underlying aquifer to allow water to flow into the landfill void. The first consideration should be whether or not the underlying aquifer provides an important contribution to river flow or other sensitive surface waters. If it does, our E1 - landfill location position statement will apply unless site-specific investigation and quantitative risk assessment demonstrates that natural connectivity to the underlying aquifer is sufficiently low to prevent a risk of long-term pollution.

Legal framework

Landfill Directive (1999/31/EC)

The Landfill Directive aims to reduce the pollution potential from waste from landfills that can impact on surface water, groundwater, soil and air, and also contribute to climate change. It sets demanding targets to reduce the amount of biodegradable municipal waste from landfills. The Landfill Directive also covers the location of landfills, and technical and engineering requirements for aspects such as water control and leachate management, protection of soil and water, and methane emissions control. It also requires an operator to have adequate financial provisions to provide for any subsequent pollution that may occur post closure.

Further information can be found in:

- Environmental permitting guidance: the Landfill Directive;
- Hydrogeological risk assessments for landfills and the derivation of groundwater control and compliance limits.

Environmental Permitting Regulations (EPR) 2010

EPR 2010 requires permitting of activities that may lead to the input into groundwater of hazardous substances or non-hazardous pollutants. Permits must only be issued after there has been adequate assessment of the risks to groundwater (prior examination) and must be subject to monitoring where necessary (requisite surveillance).

This document is out of date was withdrawn 14/03/2017

Environmental Damage (Prevention and Remediation) Regulations 2009

Under these regulations, operators of economic activities that cause serious damage to the environment (or an imminent threat of such damage) will have to pay for the prevention and/or remediation of that damage. These regulations apply to serious environmental damage, to species/habitats, to the water environment and to land. There are certain exclusions, for example, they only apply to damage caused after March 2009 (England) or May 2009 (Wales). There are also several defences in respect of remediation (for example, full compliance with a specified permit/authorisation).

This document is out of date was withdrawn 14/03/2017

F. Other waste activities

Introduction

Waste management activities are controlled via environmental permits or exemptions from the need for a permit under EPR.

In general, non-landfill waste operations pose fewer hazards to groundwater than landfill operations. With the exception of 'deposit for recovery' activities, these hazards can – unlike landfill – be removed in extreme circumstances.

The storage, treatment and processing of potentially polluting waste materials can present risks to groundwater. Leachate or other polluting substances may leak from storage and processing areas. Materials or waste may be hazardous or contain hazardous substances (for example, oils in cars and machinery, and chemical waste stored in drums).

Most of the waste activities covered here are tightly controlled by legislation and we will grant a permit if operators have put appropriate measures in place to mitigate the risks satisfactorily. However, we discourage activities with a high potential groundwater pollution risk from being located close to water supplies intended for human consumption due to the potential severity of the consequences of such pollution.

Our role

We have overall responsibility for the regulation of waste activities such as incineration, transfer stations, waste storage and treatment.

Many waste activities require a permit from us under EPR; there are many standard rules permits available or the activity may be eligible for an exemption or exclusion under EPR. Groundwater protection would normally be achieved via these controls as we apply risk-based regulation.

For some types of permit, a site must have valid planning permission before a permit is issued. Planning permissions are controlled by planning legislation and are the responsibility of local planning authorities. When responding to some planning applications we will need to give more detailed consideration and, where appropriate, recommend parallel tracking if a proposed development includes an activity which will require detailed risk assessment, stringent control and additional mitigation in order to manage risks to groundwater and obtain a permit.

Unless sufficient evidence is submitted to demonstrate that the risk to groundwater can be satisfactorily managed or where a proposed development would present an unacceptable risk to groundwater that could not be managed by conditions on an environmental permit, or by the terms and conditions of a registered exemption, we would be unlikely to issue a permit or exempt the activity. In these cases we will object to the development when responding to the planning application consultation.

Further guidance on how we respond to planning consultations which require an environmental permit is set out in our Guidelines on developments requiring planning permission and environmental permits.

Where the activity is not controlled by a permit that we administer, we can use notices to control the risk of pollution of groundwater by either prohibiting the activity or where there is an input of pollutants to groundwater, by notifying the operator that the activity is a groundwater activity under the EPR and therefore requires a permit. We may also

This document is out of date was withdrawn 14/03/2017

apply our position statements on section G - discharge of liquid effluents into the ground to some waste activities.

Our role in the disposal of landspreading, sludge and slurry is outlined in section H - diffuse pollution.

This approach complements our strong role in promoting the government's waste hierarchy of prevention, preparing for re-use, recycling, other recovery and finally disposal, so as to reduce the need for landfill.

Radioactive waste

Waste management activities involving radioactive materials are also controlled via EPR. However, radioactive waste disposal facilities and radioactive facilities are not covered by GP3 as there is separate guidance on these activities. For example we have specific guidance with respect to radioactive waste disposal (Environment Agency 2009b). See also our position statement E2 - extension of landfill location position statement to radioactive wastes (where we adopt the same principles as for E1 - landfill location and storage of radioactive substances.

Position statement

F1 - Non-landfill waste activities
Inside SPZ1 we will only object to proposals for new development of non-landfill waste operations where we believe the operation poses an intrinsic hazard to groundwater. We will oppose such new developments via the development planning system. For any other non-landfill waste operations that are proposed in SPZ1, when considering any environmental permit application we will usually require detailed risk assessment and additional mitigation measures to be put in place to manage any risks to groundwater. Accordingly, we will raise this as a serious concern when responding to any planning application consultation. In sensitive groundwater locations, we will therefore strongly encourage parallel tracked environmental permit applications with planning applications. Outside SPZ1 we will agree to proposals for new developments of non-landfill waste operations where risks can be appropriately controlled by an environmental permit or a relevant waste exemption.

Note: the requirement for a risk assessment for the purposes of our position statement F1 - non-landfill waste activities would be satisfied by the generic risk assessment that supports the application for an EPR standard permit, where these are available.

Legal framework

Waste Framework Directive

The Waste Framework Directive (2008/98/EC) is an overarching legislative framework for the collection, transport, recovery and disposal of waste. The directive is primarily implemented in England and Wales via:

This document is out of date was withdrawn 14/03/2017

- The Environmental Protection Act 1990;
- The Environmental Permitting (England and Wales) Regulations 2010 (as amended).

Environmental Damage (Prevention and Remediation) Regulations 2009

Under these regulations, operators of economic activities that cause serious damage to the environment (or an imminent threat of such damage) will have to pay for the prevention and/or remediation of that damage. These regulations apply to serious environmental damage, to species/habitats, to the water environment and to land. There are certain exclusions, for example, they only apply to damage caused after March 2009 (England) or May 2009 (Wales). There are also several defences in respect of remediation (for example, full compliance with a specified permit/authorisation).

This document is out of date was withdrawn 14/03/2017

G. Discharge of liquid effluents into the ground

Important note: Small sewage effluent discharges to ground in England

In England, the requirement to register small sewage effluent discharges as exempt from the need for a permit is currently under review by the government. This review also includes the permitting requirements in non-SPZ1 sensitive areas where the exemption is not applicable. Furthermore, we have moved to a more risk-based approach for new sewage effluent discharges in SPZ1. The review does not apply to Wales as the Welsh Government is not undertaking a review; notwithstanding this, all the position statements in this section are valid in Wales.

A small sewage effluent discharge is defined as ‘a discharge of sewage effluent from a sewage treatment system into ground through an infiltration system/drainage field of 2 m^3 per day or less.

See our website for information on septic tanks and small sewage treatment plants.

For activities such as the landspreading of waste, please refer to our position statements on section H - diffuse sources.

Introduction

This section applies to the millions of litres of sewage effluent, surface water run-off, industrial effluent and waste waters that are released into the ground every year via drainage or infiltration systems (sewage treatment plants - STPs).

The acceptability of a discharge depends on its composition and volume and also the appropriate design and location of the infiltration system.

Where necessary, we require environmental permits or may serve notices in order to control the risk to groundwater from polluting discharges. Some discharges to ground (such as clean roof drainage or highway drainage) may not require permits. However, they can still have the potential to cause pollution if the discharge is not carefully designed or managed.

As the discharge of effluents into the ground is tightly constrained by legislation (EPR), we have only produced position statements to cover matters of interpretation or where there is some ambiguity.

Our role

We have responsibility to control effluent discharges through permitting or exemptions where appropriate. Our response to any proposal is based on the specific requirements set out in legislation and the site-specific risk. For discharges that require environmental permits, we will expect an adequate level of prior examination to be undertaken. The assessment will include consideration of the nature of the discharge including its chemical composition, volume and location.

In addition, we have a more general duty to protect groundwater. We must consider the potentially adverse effects from those discharges that we do not control through permits (for example, road drainage). Here, we advocate a preventative approach. This includes encouraging dialogue with developers and planners, including the new SuDS approving body (SAB) in county and unitary councils when this has been put in place, over new developments and the early consideration of the risks to groundwater at the design stage. We will also use our powers to serve notices to prohibit or bring into control activities that may lead to a discharge of pollutants to groundwater if we think it is necessary.

This document is out of date was withdrawn 14/03/2017

Background information

Details of our permitting powers under EPR are given in Chapter 7. EPR allows the option of issuing permits, granting exemptions and determining exclusions. Our EPR H1 guidance Groundwater risk assessment for treated effluent discharges to infiltration systems (Environment Agency 2011c) covers how we assess discharges to ground via an infiltration systems. See also Defra's environmental permitting guidance for groundwater activities (Defra 2010a).

Exemptions

Under EPR, we can determine that a low risk activity can be exempt from the need for an environmental permit. We may decide on the level of control for such discharges (for example, registered exemptions or general binding rules).

Exclusions

Under EPR we may technically determine that a discharge, or an activity that might lead to a discharge, is not a groundwater activity. Therefore, it does not need an exemption or an environmental permit. It is excluded from control. We may determine that all or only part of a discharge may qualify for an exclusion from the need for a permit or exemption. (See interpreting groundwater activity exclusions).

Position statements

G1 - Direct inputs into groundwater
We will only agree to the direct input of non-hazardous pollutants into groundwater if all of the following apply: • it will not result in pollution of groundwater; • there are clear and overriding reasons why the discharge cannot reasonably be made indirect; • there is adequate evidence to show that the increased pollution risk from direct inputs will be mitigated.

The emphasis in position statement G1 is on non-hazardous pollutants as the direct input of hazardous substances to groundwater is not permitted by regulation unless it satisfies certain specific criteria.

Discharges that concentrate the flow of effluent at one location and bypass some of the soil layers will limit the ability of the ground to attenuate pollutants and protect groundwater. Direct input into groundwater presents a significantly increased risk of pollution.

We are seeking to stop cases where discharges are directly into the groundwater through wells, boreholes and shafts. We will only allow them if they meet the criteria above.

This document is out of date was withdrawn 14/03/2017

G2 - Sewage effluent discharges inside SPZ1

Inside SPZ1 we will require all sewage effluent discharges (new or existing) to hold a permit.

All permit applications will be considered on the basis of risk assessment and the appropriateness of the discharge with respect to the local environmental setting. Where necessary we will use a notice to stop any unacceptable discharge.

For certain specified small-scale activities where sufficient information is supplied with the application, we may be able to undertake an initial risk assessment ourselves, but generally operators must also assess the environmental impact of their proposal to demonstrate an acceptable environmental outcome at the site. Though it will normally be the case, the operator cannot assume that compliance with the indicative technical measures will avoid adverse local impacts (Environment Agency 2010c).

For new small sewage effluent discharges in SPZ1 we will undertake the initial risk assessment. We may ask for additional information if required.

Permit applications for existing small sewage effluent discharges in SPZ1 will be dealt with sympathetically where there is evidence of no historical impact on the abstraction for which the SPZ1 is designated or where there are other mitigating factors such as recent improvements to the sewage effluent system.

G3 - Cumulative impact from sewage effluent discharges

We will only agree to developments where the addition of new sewage effluent discharges to groundwater in an area of existing discharges is unlikely to lead to an unacceptable cumulative impact. This will apply especially to sewage effluent in areas where concentrations of non-mains drainage to ground have given rise to known surface or groundwater pollution.

Small sewage effluent discharges may not pose a risk to groundwater quality individually but the cumulative risk of pollution from aggregations of discharges can be significant. All discharges of sewage effluent to ground now require some form of legislative control under EPR. Most small sewage effluent discharges to ground in England and Wales are eligible to be classified as exempt groundwater activities (Environment Agency 2011b). All other such discharges that are ineligible for exemption will require environmental permits as detailed in Defra's environmental permitting guidance for groundwater activities (Defra 2010a). We may in some cases seek improvements before granting an environmental permit.

G4 - Trade effluent and other discharges inside SPZ1

Inside SPZ1 we will object to any new trade effluent, storm overflow from sewer system or other significantly contaminated discharges to ground where the risk is high and cannot be adequately mitigated. If necessary, we will use a prohibition notice to stop any such existing discharge.

This document is out of date was withdrawn 14/03/2017

G5 - Connection to public foul sewer
Generally, we will only agree to developments involving sewage effluent, trade effluent or other contaminated discharges to ground if we are satisfied that it is not reasonable to make a connection to the public foul sewer. This position will not normally apply to surface water run-off via sustainable drainage systems and discharges from sewage treatment works operated by sewage undertakings with appropriate treatment and discharge controls.

Where connection to the foul sewer is not feasible, additional guidance on sewage disposal to ground is available in PPG4: Treatment and disposal of sewage where no foul sewer is available.

G6 - Cesspools and cesspits
Inside SPZ1 we will only agree to the use of sealed sewage storage (cesspools and cesspits) if it can be demonstrated that there is no practical alternative. Outside of SPZ1 we do not encourage their use, except in anything other than exceptional circumstances. A cesspool or cesspit is a sealed unit with no discharge to the environment that is used for the storage of untreated sewage. Poorly managed cesspools and cesspits present a considerable risk of causing pollution, which can be difficult to monitor and correct.

G7 - Historical pollution from sewage effluent
Outside SPZ1, we will work with dischargers to seek solutions to historical pollution arising from domestic sewage effluent. Where necessary we may use our notice powers to require permits or to prohibit further discharge.

G8 - Sewerage pipework
We will require the use of the highest specification pipework and designs for schemes involving new sewerage systems in SPZ1 to minimise leakage.

G9 - Use of deep infiltration systems for surface water and effluent disposal
We will only agree to the use of deep pit based systems (including boreholes or other structures that bypass the soil layers) for surface water or effluent disposal if the developer can show that all of the following apply: • there are no other feasible disposal options such as shallow infiltration systems (for surface water) or drainage fields/mounds (for effluents) that can be operated in accordance with current British Standards; • the system is no deeper than is required to obtain sufficient soakage; • pollution control measures are in place; • risk assessment demonstrates that no unacceptable discharge to groundwater will take place, in particular that inputs of hazardous substances to groundwater will be prevented; and • there are sufficient mitigating factors or measures to compensate for the increased risk arising from the use of deep structures.

This document is out of date was withdrawn 14/03/2017

We will apply our position statement G1 - direct inputs to groundwater to any deep infiltration systems potentially involving the discharge of non-hazardous pollutants and we will encourage operators of existing deep infiltration systems to alter their facilities so that direct inputs of pollutants are avoided, particularly where there is potential for hazardous substances to enter groundwater.

Mitigating factors for deep infiltration systems may include additional levels of effluent treatment but, in all cases, there must be evidence of a sufficient unsaturated zone with suitable geological properties to provide an effective attenuation layer below the base of the structure. Our position statement G1 - direct inputs to groundwater will also apply if the input to groundwater is direct.

While we cannot discount boreholes for sewage effluent disposal, their use must not be regarded as a routinely appropriate disposal option. BS6297 (BSI 2008) makes it clear that drainage fields are considered to be an important component of a non-mains wastewater treatment system. It states that deep pit based systems should not be used as they do not provide sufficient treatment. This is because the effluent would not be distributed so as to minimise the hydraulic loading and maximise the beneficial effects of biological action around infiltration systems. It will also not maximise attenuation in the soils and unsaturated zone.

BS6297 does not specifically refer to the use of boreholes for disposal but the principles are the same; a borehole may bypass even more of the available attenuation capacity and allow direct input of pollutants to groundwater. It is also possible that bio-fouling will diminish the efficiency of the system with time.

The level of prior examination required to support a proposal to use a borehole may be significantly greater than required for near surface infiltration systems since we cannot make the basic assumptions about the effectiveness of drainage fields that normally form part of our risk-based approach. The extent of examination is site-specific and a matter for local judgement by our staff based on local groundwater sensitivity. In general, the larger the discharge and the more vulnerable the location, the more likely it is that a detailed quantitative risk assessment is required. This may need to be supported by site specific data on the aquifer properties, seasonal variation in depth to water table and baseline groundwater quality.

G10 - Developments posing an unacceptable risk of pollution

We will object to new developments that pose an unacceptable risk of pollution to groundwater from sewage effluent, trade effluent or contaminated surface water. This applies if the source of pollution is an individual discharge or the combined effects of several discharges, or where the discharge will cause pollution by mobilising contaminants already in the ground. In all cases we will object to any proposal to discharge untreated sewage* to groundwater and will use our notice powers to ensure treatment of any existing discharges.

* A sewage treatment system means a septic tank, infiltration system, drainage field and/or a package treatment plant or any other additional treatment in place. It does not include cesspools.

This document is out of date was withdrawn 14/03/2017

This document is out of date was withdrawn 14/03/2017

G11 - Discharges from areas subject to contamination

Discharges of surface water run-off to ground at sites affected by land contamination, or the storage of potential pollutants are likely to require an environmental permit. This applies especially to sites where storage, handling or use of hazardous substances occurs (such as for example, garage forecourts, coach and lorry parks/turning areas and metal recycling/vehicle dismantling facilities). The site will need to be subject to risk assessment with acceptable effluent treatment provided.

G12 - Discharge of clean roof water to ground

The discharge of clean roof water to ground is acceptable both within and outside SPZ1 provided that all roof water down-pipes are sealed against pollutants entering the system from surface run-off, effluent disposal or other forms of discharge. The method of discharge must not create new pathways for pollutants to groundwater or mobilise contaminants already in the ground.

Our position statements G11 - discharges from areas subject to contamination and G12 - discharge of clean roof water to ground should also be read in conjunction with C4 - transport developments.

G13 - Sustainable drainage systems

We support the use of sustainable drainage systems (SuDS) for new discharges. Where infiltration SuDS are to be used for surface run-off from roads, car parking and public or amenity areas, they should have a suitable series of treatment steps to prevent the pollution of groundwater.

Where infiltration SuDS are proposed for anything other than clean roof drainage (see G12 - discharge of clean roof water to ground) in a SPZ1 we will require a risk assessment to demonstrate that pollution of groundwater would not occur. They will also require approval from the SuDS approval body (SAB), when these bodies have been established, to ensure they follow the criteria set out in the SuDS national standards (when published), including standards for water quality, design and maintenance.

For the immediate drainage catchment areas used for handling and storage of chemicals and fuel, handling and storage of waste and lorry, bus and coach parking or turning areas, infiltration SuDS are not permitted without an environmental permit.

Our position statement G13 - sustainable drainage systems needs to be read in conjunction with G10 - developments posing an unacceptable risk of pollution.

The design of infiltration SuDS schemes and their treatment stages needs to be appropriate to the sensitivity of the location and subject to a relevant risk assessment considering the types of pollutants likely to be discharged, design volumes and the dilution and attenuation properties of the aquifer. Unless the supporting risk assessments show that SuDS schemes in SPZ1 will not pose an unacceptable risk to the drinking water abstraction, we will object to the use of infiltration SuDS under G10 - developments posing an unacceptable risk of pollution.

G13 - sustainable drainage systems also needs to be read in conjunction with G11 - discharges from areas subject to contamination, as drainage that involves the handling and storage of hazardous substances or coach/lorry parking and turning areas needs to follow the latter.

Legal framework

Environmental Permitting Regulations (EPR)

Under EPR, it is an offence to cause or knowingly permit the discharge of any hazardous substance or non-hazardous pollutant that might lead to an input of that substance into groundwater unless permitted under EPR. Permits must only be issued after there has been adequate prior examination and must be subject to the requisite surveillance (Environment Agency 2011c). See also Chapter 7.

This document is out of date was withdrawn 14/03/2017

H. Diffuse sources

Introduction

Diffuse water pollution can arise from activities and land management practices in both rural and urban areas. Our stance on urban diffuse sources is also covered in our position statements in section A - general approach to groundwater protection and section G - discharge of liquid effluents into the ground. This section therefore focuses more on rural sources.

Examples of diffuse sources include:

- the cumulative effect of many individual and ill-defined events, such as poor management practice in storage and handling of pollutants. Although individually they can be small and hard to detect, at a larger catchment scale they can have a significant impact on groundwater quality;
- the dispersal of pollutants over an area, for example, nitrate from the atmosphere, or leaching of fertilisers and pesticides from soils.

Diffuse sources can affect both surface water and groundwater. As such sources can be hard to identify, it can be hard to link cause and effect.

Existing measures to control diffuse pollution will not be enough for us to achieve WFD objectives everywhere. In some instances, restrictions or changes of land use may be needed to meet environmental objectives. However, it may be technically not possible, or disproportionately costly to achieve these environmental objectives. We may be justified in setting less demanding objectives for groundwater that are technically possible to achieve and with costs that are proportionate to the environmental benefits.

Most new groundwater contamination in England and Wales is from diffuse sources and the largest proportion of this across the country arises from agriculture, although other sources can be locally significant (for example, leaking sewer infrastructure and urban land contamination). Diffuse pollution is the main factor in the increasing cost of treatment for water intended for human consumption.

In the future we could see increasing risks from diffuse pollutants with climate change predictions of more intense rainstorms. Changes in land management practice as a result of climate change adaptation and mitigation may also alter diffuse pollution inputs to groundwater.

The slow response times of many aquifers and the scale of diffuse pollution mean it will take concerted action over many years for the current concentrations of diffuse pollutants to reduce to an acceptable level.

Our role

We have limited existing powers to control diffuse water pollution. Often it is difficult to identify the specific individuals responsible for diffuse pollution, and existing regulatory methods are often ineffective or lack the required coverage. However, as part of our role as competent authority for the WFD we are already working in partnership with others to deliver voluntary approaches to reduce diffuse pollution. There are important approaches that reduce the need for legal measures such as:

- England Catchment Sensitive Farming Project;
- Campaign for the Farmed Environment (CFE);
- The Voluntary Initiative promoting responsible pesticide use.

This document is out of date was withdrawn 14/03/2017

We will continue to influence others to apply best practice wherever we can.

Where voluntary measures are not working or are not appropriate, it may be necessary to consider other measures. These may include pollution prevention and regulatory enforcement. Under Article 7 of the Water Framework Directive we have the power to establish safeguard zones around drinking water abstractions with the aim of avoiding deterioration in abstracted water quality in order to reduce the level of purification treatment.

Increased drinking water treatment for diffuse pollutants is often energy intensive, uses more chemicals and produces more waste. This impacts not only water companies but also the hundreds of thousands of small private drinking water supply owners across England and Wales. For public drinking supplies we encourage land use change in catchments around these abstractions, for example, through water company led catchment schemes or agri-environment schemes to help reduce carbon dioxide emissions and meet our climate change objectives. For private water supplies, protection is more challenging because we do not keep records of where these supplies are located. These details are held by local authorities and the Drinking Water Inspectorate. We are currently working to improve how we share data with other organisations.

The impact of many aspects of farming practice on groundwater is not widely acknowledged or understood. A package of integrated regulation, targeted incentives and the provision of comprehensive advice (jointly with industry partners) should bring about improved environmental practice by farmers. Our position statements contribute to this aim.

We are responsible for assessing farmers' compliance with action programmes in nitrate vulnerable zones, which are part of the Nitrates Directive. We may serve notices on farmers if they are not meeting the requirements of the action programme. Box 6.2 summarises our role in regulating cross compliance.

Box 6.2 Cross compliance

Cross compliance is the requirement for farmers to meet the obligations* under EU legislation in order to obtain full payments under the Common Agricultural Policy.

The Rural Payments Agency (RPA) in England and the Welsh Government are responsible for implementing cross compliance. They determine what payments the farmer will receive and produce guidance for farmers.

Although we no longer conduct targeted cross compliance visits in England, we remain the enforcement authority for regulations that apply to the following legislation subject to cross compliance.

- Nitrate Vulnerable Zones (Nitrate Pollution Prevention Regulations 2008);
- environmental protection of groundwater (EPR);
- use of sewage sludge on agricultural land (Sludge (Use in Agriculture) Regulations 1989);
- water abstraction for spray irrigation (Water Resources Act 1991).

We will report breaches that we find to the RPA.

We regulate the landspreading of wastes to agricultural land. The controls vary with the type of wastes; they may be authorised under EPR, applied in line with the provisions of the Sewage Sludge Regulations, or used under a relevant waste exemption. Our ability to influence the spreading activity and its related risk to the environment varies

This document is out of date was withdrawn 14/03/2017

with the type of control. We are working to improve controls on waste spread to land through our biowaste use sector plan.

Data from our groundwater quality monitoring network on the presence of pesticides helps to indicate in general terms the effectiveness of product use controls under the EU Plant Protection Products Regulation 2009. These results may be taken into consideration during reviews of existing controls. Compliance with statutory management requirement (SMR) 9 under cross compliance (audited by the RPA) would indicate a level of good practice on pesticide use.

* Statutory management requirements (SMR) derived from EU environmental legislation and good agricultural and environmental conditions (GAEC).

There are a number of emerging issues regarding diffuse groundwater pollution. These include the fate and impact of veterinary medicines, phosphate and biological pathogens (mostly from agriculture and also some synthetic chemicals such as perfluorinated compounds. The effects of these pollutants are not fully understood and will require additional investigation. We plan to work with the agricultural sector and others to review the impact of these pollutants on groundwater and put in place sustainable solutions.

Background information

Pollution of water by point sources has decreased substantially over the past 30 years, mainly in response to an effective regulatory regime. However, pollution arising from diffuse sources has not been adequately controlled, leading to a continued decline in groundwater quality. The WFD characterisation exercise (Lord, et al. 2008) reported that around 94 per cent of groundwater bodies in England and 49 per cent in Wales were at risk of failing WFD objectives because of diffuse pollution.

The amount that water companies pay to treat raw groundwater, mainly to remove nitrate and pesticides and to reduce risks associated with cryptosporidium, have increased rapidly. Additionally, the lower cost options such as blending high nitrate waters with low nitrate waters have been exhausted. These costs are ultimately passed onto the water consumer.

Contaminated groundwater may also affect surface water and the ecology dependent on this water, as well as increasing treatment costs for water supplies from these sources. Groundwater is also used for thousands of private abstractions, many for drinking water supplies. Increasing concentrations of nitrate and other diffuse pollutants in these private supplies has resulted in an increasing number of them requiring treatment.

Urbanisation and industrial activity involving chemical pollutants, in particular synthetic organic chemicals, has increased with time. This together with the ageing of infrastructure such as sewers, water mains and other underground systems means that a locally significant proportion of diffuse pollution arises from non-agricultural sources. These include industrial and commercial activities, forestry, infrastructure, housing, contaminated land and old mine workings. The characterisation exercise for the WFD reported in 2008 indicates that 26 per cent of groundwater bodies are at risk of failing to meet the WFD objectives due to diffuse urban discharges.

Surface water drainage in urban areas can be a major source of diffuse pollution; SuDS in the right location, and where properly designed and maintained, can significantly reduce this (see section G - discharge of liquid effluents into the ground).

This document is out of date was withdrawn 14/03/2017

The two most significant groundwater diffuse pollutants are nitrates (Box 6.3) and pesticides (Box 6.4). Nitrate is by far the more significant and also the more difficult to deal with.

Box 6.3 Nitrate

Nitrate concentrations in groundwater remain our biggest single water quality problem.

A study for the environment agencies in the UK and the Republic of Ireland showed from modelled examples that in rural areas indicated that most of the nitrate in groundwater may come from agriculture (SEPA et al. 2010).

As well as agriculture, nitrate can be attributed to many other sources including graveyards, sewage and Industrial, landfill, woodland, direct deposition to water, particulate and urban run-off and leaching (see Lord et al. 2008) and (SEPA et al. 2010).

We acknowledge the on-going progress that farmers are making to reduce fertiliser use and livestock numbers. However, there is still a major problem and further targeted action will be needed to meet WFD objectives.

Following the implementation of the Water Framework Directive and the Groundwater Daughter Directive (most recently through EPR), nitrate is now defined as a non-hazardous pollutant and all sources of nitrate pollution in groundwater are now subject to regulatory controls.

Box 6.4 Pesticides

There have been a number of positive changes with respect to pesticides, including:

- approvals processes that have banned some pesticides and changed the conditions of use for others;
- improvements in farm practice, for example, through the Voluntary Initiative (for promoting responsible pesticide use).

We have evidence that the impact of pesticide pollution on groundwater from banned substances (such as atrazine and simazine) is decreasing. However, the potential for pollution remains and some water companies are reporting increasing trends from other approved pesticides. This is resulting in increasing treatment costs, which are ultimately passed on the consumer. The issue of 'pollution swapping' remains a concern whereby one pesticide is banned and another takes it place.

We are working with the Voluntary Initiative to develop online geographical tools so that farmers know where drinking water protected areas are.

In 2008 over 27,000 tonnes of pesticide active ingredients were sold in 'plant protection products' in the UK. Around 80 per cent of this use related to agriculture and horticulture, 15 per cent to industrial, amenity and forestry use and the remainder to home and garden use. It can be difficult to determine accurately who is causing pollution as often the same active ingredient is used by several different sectors.

Position statements

Note: other position statements also deal with the protection of groundwater from urban diffuse sources, in particular those in section A - general approach to groundwater

This document is out of date was withdrawn 14/03/2017

protection and section G - discharge of liquid effluents into the ground. Other position statements cover storage - see section D - storage of pollutants.

H1 - Mechanisms for control of diffuse pollution
We seek to control diffuse pollution of groundwater through working in partnership with others, advice, incentives and regulation. To do this we will promote practices that protect groundwater quality and highlight areas of particular susceptibility to groundwater diffuse pollution by the use of groundwater vulnerability maps and source protection zones.

H2 - Use of water protection zones
Where partnership working and all existing controls are insufficient to prevent pollution we may be able to pursue the designation of water protection zones (section 93, Water Resources Act 1991) to control pollution within a groundwater body. However we will need significant evidence and external support for such action in order to obtain approval from the Secretary of State, who must sign off any WPZ designation.

H3 - Safeguard zones
Where appropriate we will work in partnership with water companies to designate safeguard zones around abstractions used for human consumption that are at a high risk of deteriorating raw groundwater quality. Within safeguard zones, we will target existing measures and focus additional new voluntary measures.

H4 - Water company led catchment schemes
We will support the use of water company led catchment schemes in the next water company periodic review process (PR14) and beyond to reduce the level of drinking water treatment required at public supply sources.

H5 - Good practice and land use change
We will work with farmers, farming organisations, industry and government to encourage full compliance where applicable with the Code of good agricultural practice (CoGAP) and any other relevant good practice codes. We will also encourage good practice and positively beneficial land use change by working through others through for example: • agri-environment schemes; • water company led catchment schemes; • England Catchment Sensitive Farming Project; • Campaign for the Farmed Environment; • The Voluntary Initiative; • Amenity Forum; • Agriculture and Horticulture Development Board (AHDB); • market-led schemes such as Farm Assurance.

This document is out of date was withdrawn 14/03/2017

Our position statements H6 - landspreading, H7 - livestock housing and H8 - storage of organic manures on farms relate to farm activities and developments. They are primarily intended to address risks from new developments and major expansions. Where a development is for the improvement of an existing farm (such as providing additional slurry storage to improve management or replacing existing stock housing) we will make every effort to agree to the proposals. We appreciate that in karstic areas, a small number of SPZ1s are very large. Where this is the case, we will be more sympathetic to site-specific mitigation measures.

H6 - Landspreading

We will oppose the landspreading of sludge or liquid waste containing significant concentrations of pollutants within SPZ1 or within 50 metres of any borehole, well or spring, unless we agree to site-specific mitigation measures that minimise the risk to drinking water supplies.

H7 - Livestock housing

We will oppose the establishment of substantial additional livestock housing within SPZ1 or within 50 metres of any borehole, well or spring, unless we agree to site-specific mitigation measures that minimise the risk to drinking water supplies.

H8 - Storage of organic manures on farms

We will oppose the establishment of new storage areas for organic manures (farm yard manure, sewage sludge, slurry and other organic manures) within SPZ1 or within 50 metres of any borehole, well or spring, unless we agree to site specific mitigation measures that minimise the risk to drinking water supplies.

See also D2 - underground storage, D3 - sub water table storage and D4 - use of notices.

We appreciate that in karstic areas, a few SPZ1s are very large. Where this is the case, we will consider a risk-based approach on a site specific basis to the application of position statements H6, H7 and H8.

Our position is that certain activities within SPZ1 present a hazard to drinking water sources. We therefore have a presumption that this location is not suitable for a specific activity and that we should steer the applicant to an alternative location so that risks to our drinking water supplies are minimised. However, we do not apply a blanket approach to this position whereby we say that we would never allow these activities in SPZ1, as there may be mitigating circumstances. For example, where there is a choice to locate a facility, in this case substantial livestock housing, outside SPZ1, this is our preferred approach as this removes the hazard from inside the SPZ1. However, where there is no choice as the entire farm holding is within a large SPZ1, we will work with the applicant to identify the location on their landholding that is of lowest risk. We may also require additional mitigation measures to be put in place to protect drinking water.

H9 - Nitrate and crop requirements

To avoid the excessive leaching of nitrate outside nitrate vulnerable zones we will encourage farmers and other operators to ensure that the application of all organic manures (including livestock manure and slurry, sewage sludge, and all other materials

This document is out of date was withdrawn 14/03/2017

spread onto land for nutrient recovery) is undertaken as part of a crop nutrient plan and the nutrient requirement of the crop in not exceeded.

H10 - Nutrient management plans
We will encourage farmers to produce and follow recognised nutrient management plans and adopt farming practices that go beyond cross-compliance requirements, to further reduce loss of nutrients.

H11 - Land use change around drinking water abstractions
We encourage, where appropriate, the wider use of a payment for ecosystems services approach for farmers who provide the service of clean recharge water. We will encourage such schemes that result in cost effective land use change, which are beneficial to the environment and the consumer.

In the context of protecting drinking water abstractions from agricultural pollution, we acknowledge that the 'polluters pays' principle may not always produce the required outcome. We therefore encourage, where appropriate, wider use of a payments for ecosystems services approach whereby farmers are paid for the service of providing clean recharge water.

Legal framework

Please also refer to Chapter 7.

Water Resources Act 1991

Section 93 of the Water Resources Act 1991 allows water protection zones to be designated by the Secretary of State or Welsh ministers and activities prohibited or restricted in these areas in order to prevent pollution.

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 extend the use of water protection zones.

Sections 161A to 161D (Anti-pollution works and operations) allow us to serve a notice to prevent pollution happening or remedy the effects of pollution.

The Code of good agricultural practice (CoGAP) is a statutory code under the Water Resources Act that contains provisions for protection of groundwater and groundwater fed water supplies. There is a parallel code in Wales.

Environmental Permitting Regulations (EPR)

Some sources of diffuse pollutants will be regulated under EPR. In many cases, a permit is not required. However, if an activity is clearly leading to an input of pollutants to groundwater then we may serve a notice to either stop the activity or determine it to be a groundwater activity and thereby require a permit.

Nitrate is now a non-hazardous pollutant. Therefore inputs of nitrate to groundwater must be limited to avoid pollution.

This document is out of date was withdrawn 14/03/2017

Water Framework Directive

The WFD (2000/60/EC) requires controls on diffuse sources of pollution. The first river basin management plans (RBMPs) produced in 2009 set out the steps that will be taken to meet the WFD environmental objectives.

New measures to tackle diffuse groundwater pollution include:

- safeguard zones;
- extension of the England Catchment Sensitive Farming Project;
- targeted pollution prevention schemes.

We will also be undertaking many investigations into diffuse pollution issues to reduce our uncertainly and to identify new measures.

Nitrate Pollution Prevention Regulations 2008

These regulations implement the EU Nitrates Directive to reduce nitrates from agriculture entering water systems. Their provisions include:

- a requirement to designate nitrate vulnerable zones (NVZs);
- a requirement to plan nitrogen applications;
- the setting of limits on nitrogen fertiliser applications;
- the establishment of closed periods for spreading;
- controls on the application and storage of organic manure.

NVZs are designated on the basis of the following criteria:

- the measured nitrate concentration in the water exceeds, or any rising trend will exceed an action level of 50 mg per litre nitrate; or
- waters are eutrophic, or would become eutrophic if they were not designated.

This document is out of date was withdrawn 14/03/2017

J. Land contamination

Introduction

Land contamination can be a significant source of groundwater pollution. In the worst cases pollution can extend many kilometres and contamination can also cause groundwater pollution that impacts on boreholes used for groundwater abstraction.

We have drawn up a distinction between 'contaminated land' and 'land contamination.'

Contaminated land refers to a site that has been officially determined by a local authority to meet the definition set out in Part 2A of the Environmental Protection Act 1990.

We use **land contamination** to describe sites that contain pollutants and may require action to reduce risk to people or the environment but have not been determined under Part 2A.

We estimate that there may be between 100,000 and 300,000 ha of land potentially affected by contamination in England and Wales. Our first priority is to prevent any new land contamination occurring by effective influencing and regulatory control of potentially polluting activities. We strongly encourage voluntary remediation or remediation under the planning regime. Where this is not possible we may require remediation using anti-pollution works notices or a remediation notice.

The concept that a site should be 'suitable for use' underlies our approach to remediation of historic contamination. The term 'suitable for use' is also applicable to new contamination via spills and accidents. This means suitable for the environment as a whole, not just for use by people. Protecting surface water and groundwater may mean carrying out work over and above that required to make the land suitable for the proposed development and to protect human health.

Our role

We seek to protect groundwater quality through our various regulatory and advisory roles with respect to land contamination. We expect adequate and effective pollution prevention measures to be adopted, maintained and monitored to prevent new land contamination from occurring and expect problem holders to act responsibly and in accordance with good practice.

We seek to prevent the creation of new contamination by promoting pollution prevention measures and the adoption of good practice and by regulating business and industry through a variety of pollution prevention and control regimes.

We focus our efforts on:

- the highest risk cases and those that will deliver the greatest environmental benefits;
- sites posing the greatest hazard and on sites located close to the most sensitive receptors.

We address existing contamination through the following approaches:

- encouraging problem holders to proactively assess and take action to manage risks from contamination voluntarily;

This document is out of date was withdrawn 14/03/2017

- using our consultee role, working with local planning authorities under the town and country planning regime to require the investigation and remediation of contamination where it may affect ground or surface waters.
- assisting local authorities to identify contaminated land under Part 2A by advising on ground or surface water issues.
- promoting good practice through use of the framework, tools and supplementary guidance set out in Model procedures for the management of land contamination (Contaminated land report 11) (Environment Agency and Defra 2004);
- collaborating with others to develop tools and guidance that help identify and sustainably deal with land contamination;
- promoting the safe development of housing on land affected by contamination (NHBC and Environment Agency 2008).
- serving anti-pollution works notices to prevent or remediate water pollution (though we may also carry out the work ourselves and recover the cost we act as the enforcing authority for any contaminated land designated a special site).

Position statements

J1 - Promptly clean up new contamination
We require those who cause new contamination (for example, contamination from an environmental accident or incident) to manage it quickly and effectively. They should identify and secure the source and remediate the contamination and any effects it has caused, to ensure groundwater quality is protected and where necessary restored.

J2 - Risk-based prioritisation
We apply a risk-based approach to prioritise our effort in dealing with land contamination so that those sites causing pollution or harm, or posing the greatest environmental risk, are given the highest priority for action.

J3 - Take responsibility and adopt good practice
We will provide generic advice on key objectives and approaches to dealing with land contamination to ensure groundwater is protected or remediated. We expect this advice to be followed, and the good practice we promote adopted, so that risks from contamination are managed appropriately. This should be normal practice and not rely on us being directly involved in a particular project.

J4 - Working with planning authorities and local communities
We will help planning authorities and local communities understand the problem of groundwater pollution from land contamination. We will encourage them to acknowledge the need to reduce and manage groundwater pollution as part of sustainable development in their strategies and plans.

This document is out of date was withdrawn 14/03/2017

J5 - Working with local decision-makers
We provide guidance, and in higher risk cases site-specific advice, to local decision-makers on development involving land contamination to ensure groundwater is protected or is remediated. This will help deliver objectives under the WFD.

J6 - Support to local planning authorities
We will support local planning authorities who require developers to investigate and monitor land and groundwater contamination. This may be to provide support to a planning application or to assess satisfactory compliance with planning conditions where appropriate. Local planning authorities should also require remediation where it is necessary and ensure that it is verified. We may recommend the refusal of a planning application where we judge the risk of groundwater pollution is too high or it has been inadequately assessed.

J7 - Promote appropriate sustainable remediation
We encourage the use of sustainable and effective remedial measures to prevent or address groundwater pollution from sites affected by contamination. This includes the recycling of water and soils where appropriate. However, these operations must not result in an unacceptable release to groundwater and must where necessary have appropriate permits and controls.

Re-injection of effluent and re-use of soils during remediation

Our regulatory approach on a variety of remediation technologies and techniques is set out in our remediation position statements. Statement 3 (Excavation for disposal/recovery) and Statement 3A (Removal of groundwater for disposal/recovery) in particular describe our stance on re-use, re-injection and protecting groundwater.

Where soils are to be re-used, the CL:AIRE definition of waste: development industry code of practice is also relevant. This is a voluntary code of practice which provides a framework for determining whether or not excavated material used in land development is waste. It was produced by industry and has our support. Our definition of waste position statement explains how we will take account of the CL:AIRE code of practice in regulating development activities.

Achieving sustainable remediation

Sustainable remediation seeks to manage unacceptable risks to human health and the environment (including groundwater), while optimising the environmental, economic and social impacts. Sustainable remediation appraisal requires consideration of a wide range of environmental, social and economic factors, including, for example, climate change impacts such as greenhouse gas emission from the remedial works or the site itself, worker safety and cost.

The Sustainable Remediation Forum UK (SuRF-UK) has produced a framework for assessing the sustainability of soil and groundwater remediation (SuRF-UK 2010). The framework document sets out why sustainability issues associated with remediation

This document is out of date was withdrawn 14/03/2017

needs to be factored in from the outset of a project and identifies opportunities for considering sustainability at a number of key points in a site's redevelopment or risk management process.

Guiding principles for land contamination

Our Guiding principles for land contamination (GPLC) are a package of three documents providing generic guidance for problem holders and their expert advisors and consultants (Environment Agency 2010d, e and f). The main aims are to:

- help clarify roles and responsibilities;
- encourage good practice to promote compliance with the requirements, or avoid the need for regulation;
- guide those interested to guidance and advice in other documents.

Legal framework

Part 2A of the Environmental Protection Act 1990

Part 2A of the Environmental Protection Act requires local authorities to inspect their areas to identify contaminated land. Unacceptable risks from contaminated land to human health and the environment must be dealt with. This includes the investigation and remediation of groundwater pollution where appropriate. Remediation notices may be served on those responsible for the contamination requiring them to remediate it.

Local authorities are the regulator for most contaminated land but we regulate sites designated as 'special sites'. The criteria for designation as a special site are set out in the English and Welsh contaminated land regulations and include some cases of water pollution.

Town and Country Planning Act 1990

The Town and Country Planning Act 1990 is applied in conjunction with planning policy documents and guidance. It allows local planning authorities to apply conditions to planning permission for land (re)development to protect groundwater. Permission may be refused where the risks to groundwater have not or cannot be adequately addressed.

Environmental Permitting (England and Wales) Regulations (EPR) 2010

Although the style of regulation and the offences have changed, EPR does not make significant changes to the way land contamination is regulated. It is now an offence to cause or knowingly permit a groundwater activity without a permit (see Chapter 7). However, as was previously the case, a passive release of pollutants from such land where the original activity that led to the contamination has ceased is not considered to be a discharge to groundwater that needs a permit under EPR as there is no surface activity to control. A discharge to groundwater that potentially requires an environmental permit only occurs if an activity that disturbs land causes a release of pollutants.

Certain clean-up schemes involve promoting in situ treatment of soils and groundwater by injecting substances such as nutrients or chemical oxidants. In small quantities, such groundwater activities may be eligible for a registered exemption under EPR (see

This document is out of date was withdrawn 14/03/2017

Annex J2). Registered exemptions would not apply to any microbiological or radioactive agents. Waste soil treatment activities are, however, usually permitted under EPR standard rules mobile treatment or bespoke permits. These permits ensure that the treatment process does not itself cause pollution or harm.

Water Resources Act 1991 and Anti-Pollution Work Regulations 1999

Section 161A and the Anti-Pollution Works Regulations 1999 allow use of works notices to prevent or remedy pollution of surface and groundwater. We may prosecute anyone who fails to comply with a works notice and if necessary carry out the works ourselves and recover our costs. Works notices may be used where other regimes such as Part 2A do not apply or where it appears that pollution of controlled waters would not be addressed within an acceptable timescale using Part 2A.

This document is out of date was withdrawn 14/03/2017

K. Mining induced pollution

Introduction

The water resources implications of mining and other activities that may affect groundwater flow are covered in section N - managing groundwater resources and specifically:

- N7 - hydrogeological risk assessment;
- N8 - physical disturbances of aquifers in SPZ1;
- N9 - obstruction of flow; and
- N11 - protection of resources and the environment from changes to aquifer conditions.

This section deals more specifically with the potential pollution due to mines and mining.

Historically, mining was carried out with little regard for its environmental consequences. Until recently there was little environmental legislation capable of controlling adverse effects on the environment after mines were closed. As a result, mining activities have left large areas of the country with polluted land, groundwater and rivers.

When mines are abandoned, groundwater levels begin to rise and mobilise naturally occurring contaminants so that groundwater within the mine workings becomes contaminated. Over time groundwater levels recover and this mine water will discharge to either rivers or overlying aquifers. The typical pollutants are metals such as iron, lead, zinc, copper and cadmium, as well as chloride and sulphate. In surface waters these can have a direct toxic effect. Iron, a common pollutant particularly from abandoned coal mines, is characterised by orange deposits of iron hydroxide or 'ochre', which smothers the river bed and harms the aquatic flora and fauna. In rivers impacted by abandoned metal mines, the concentrations of zinc, cadmium and lead frequently exceed environmental quality standards. In some areas, contamination of groundwater by sulphate or chloride means that additional treatment is needed to allow abstraction for drinking water supply or industry.

Working in partnership with the Coal Authority, we have made significant progress in dealing with historic pollution from abandoned deep coal mines, while European legislation such as the Water Framework Directive and the Mining Waste Directive have brought about improvements in regulatory control of working mines. This builds upon existing water quality protection measures and supporting regulations such as the Mines (Notice of Abandonment) Regulations 1998, which Defra recently decided to retain.

The situation with abandoned non-coal (primarily metal) mines is less advanced. In 2010 the Coal Authority was given legal powers, but no liability, to realise solutions for non-coal mines. We are working with it to deliver a programme of metal minewater treatment in England.

Under our metal mines strategy in Wales, published in 2003, we are investigating the feasibility of cleaning up the worst sites. In 2009, with support from Defra and the Welsh Government, we completed the Non-Coal Abandoned Mines (NoCAM) project which identified and prioritised the rivers impacted by mining pollution and its sources. We have identified measures to deal with high priority mines through river basin management plans.

This document is out of date was withdrawn 14/03/2017

We are working with the Coal Authority, Defra, the Welsh Government and others to develop a comprehensive clean-up programme for abandoned metal mines.

Nine per cent of groundwater bodies (20 per cent by area) and 9 per cent of surface water bodies (12 per cent by length) in England and Wales are impacted and at risk of not meeting WFD objectives due to pollution from mine waters and mining waste. Polluted groundwater from abandoned mines discharges as much lead, cadmium and zinc into rivers each year as arises from all permitted industrial discharges.

Our challenge is to achieve sustainable and affordable solutions that prevent new pollution, reverse existing damage and meet regulatory requirements, while balancing the needs of the environment and local communities. Our priority is to ensure that no new pollution of surface waters or groundwater occurs from active or closed mines.

Our role

We fulfil our duties in connection with active and abandoned mineral sites via various regulatory and non-regulatory measures.

We are a statutory consultee for planning applications for mineral exploitation. Through this mechanism we influence how the environmental impact from operational mines is controlled during operation and after closure.

We control the management and disposal of extractive waste, which falls under the Mining Waste Directive at operating sites through EPR. These regulations are also the means by which inputs of pollutants to groundwater arising from the disposal or re-disposal of mining waste at other sites are controlled; these activities become groundwater activities under EPR and therefore require a permit.

We regulate water abstraction (see section N - management of water resources) and control water discharge quality from working mines through environmental permits.

The Water Resources Act 1991 gives us a mechanism to control future abandonment. Mine operators planning closure are required to submit a notice of abandonment to us. This includes a review of the groundwater situation in the mine and a forecast of the potential impacts from minewater.

The defence against a charge of knowingly permitting a polluting discharge from an abandoned mine was removed from legislation from 1 January 2000. Under the Part 2A contaminated land regime we can force the remediation of some aspects of historic mining pollution. Where directed by government to do so, we have some responsibility for tackling pollution caused by abandoned non-coal mines.

In Wales, and more recently in England, funding has been made available by the Welsh Government and Defra to:

- prioritise river catchments impacted by abandoned metal mines;
- carry out monitoring investigations;
- identify and implement the necessary remedial measures.

We have a memorandum of understanding with the Coal Authority. This provides an operating framework for working in partnership to manage risks from abandoned coal mines.

Background information

Abandoned mines are one of the most significant pollution threats in England and Wales. Many thousands of mines have been abandoned and now discharge minewater

This document is out of date was withdrawn 14/03/2017

containing metals and other pollutants into our watercourses. Other more recently closed mines are still filling up with groundwater and will start discharging in the future. Pollution from mining activities is particularly difficult to deal with due to the length of time over which discharges can persist.

We are leading efforts to deal with the problem along with SEPA and the Coal Authority. The environment agencies have prioritised all existing discharges from abandoned coal mines based on their environmental impact. The Coal Authority is operating around 50 minewater treatment plants in England and Wales, including Wheal Jane tin mine in Cornwall. These prevent 2,200 tonnes of iron and other metals from entering the water environment every year, protecting over 700 km of rivers and drinking water aquifers. Priority non-coal mines are metal mines in the ore fields of Wales, south-west England and northern England that continue to cause pollution despite being closed for over a hundred years.

We are continuing research into sustainable treatment methods for metal mine discharges that do not rely on costly technology or substantial raw materials and power, including the operation of pilot-scale treatment plants.

Abandoned metal mines are not only a source of pollution but also part of our national heritage and an important reserve of biodiversity. Many sites are designated as sites of special scientific interest (SSSIs) or scheduled ancient monuments. The tin and copper mining areas of Cornwall and west Devon have been declared a UNESCO World Heritage Site. This means that certain treatment methods cannot be employed, although a collaborative approach may help to deal with the pollution threat.

Position statements

K1 - Environmental impacts on mining
We work with governments, other regulators, agencies and landowners to control and remediate the environmental impacts of mining. In particular we will: • continue to resolve polluting discharges from abandoned coal mines into groundwater and surface water, in collaboration with the Coal Authority; • develop plans to tackle the complex issues of abandoned non-coal mines, spoil heaps and mineral preparation wastes; • integrate measures to tackle these problems within the Water Framework Directive and to fulfil the requirements of the Mining Waste Directive and the Habitats Directive.

K2 - Future environmental impacts
We aim to prevent future environmental impacts. To do that we will: • work with the Coal Authority to ensure that where groundwater is still rebounding in closed mines it does not pollute groundwater or surface waters; • review water management plans for mines closed after 1 January 2000 and enforce monitoring and pollution prevention plans as required; • use the range of regulatory tools at our disposal to ensure that new pollution is not caused, and water resources are not compromised at working mines; • ensure that the disposal or re-disposal of mining spoil or mineral preparation wastes complies with relevant European and domestic legislation.

This document is out of date was withdrawn 14/03/2017

Legal framework

Water Resources Act 1991 as amended by the Water Act 2003

The Water Resources Act 1991 (as amended by the Water Act 2003) regulates abstraction of water. The de-watering of mines is currently exempt from control by abstraction licence but work is on-going to bring it into the licensing regime.

Environmental Permitting (England and Wales) Regulations (EPR) 2010

EPR controls discharges to the water environment and the management and disposal of mineral waste. This includes the re-working and relocation of existing spoil heaps (see Annex J groundwater).

Mines (Notice of Abandonment) Regulations 1998

These regulations define the information a mine operator is obliged to provide to us on abandonment of a mine or part of a mine, including the likely consequences of that abandonment and the measures the operator is going to take to mitigate those consequences.

Water Framework Directive

The WFD (2000/60/EC) requires:

- water bodies to meet good ecological and chemical status;
- the implementation of measures to reverse any rising polluting trends in groundwater;
- the prevention and limiting of groundwater pollution from all anthropogenic sources.

Mining Waste Directive

The Mining Waste Directive (2006/21/EC) requires management of extractive waste in a manner to prevent harm to human health and the environment. It aims to reduce any negative impacts on human health and the environment by controlling the management of extractive waste at active sites. It recognises the impacts of historic mining and requires an inventory of closed and abandoned mine waste facilities. This directive is implemented through EPR and the Major Accident Off-Site Emergency Plan (Management of Waste from Extractive Industries) Regulations 2009.

Part 2A of the Environmental Protection Act 1990

Part 2A of the Environmental Protection Act requires the identification and remediation of contaminated land where contamination poses unacceptable risks to human health or the environment.

The Conservation of Habitats and Species Regulations 2010

These regulations require that abstractions or discharges must not have an adverse effect on protected areas and/or ecosystems.

This document is out of date was withdrawn 14/03/2017

L. Cemetery developments

Introduction

We refer here to the development of new cemeteries or the extension or redevelopment of existing cemeteries. We understand this is an emotive and difficult issue. There is however, clear evidence of the pollution potential from cemeteries and some form of control is often needed

The burial of human remains results in the release of a variety of substances and organisms into the subsurface. These may, in time, find their way into the groundwater. Therefore, groundwater can be at risk of pollution from human burials where the numbers are sufficient and the protection afforded by the subsurface geology is poor.

There are approximately 140,000 burials per year in Great Britain, and with an area of up to 5 m^2 per burial (Environment Agency 2004), approximately 70 hectares of land are needed each year for this purpose.

Large numbers of human burials may increase the likelihood that pollutants can enter groundwater and cause pollution, which our position statements aim to minimise. We are particularly concerned where groundwater is heavily used, or used for potable supply. In practice, there have been relatively few problems from existing cemeteries. This is potentially in part due to the sensible precautions taken in historical times regarding the careful location and protection of receptors such as wells and springs.

Population rise is increasing the need for the development of new sites or the redevelopment of existing sites, including the reuse or 'lift and deepen' practices. In the case of redevelopment of existing sites, our position statements L1 - locating cemeteries close to a water supply used for human consumption and L3 - protecting groundwater in highly sensitive locations will not apply, unless impacts on groundwater have previously been identified.

We will only agree to proposals for new or existing developments if the risk to groundwater is acceptable. The larger a development is, the greater the potential hazard it presents. Appropriate engineering design (based on site investigation) and long-term monitoring are likely to be needed. Our position statements aim to manage the increased risk to vulnerable groundwater of such developments.

We expect operators of cemeteries to take appropriate measures to manage their sites to ensure they do not cause unacceptable discharges.

In the event that emergency measures are needed to deal with large numbers of fatalities such as during an outbreak of epidemic disease, groundwater – especially drinking water supplies – remains a priority for protection. Clear plans are needed to ensure the maximum availability of alternatives to burial. If large new cemeteries are necessary then we encourage planners to identify areas of land that will not threaten groundwater or other water supplies. We encourage the effective use of currently available burial facilities; where possible, these should be included within contingency plans. However, older cemeteries may not comply with current standards and their suitability should be established by appropriate investigation, as with new areas. For further advice, planners should refer to Home Office framework for planners preparing to manage deaths (Home Office 2007).

For pet cemeteries please see section M - burial of animal carcasses.

This document is out of date was withdrawn 14/03/2017

Our role

Our work relating to cemeteries is carried out:

- as consultees in the planning process or in redevelopment of existing sites;
- in providing advice for identifying sites for large casualty burials (emergency contingency);
- during investigation of pollution incidents;
- if contacted by members of the public relating to private burial arrangements.

We aim to protect groundwater from pollution risks and will respond to consultations or enquiries in line with the position statements set out here. Where appropriate we will request conditions requiring future site monitoring.

Our approach considers the potential groundwater pollution risks from areas of land used for multiple burials. The pollution risks to groundwater are based on the geophysical and biogeochemical setting of the site and the nature of the potential source of pollution.

While new sites should comply with good practice, we recognise that many existing cemeteries were established before modern standards and we support the use of appropriate engineering methods to reduce the risk from existing sites. However, any extensions to existing sites should comply with good practice.

Disposal of ash from cremation would need to be considered on a site-specific risk basis if it does not meet the requirements of the de minimis exclusion from EPR which covers the scattering of ashes from individual human (or animal cremations). This is described in more detail in interpreting groundwater activity exclusions.

We recommend to have at least one metre of unsaturated zone (the depth to the water table) below the base of any grave. Allowance should also be made to any potential rise in the water table (at least one metre should be maintained).

Position statements

L1 – Siting cemeteries close to a water supply used for human consumption
We will object to the siting of any new cemetery, or the extension of any existing cemetery, within SPZ1, or 250 metres from a well, borehole or spring used to supply water that is used for human consumption, whichever is the greater distance.

L2 - Mass casualty emergencies
We will object to or may refuse to permit new or existing cemeteries planned for use in mass casualty emergencies if they are in SPZ1 or within 250 metres of an abstraction point, whichever is the greater distance. Where there is a risk of disease transmission into groundwater we will extend our objection to SPZ2.

L3 - Cemeteries: Protecting groundwater in highly sensitive locations
We will apply a risk-based approach to assessing the suitability of sites outside of the zones noted in our position statements L1 and L2. We will place a high priority on protecting groundwater within principal aquifers and groundwater catchments for

This document is out of date was withdrawn 14/03/2017

drinking water supply. We will seek to avoid new cemetery developments for greater than 100 graves in these high vulnerability areas except where the thickness and nature of the unsaturated zone, or the impermeable formations beneath the site protect groundwater, or the long-term risk is mitigated by appropriate engineering methods.

Note that all cemetery developments and burials must maintain an unsaturated zone below the level of the base of the grave(s). We will work with the local authorities to identify alternative options where necessary.

L4 - Home burials

We would not expect to be consulted on home burials or sites used for single burials but would expect that the site should conform to the requirements set out in our burials guidance (Environment Agency 2006b).

Legal framework

Town and Country Planning Acts and regulations (various dates)

The Town and Country Planning Acts and regulations are used by local authorities and the Secretary of State to control developments and land use in their area. Local authorities may apply conditions to ensure that groundwater is protected.

Water Resources Act 1991

We have power under section 161A of the Water Resources Act 1991 and the Anti-Pollution Works Regulations 1999 allowing works notices to be served to prevent or remedy pollution of controlled waters, and under EPR to prevent pollution of groundwater.

Waste Framework Directive (2008/98/EC)

A communication from the European Commission indicates that, for ethical reasons, human corpses cannot be defined as waste. As a consequence, EU waste legislation does not apply to human cemeteries.

Environmental Permitting (England and Wales) Regulations

Burials can result in the discharge of hazardous substances and non-hazardous pollutants to groundwater. They are therefore covered by the requirements of the Groundwater Daughter Directive as implemented by EPR (see Chapter 7).

Individual burials spaced out over time will only release trivial amounts of polluting substances. These are considered to fall under the de minimis exclusion, which is described in more detail in interpreting groundwater activity exclusions.

Large numbers of burials in a short time, or the cumulative effects of many individual burials, may cause groundwater pollution. In this case we will, where appropriate, use our powers under EPR to control or prohibit the burial. This has specific relevance to L2 - mass casualty emergencies but will apply more generally.

This document is out of date was withdrawn 14/03/2017

M. Burial of animal carcasses

Introduction

This section refers principally to emergency disposal either on-farm or in similar locations and circumstances. An emergency will include the potential need to cull large numbers of animals in a short time period. It also covers routine animal burials such as pet cemeteries, which requires a permit from us under EPR.

Under normal circumstances, the burial of fallen stock is prohibited by the Animal By-Products Regulations, although certain derogations apply in more isolated areas such as the Isles of Scilly or the Isle of Wight. The preferred disposal options are rendering/commercial incineration or disposal at a fully engineered and appropriately permitted landfill. In an emergency, these options are not available and burial may be allowed, by notice from the Secretary of State or Welsh Minister.

The government updates its contingency plans for exotic notifiable diseases of animals annually. This document takes precedence over GP3.

The burial of carcasses presents a potential hazard to water quality from putrefaction, veterinary medicines and pathogens. Disposals need to be adequately assessed and controlled to prevent pollution. This applies equally under emergency conditions.

Sites in low permeability ground present lower risks to groundwater resources, but there is a consequentially higher risk that contaminated water will build up and present a hazard to surface water.

There are limited data currently available on the fate and transport of viruses in groundwater. What data exist suggest extended survival times in groundwater and so disposal involving diseased or potentially diseased carcasses demands we adopt the precautionary principle.

Even with precautions to prevent pollution, burial in unlined pits under emergency conditions (and the pressures for burial capacity that this entails) will impact on groundwater quality. It may be necessary to restrict the new development of groundwater supplies around these burial sites; the larger the burial, the greater the hazard and the likely need for investigations, engineering design and long-term site management. This limits the extent to which burial can be safely allowed into unlined pits based only on the simple risk assessments that are feasible under emergency conditions. In practice, this will mean that larger disposals must go to suitably engineered and currently permitted landfill sites.

The risk of pollution is site-specific and depends on a number of factors including:

- the volume and type of carcasses;
- the method of burial;
- the surrounding geology;
- the depth to the water table.

In assessing the risk of pollution we need to take into account all the existing and potential future uses of the groundwater over the time that the burial is likely to remain an active source of contamination. This includes not only drinking water abstractions but also the natural discharges of groundwater to the surface through springs and river baseflow. Where viruses are a potential hazard, additional consideration may be needed to protect uses such as stock watering.

This document is out of date was withdrawn 14/03/2017

Our role

In an emergency situation we still have to protect the environment and meet the requirements of EPR. Our role in such situations is to support prior examination, issue an environmental permit if burial is justified and then review the results from requisite surveillance. We also provide advice and support to the government's contingency planning and support any emergency response if a serious disease outbreak occurs.

We aim to protect all groundwater from pollution from carcass burial but our immediate priority in any emergency is to safeguard existing supplies of drinking water. The areas of highest permeability, and where there is the greatest concentration of public water supply catchments, are the principal aquifers. Within these areas we require a high level of confidence that a burial is suitable. This may demand a level of quantified risk assessment for which data and time are not available in emergency conditions. For this reason, it is particularly important that the appropriate authorities work with us to plan for alternative disposal capacity for carcasses in areas of principal aquifer and SPZs.

Pet cemeteries constitute landfills in terms of the Landfill Directive. In practice we do not consider it appropriate to apply our E1 landfill location position statement and therefore should apply:

- M1 - burials close to water supply used for human consumption or farm dairies
- M3 - risk-based approach
- M4 - protecting groundwater in highly sensitive locations

Disposal of ash from the cremation of animals would need to be considered on a site-specific risk basis if it does not meet the requirements of the de minimis exclusion. This is described in more detail in interpreting groundwater activity exclusions.

Large burials (that is, those exceeding eight tonnes per year per farm unit) will require an environmental permit before burial can take place, although disposal may not be acceptable in certain locations following prior examination. We will not normally seek to authorise any burial of two tonnes or less per year per farm unit as this presents minimal risk – subject to the application of M1 - burials close to water supply used for human consumption or farm dairies. Additional burials of this size may be made in the same year without authorisation provided no two burials are within 500 metres of one another on any given farm unit.

Where burials are between two and eight tonnes, we should be consulted and a decision will be made on the basis of readily available information as to whether an environmental permit is required and if so whether the location is suitable. However, if further investigation is required to establish the likely risk, the disposal will need to be permitted.

For all burials, the following basic good practice requirements should be followed. A burial site should:

- be at least 250 metres away from any well, borehole or spring that supplies water for human consumption or for use in farm dairies;
- be at least 30 metres from any other spring or watercourse and at least 10 metres from any field drain;
- have at least one metre of subsoil below the bottom of the burial pit, allowing a hole deep enough for at least one metre of soil to cover the carcass;
- have at least one metre of unsaturated zone (the depth to the water table) below the base of any grave. Allowance should also be made to any potential rise in the water table (at least one metre should be maintained)

This document is out of date was withdrawn 14/03/2017

Position statements

M1 - Burials close to water supply used for human consumption or farm dairies
We will object to the burial of carcasses within SPZ1 or 250 metres from a well, borehole or spring used for water supply that is used for human consumption or farm dairies, whichever is the greater distance. Where carcasses present a risk of disease transmission into groundwater, we will extend this objection to SPZ2.

M2 - On-farm carcass burials
Outside the zones noted in M1, we may consider on-farm carcass burial provided the operator can demonstrate that no alternative disposal options are available. We will only agree to a burial exceeding 50 tonnes per farm unit if the operator can further demonstrate that the disposal will be subject to appropriate engineered containment and associated site management controls.

M3 - Risk-based approach
Outside the zones noted in M1, we will apply a risk-based approach to assessing the suitability of sites for carcass burial.

M4 – Animal carcasses: Protecting groundwater in highly sensitive locations
Outside of the zones noted in M1, we will place a high priority on protecting groundwater within principal aquifers and groundwater supply catchments. We seek to avoid burial in these areas and will work with others to identify alternative disposal options.

Legal framework

Avian Influenza Directive (2005/94/EC) and associated decisions

The Avian Influenza Directive provides measures for the control of avian influenza.

Animal Health Act 1981

The Animal Health Act provides powers for the control of outbreaks of avian influenza, Newcastle disease, and foot and mouth disease.

Animal By-Products (Enforcement) (England) Regulations 2011 and Animal By-Products (Enforcement) (Wales) (No. 2) Regulations 2011

These regulations implement Regulation (EC) No. 1069/2009 which prohibits (except in defined cases) the burial of animal carcasses on the premises where they died. One exception is the case of disease outbreak (as defined in Part A of Annex II to Commission Regulation (EC) No. 142/2011), when the Secretary of State would authorise a derogation. These regulations do not apply to burials arising from the culling of wild animals, other than wild game. There is a derogation allowing burial of pet animals and horses. For more information on the derogations, please see Defra's guidance document (Defra 2011c).

This document is out of date was withdrawn 14/03/2017

Environmental Permitting (England and Wales) Regulations (EPR)

EPR requires permitting of activities that may lead to the input into groundwater of hazardous substances or non-hazardous pollutants, unless it meets the requirement of the de minimis exclusion (see interpreting groundwater activity exclusions). This control applies to larger burials of animal carcasses.

This document is out of date was withdrawn 14/03/2017

N. Groundwater resources

General groundwater resources

Introduction

When groundwater is abstracted, the implications are much wider than just a withdrawal from groundwater storage. All abstraction of groundwater eventually has an impact on surface waters; it is only a question of where the impact will appear and how long it will take and the size of the impact.

Climate change predictions suggest that there may be changes to groundwater resources in the future, changes in patterns of land use as well as changes in demand for water. This could put our resources under increasing pressure.

Many activities result in physical disturbance of aquifers. Examples include:

- mining, quarrying and gravel extraction;
- oil exploration;
- ground source heat pumps;
- construction of cuttings and tunnels;
- new road schemes;
- developments that require piling;
- foundation development;
- basement excavations;
- installation of impermeable barriers such as bentonite or concrete slurry walls and lined landfills.

These activities can artificially lower or raise groundwater levels, alter groundwater flow paths, or even cut off groundwater flow completely. This can cause resource and quality problems. Some activities (for example, tunnels and open boreholes) can also interconnect aquifers that were previously separate. This can cause resource and quality problems.

Other activities such as field drainage and large areas of concrete, asphalt or other impermeable material can intercept water that would have become groundwater recharge by diverting it into surface watercourses. This can have the effect of reducing the available groundwater resource. Changes in land use such as large scale planting of crops with a high water demand can also affect the volume of water recharging the ground.

Our role

We are responsible for the management of groundwater resources in England and Wales, and for the control of groundwater abstractions. In a few instances we also have an operational role in managing water resources (for example, the Shropshire Groundwater Scheme).

We use catchment abstraction management strategies (CAMS) as the framework to manage both groundwater and surface water resources so that new abstractions do not cause the available resource to be exceeded and we also protect the rights of existing water users when a new abstraction is authorised*.* Managing water abstraction

This document is out of date was withdrawn 14/03/2017

(Environment Agency 2010a) sets out the national position and regulatory framework within which CAMS operates.

Our Restoring sustainable abstraction (RSA) programme is used to manage the impact of historic over-abstraction. It provides an umbrella for work required under the Habitats Directive, for SSSIs, biodiversity action plans (BAPs) and undesignated sites of local importance as well as for meeting WFD objectives. Where it appears that an abstraction licence is unsustainable and licensed abstraction rates are causing environmental damage, or could cause damage, we will work with the licence holder(s) to investigate this. If action is justified by an investigation, we will work with the licence holder to implement a solution to protect the environment. This may mean we have to propose changes to abstraction licences to protect the environment while considering the continuing need to have secure reliable public water supplies.

Following the publication of the WFD river basin management plans, we have put in place in partnership with others such as water companies a programme of investigations to determine reasons for groundwater bodies not achieving good groundwater quantitative status. This will be used as the basis to identify measures which ensure sustainable abstraction in the future.

In addition, when making decisions on groundwater abstraction licences, we consider not only the environmental implications of water resource development options, but also the social and economic implications and the impacts on natural resources. This is particularly the case when the proposal concerns a rural area. Here we take account of the effect of water resource proposals on the economic and social well-being of local communities in such areas.

Under section 48A of the Water Resource Act 1991 anyone who suffers loss or damage (such as subsidence) caused by abstraction can bring a claim against the abstractor. This is a matter between the abstractor and the third party.

Background information

Resource assessment is a key element of CAMS based on the principle of balancing inputs to and outputs from each water resource management unit. As far as groundwater is concerned, the main 'input' is the long-term annual average recharge (the proportion of rainfall that becomes groundwater). The main 'outputs' are the needs of the groundwater-dependent environment (such as baseflow to rivers, support to wetlands and so on) and groundwater abstractions. For any groundwater management unit, the amount available for licensing is the long-term annual average recharge minus the needs of the groundwater-dependent environment. This calculation leads to a resource availability status. Most of our approaches to groundwater resource licensing also consider in detail the impacts of groundwater abstraction on river or surface water flows.

As a result of the Water Act 2003, all new abstraction licences are required to be time-limited, typically for 12 years. CAMS set out our approach for the renewal of time-limited licences. We would also like to see holders of permanent abstraction licences convert them to time-limited licences and are investigating ways in which this can be achieved. This would allow us to respond more flexibly to uncertainties such as climate change.

All abstractors have a responsibility not to let their abstraction cause loss or damage to others. From July 2012, we can seek to amend or revoke permanent abstraction licences without compensation if they are causing serious damage to the environment.

This document is out of date was withdrawn 14/03/2017

We will use the abstraction licensing system to:

- prevent the loss of future resources by over-abstraction;
- protect groundwater-dependent environmental features;
- prevent the deterioration of groundwater quality.

This applies to all types of abstraction licence – temporary, transfer and full. Abstractions that do not consume any water can still have unacceptable impacts. Alternatively, an abstraction may derogate existing protected rights to water of another abstractor, or lead to deterioration in groundwater quality. Appropriate mitigation by the abstractor may offset any detrimental impacts of the abstraction and allow us to grant the licence.

In some circumstances, we may wish to see groundwater resources augmented to increase the available resource in water scarce areas. Techniques include the following:

- Infiltration sustainable drainage systems (SuDS) are designed to manage run-off from rainfall and encourage groundwater recharge by means of infiltration systems, where appropriate. SuDS have added benefits for surface water quality and flooding.
- Treated effluent from wastewater treatment plants can be returned to the ground so that the resource is not lost to the catchment.
- Under the right conditions, water can be recharged into the ground to augment resources or for storage (to be recovered later for use) (see section Q - managed aquifer recharge and recovery schemes).

With all these techniques, the main constraint is usually water quality. If the run-off, treated effluent or injection water is poor quality, the aim of enhancing resources can conflict with the need to protect the groundwater from pollution. On land that is contaminated, there are also risks around mobilising contaminants into groundwater by undertaking these recharge techniques. See N10 - augmenting groundwater resources.

Groundwater rebound (see section S - flooding from groundwater) caused by reduction in groundwater abstraction can adversely affect underground structures that have been built when abstractions were at greater levels. Although it is not our responsibility to manage groundwater rebound, where possible we will work with the relevant bodies such as local authorities to address the problem (for example, by trying to encourage abstraction through the CAMS process). However, there is a sustainability issue if the solution involves pumping indefinitely.

Any groundwater abstraction can cause movement of an existing pollution plume in a connected aquifer. However, this may be acceptable if N5 - protecting groundwater resources is met.

This document is out of date was withdrawn 14/03/2017

Position statements

N1 - Sustainable catchments
CAMS aim to ensure that the total authorised abstraction from any groundwater management unit does not exceed the long-term annual average available resource, after environmental needs have been accounted for. This will support achievement of the good groundwater quantitative status requirements of the WFD.

N2 - Reducing unsustainable abstractions
We will progress options to reduce licensed abstractions that are: • causing environmental problems; or • in excess of the available resource; or • threatening to cause environmental problems if fully utilised.

N3 - Time-limited licences and tests for renewal
All new abstraction licences and most variations will be time-limited. Time-limited licences will carry a presumption of renewal where licence holders can satisfy us that all of the following three tests are met: • environmental sustainability is not in question; • there is continued justification of need; • the licence holder can demonstrate that water used as a resource is being used in an efficient manner.

N4 - Water resource management arrangements
We will take steps to secure the proper management of water. Where appropriate, we will enter into water resources management arrangements with abstraction licence holders to protect or enhance the water environment or to secure the proper management of water resources.

N5 - Protecting groundwater resources
We will only authorise abstractions if it can be shown that: • there will be no derogation of existing protected rights; • there will be no unacceptable detriment to any groundwater-dependent environmental features such as rivers, lakes or wetlands; • they can be managed so that they will not cause pollution; • there will be no environmentally significant upward trends of pollutants through the intrusion of saline or polluted waters.

This document is out of date was withdrawn 14/03/2017

N6 - Water and development planning

We will work with local government to ensure that water is considered at all stages of the planning system. We will use the planning system to protect groundwater resources by seeking to incorporate sustainable water management approaches into planning guidance, strategies, and development frameworks and plans.

N7 - Hydrogeological risk assessment

Developers proposing schemes that present a hazard to groundwater resources, quality or abstractions must provide an acceptable hydrogeological risk assessment (HRA) to us and the planning authority. Any activities that can adversely affect groundwater must be considered, including physical disturbance of the aquifer. If the HRA identifies unacceptable risks then the developer must provide appropriate mitigation. If this is not done or is not possible we will recommend that the planning permission is conditioned or object to the proposal.

N8 - Physical disturbance of aquifers in SPZ1

Within SPZ1, we will normally object in principle to any planning application for a development that may physically disturb an aquifer.

N9 - Obstruction of flow

We will only agree to proposals where the obstruction of groundwater flow is likely to cause an unacceptable change in groundwater levels or flow, if measures to mitigate any effects can be agreed.

N10 - Augmenting groundwater resources

Providing there is no pollution or risk of groundwater flooding, we will encourage the augmentation of groundwater resources through techniques such as SuDS (where they meet the SuDS national standards or have a relevant environmental permit) and artificial recharge, particularly where resources are scarce, or where such activities would reduce the flood risk from development.

N11 - Protection of resources and the environment from changes to aquifer conditions

For any proposal that would physically disturb aquifers, lower groundwater levels, or impede or intercept groundwater flow, we will seek to achieve equivalent protection for water resources and the groundwater-dependent environment as if the effect were caused by a licensable abstraction.

N12 - Rising groundwater levels

Where rising groundwater levels are causing or are likely to cause problems, we will encourage increased abstraction within the relevant abstraction licensing framework.

See also our position statement on our role in flooding from groundwater.

This document is out of date was withdrawn 14/03/2017

Legal framework

Water Resources Act 1991, as amended by the Water Act 2003

The primary tool used for water resources management is abstraction licensing. Small abstractions under 20 m^3 per day do not need an abstraction licence, whatever the purpose of the abstraction. We can request alternative thresholds in the future that will provide the right balance between effectively managing risks to the environment and imposing a regulatory burden.

For groundwater, the first stage is for the applicant to provide evidence for us to assess whether the proposed abstraction will be sustainable and not have an adverse impact on the water environment and other legitimate abstractors. Therefore, in order to allow operators to drill and test pump a borehole without the need for a full licence, we issue a groundwater investigation consent (GIC) to allow operators to undertake this work. Potential abstractions under 20 m^3 per day do not need a GIC.

Once the drilling and testing has been completed successfully, there are three types of licence – a temporary licence, a transfer licence and a full abstraction licence. Licensing covers both surface and groundwater abstractions and details can be found on our website.

The Conservation of Habitats and Species Regulations 2010

These regulations require that consented activities (including abstractions) must not have an adverse effect on the integrity of designated Natura 2000 sites such as special protection areas (SPAs) and special areas of conservation (SACs). This may be relaxed if it can be shown that there are imperative reasons or overriding public interest, there are no alternative solutions, and compensatory measures are provided.

The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003

These regulations require that the aim should be to achieve ‘good groundwater status’, which includes groundwater quantity requirements. Development and use of land is the one consistent element in the list of potential risks to groundwater resources. Therefore, in addition to the licensing process, land use planning legislation, policies and procedures can make a major contribution to protection of groundwater resources.

This document is out of date was withdrawn 14/03/2017

P. River augmentation

Introduction

River augmentation is the discharge of groundwater into a river to augment its flow or support abstraction from it. To ensure a resilient supply of water throughout the year, taking account of predictions of climate change, water companies and others may need to have more integrated use of both surface and groundwater. Groundwater may be more able to provide water in the summer months when river levels are low. This may include river augmentation or combined use of groundwater and surface water. In some settings, stream support may not be able to replicate natural flows and so may not be appropriate.

It is essential to understand how surface water and groundwater interact in order to quantify how much the river will benefit from the groundwater discharge. There is a trade-off between hydrogeological and cost factors as the best technical design may not be the most cost-effective.

In designing these schemes there are a number of factors to consider. These include:

- groundwater must not be depleted year-on-year as this could then affect river flows throughout the year;
- reduction of augmentation needs to be carefully timed to fit in with the natural recovery in river flows;
- special arrangements need to be made for augmentation in times of drought;
- regular review of augmentation schemes must be made to take account of changes in catchment conditions including the impacts of climate change on surface water flows.

We need to ensure that schemes are operated efficiently to minimise greenhouse gas emissions and that the long-term sustainability of a scheme is considered.

River augmentation is undertaken for either or both fundamental reasons, that is, to support downstream river abstraction and for environmental protection. There are over 60 river augmentation schemes in England and Wales. Schemes for supporting downstream abstraction can vary widely in scale. At one end of the scale are major developments such as the Candover scheme in Hampshire, which pumps up to 36 million litres per day (Ml/d) of groundwater into the River Candover, a tributary of the River Itchen. At the other end of the scale are schemes to provide occasional flow support to a river or stream as one of the conditions attached to a relatively small groundwater abstraction licence.

Our role

We have a statutory duty to secure the proper use of water resources, which may include the promotion of river augmentation schemes. Many river augmentation schemes are initiated within the context of large scale (linked to water company areas) or even national water resources planning. For example, the Shropshire Groundwater Scheme discharges groundwater into the River Severn to be re-abstracted for public water supply, industrial and agricultural uses many miles downstream. It is also used to maintain flows for ecology, river and estuary habitats, navigation and recreation.

We encourage a twin-track balanced approach to water resources by seeking the efficient use of water while encouraging resource development where appropriate. We also need to ensure that water resource schemes minimise greenhouse gas emissions,

This document is out of date was withdrawn 14/03/2017

protecting the environment and maintaining security of supply. This is detailed in our water resources strategy (Environment Agency 2009a).

Position statements

P1 - Design of river augmentation
We will insist that the design of the scheme is based on a robust understanding of the groundwater and surface water systems and their interaction, with a realistic assessment of the long-term net gain.*   * Long-term net gain refers to increase in river flows as a result of the scheme compared to the situation without augmentation. While we need some consideration of long-term average recharge and annual abstraction, we also have to consider current recharge and current abstraction (if one year is higher than another) especially with predictions of climate change.

P2 - Operating rules and responsibilities for augmentation
We will require the objectives of the scheme to be clearly defined, with agreed operating rules and clear responsibilities for meeting the on-going operating and maintenance costs.

P3 - Assessing groundwater abstraction for river augmentation
We will assess the groundwater abstraction component of a river augmentation scheme in the same way as any other groundwater abstraction to ensure that there are no unacceptable impacts on the groundwater-dependent environment and that there is no derogation of existing protected rights.

P4 - Assessing discharge for river augmentation
The discharge component of a river augmentation scheme will be assessed in the same way as any other discharge to ensure that the water quality of the discharge is compatible with the receiving water quality and that the natural flow variability of the receiving river is not adversely compromised.

P5 - River augmentation for water resource development
We will encourage the augmentation of river flows from groundwater in appropriate situations as a valid means of developing water resources to their full potential while still protecting the environment.

P6 - Cost–benefit for river augmentation
We will require full cost–benefit analysis and will accept the use of other tools (such as life-cycle analysis, multi-criteria decision analysis, qualitative approaches and efficiency analysis of proposed river augmentation schemes) within the context of the government's approach to sustainable development and the need to minimise greenhouse gas emissions. We will also encourage regular reviews of the effectiveness of existing schemes.

This document is out of date was withdrawn 14/03/2017

Legal framework

Water Resources Act 1991, as amended by the Water Act 2003 and Environmental Permitting Regulations

Where borehole abstraction exceeds the threshold for licence control (currently 20 m^3 per day), an abstraction licence is required for the boreholes used to provide the augmentation water. If the boreholes are owned and operated by us, we will apply to the Secretary of State or Welsh Ministers and the same requirements and process to secure a licence will apply. All these boreholes also require a GIC as detailed in Managing water abstraction (Environment Agency 2010a). Discharges of groundwater to augment a river may also need an environmental permit.

The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003

River augmentation schemes are likely to form an integral part of some river basin management plans.

The Conservation of Habitats and Species Regulations 2010

The use of river augmentation schemes may be part of a solution to maintain or restore the condition of a SPA or SAC.

This document is out of date was withdrawn 14/03/2017

Q. Managed aquifer recharge and recovery schemes

Introduction

To ensure a resilient supply of water throughout the year, taking account of climate change predictions, water companies and others may need to make more integrated use of both surface water and groundwater. Aquifers can provide a useful store of water through managed aquifer recharge (MAR) and recovery schemes that can be used when other supplies are not available.

A subset of MAR, termed aquifer storage and recovery (ASR), involves water being injected to form a lens or 'bubble' of fresh or drinking quality water within the body of groundwater which is of different quality (for example, saline). The concept of ASR is that the developer is effectively creating a 'below ground reservoir' in which to store high quality groundwater. Just pumping it into an aquifer (artificial recharge) requires a 'good, productive' aquifer to be available. ASR was first used in the US where it involved an unexploited geological horizon, potentially containing poor quality groundwater and injecting, then re-abstracting, treated/potable water – hence the 'bubble' concept. The technique has so far only been trialled on a small scale in the UK.

The main challenges for ASR are the uniqueness of each individual site and the complex hydrogeological investigations needed to establish the viability of a scheme. Some schemes fail simply because the aquifer will not receive or yield sufficient quantities of water, or where water drains out of the aquifer too quickly to be of use. Even where yields are adequate, water quality is the main concern.

In favourable hydrogeological conditions, MAR can be used instead of surface reservoirs that occupy potentially large tracts of land and can disrupt natural river flow. Water storage, including MAR, is one of the ways mentioned in our water resources strategy (Environment Agency 2009a) of increasing resilience to climate change. We advocate the use of innovative and combined use of groundwater resources as pressures on water resources increases.

The artificial recharge of water into aquifers and the subsequent abstraction of this groundwater is technically complex. New schemes are likely to be developed in a phased manner, with separate authorisations required at each stage. We will work with the applicant in authorising these schemes where they make the best use of our valuable water resources.

There are some key complexities with all MAR schemes, including ASR schemes, such as identifying and investigating the source of water to be recharged and then drilling and isolating the target aquifer. General good practice needs to be followed to avoid drilling through contaminated soil or ground, which could pollute groundwater or create undesirable connections between discrete aquifer units, adversely affecting local groundwater level and flow patterns. Establishing the permeability and storage regime of the aquifer through a series of recharge and abstraction tests is also an important part of the process. Schemes should also investigate impacts on water quality, so we understand the consequences of mixing recharge water with groundwater of a different quality within the aquifer, particularly the longer term changes from operation of recharge/abstraction cycles over several years.

Some MAR schemes involve injection of water into good quality, generally well-utilised aquifers to enable improved or increased use of water resources. Strategic use of MAR provides additional recharge permitting further abstraction in over-exploited aquifers. The water can be abstracted from the same boreholes as used for injection, or from additional boreholes down hydraulic gradient.

This document is out of date was withdrawn 14/03/2017

MAR schemes are driven by the need to increase sustainability of water resources or to cut costs through increased cost effectiveness. In a typical case, an aquifer is developed for artificial recharge instead of building a small or medium-sized surface reservoir. Schemes developed in the UK include the North London Artificial Recharge Scheme owned and operated by Thames Water.

Our role

We are responsible for making sure that water abstractions and discharges do not damage the environment. We see MAR as an option for increasing water availability, particularly at peak demand periods and as an alternative to small- and medium-sized surface reservoirs. We also encourage the use of MAR projects as an option for redressing previously unsustainable water resources abstractions under our Restoring sustainable abstractions programme.

We encourage developers of proposed MAR schemes to liaise with us at the outset and to maintain regular dialogue as the scheme progresses.

Position statements

Q1 - Control of MAR schemes
We will regulate all managed aquifer recharge and subsequent re-abstraction over 20 m3 per day to ensure effective development of water resources while at the same time protecting the environment and other abstractors. In particular, schemes must be sustainable in terms of quantities recharged and re-abstracted.

Q2 - Detailed investigation for managed aquifer recharge (MAR) and recovery
We require developers to undertake appropriate investigation for MAR schemes. This will include a hydrogeological risk assessment at the pre-licence stage and method statements for their construction and operation.

Legal framework

Water Resources Act, 1991 (as amended by the Water Act, 2003) and Environmental Permitting Regulations 2010

All MAR (including artificial storage and recovery) schemes require authorisations from us. In general, developers should ensure that:

- abstraction of water from an aquifer or surface water source is authorised by an existing licence or a groundwater investigation consent;
- the discharge of any water to surface water or groundwater is authorised by a suitable environmental permit or exemption.

We encourage pre-application discussion to ensure all parties understand what is intended.

This document is out of date was withdrawn 14/03/2017

R. Ground source heating and cooling

Introduction

Achieving UK climate change targets will require a massive shift from fossil fuels to renewable energy and other technologies with low greenhouse gas emissions. The UK is committed to generating 15 per cent of its energy from renewables by 2020. This includes heat, of which only about one per cent currently comes from renewable sources. Government projections suggest that this should increase to 12 per cent by 2020. Ground source heat is one technology that could help achieve this.

Ground source heating and cooling (GSHC) systems utilise a renewable energy source as it is the warming of the ground by solar radiation that keeps 'shallow' groundwater at its constant temperature. Heat from deep in the Earth's interior can warm groundwater but this is not normally significant within 100 m of the surface and so, for the purposes of GP3, any schemes that use heat from the Earth's interior will be called 'deep geothermal schemes' and not GSHC systems.

In recent years there has been considerable interest in these systems in the UK. In 2009 there were approximately 8 000 GSHCs in the UK and research conducted for us suggests that by 2020 there could be between 320 000 and 1.2 million systems installed.

There are two types of GSHC systems: 'closed loop' and 'open loop'. In general, open loop systems require more detailed assessment, planning and regulation. Our Environmental good practice guide for ground source heating and cooling (EGPG) covers both open and closed loop GSHC schemes.

In **open loop** systems, water is abstracted from the ground and pumped through a heat exchanger before it is pumped back into the ground, a sewer or river. Open loop systems require more detailed assessment, planning and regulation. In **closed loop** systems, fluid is re-circulated through a heat exchanger connected to a sealed system of pipes in boreholes, trenches or piles. The fluid moves heat energy between the ground/groundwater and the heat exchanger.

Operators should manage GSHC systems carefully, following our EGPG and adhering to permit conditions for open loop systems. This includes assessing and understanding the environmental risks of a proposed scheme and taking steps to reduce environmental risks.

Both closed and open loop systems installed at depth can:

- result in changes in groundwater flow and quality by interconnecting aquifers, posing contamination risks or changes to flow during both drilling and installation (these risks can be managed by following EGPG);
- mobilise contaminants if installed inappropriately on contaminated sites;
- result in undesirable temperature changes in the water environment and for example, impacting on ecology.

In addition, open loop systems give rise to concerns about:

- availability of groundwater to abstract without impacts on existing water users or the environment – if water is available these risks should be low providing the water is returned to the same aquifer (and not to rivers or sewers) making the abstraction non-consumptive;

This document is out of date was withdrawn 14/03/2017

- adverse impacts of returning water into an aquifer such as localised mounding of groundwater levels, causing flooding or impacting on adjacent structures including scheduled ancient monuments.

Closed loop systems have few additional environmental issues associated with them other than the need to avoid groundwater pollution from leaking circulation fluid.

The risks indicated above need to be balanced against the environmental advantages associated with these schemes in potentially cutting greenhouse gas emissions. Where the risks and environmental advantages are not balanced. However, high densities of GSHC systems may not be sustainable in the long term as they may alter the local ground or groundwater temperature resulting in impacts to the efficiency, and therefore greenhouse gas emission savings, of adjacent systems.

Our role

We are responsible for managing the use of the water resources in England and Wales. As part of this duty, we control water abstraction and discharges of pollutants to the environment. To support the deployment of GSHC systems we have developed EGPG for our staff and developers, adopting a risk-based approach to the regulation of GSHC and ensuring we have sufficient resources and expertise to manage an expected increase in applications in the future.

However, no specific requirements regarding the control of heat are detailed in legislation or statutory guidance. We may control discharges with a permit, where appropriate, to avoid pollution or failure to achieve WFD objectives. Closed loop schemes do not discharge substances that we would be able to regulate. The heat associated with these schemes is therefore not under our regulatory control.

Open loop schemes

Open loop schemes that abstract and discharge water to the environment are regulated. These schemes require a groundwater investigation consent (GIC) followed by an abstraction licence if the abstraction is greater than 20 m^3 per day; they also require an environmental permit to discharge to groundwater or surface water. Where necessary to prevent pollution, we will set temperature limits on these environmental permits. These permits and consents allow us to ensure that schemes comply with environmental legislation such as the Habitats Directive and the WFD.

Developers of open loop GSHC schemes should contact us at an early stage to discuss the proposed design, intended location and operation of their system.

Some deep geothermal schemes operate by the injection of water that is subsequently re-abstracted from a depth considerably below the active hydrogeological zone as there is negligible natural groundwater at this depth. These types of scheme do not require a GIC or abstraction licence to re-abstract this water from depth as there is no abstraction from a source of supply. Discharges at this depth do not require an environmental permit again if there is negligible groundwater and therefore not considered by us to be a groundwater activity. Operators who consider their scheme fits into this category should contact us for confirmation. Abstraction of shallow groundwater or surface water to fill these schemes will require licensing where abstraction volumes are greater than 20 m^3 per day. If the activity is taking place where there is natural deep groundwater that is utilised for this purpose, then the approach will be the same as for GSHC.

This document is out of date was withdrawn 14/03/2017

Closed loop schemes

Operation of a closed loop GSHC scheme does not require an environmental permit. However, we strongly recommend the use of non-hazardous pollutants in closed loop systems to avoid pollution. If a developer proposes to use hazardous substances in a sensitive location such as a SPZ1 we may issue a notice to prevent pollution.

Developers of closed loop schemes should ensure best practice is followed and should contact us if they have concerns relating to, for example, contamination.

Position statements

R1 - Encouraging sustainable renewable energy
We are committed to facilitating and enabling the deployment of sustainable renewable energy, including ground source heating and cooling (GSHC) systems.

R2 - Regulation of GSHC
GSHC systems can, in some circumstances, have negative impacts on the environment or on other users of water. We take a proportionate and risk-based approach to schemes that we regulate to mitigate these impacts where they occur. Where schemes are non-consumptive of water resources and low risk to the environment, we aim to reduce the regulatory burden for these schemes.

R3 - Balanced systems
We consider that the most sustainable type of GSHC system or group of systems balances heating and cooling demand across a year in instances where cooling is required. This will avoid unacceptable heating of the ground or groundwater.

R4 - Good practice
We expect all developers to follow our published environmental good practice guide (EGPG), which details the environmental risks of all types of schemes and how these can and should be mitigated. We will require a risk assessment for both the abstraction and discharge from the schemes we regulate. We expect developers to assess risks for schemes we do not regulate and we should be made aware of GSHC proposals on contaminated land or in a SPZ1.

This document is out of date was withdrawn 14/03/2017

R5 - Serving notices
An environmental permit is not required to construct or operate a closed loop system. However, if the system uses hazardous substances we will if necessary issue a notice to prevent pollution. We strongly recommend that systems do not use hazardous substances.

R6 - Operator's responsibilities
It is the developer's responsibility to consider the fact that the ground and groundwater can eventually warm or cool to a point where the system may not operate efficiently. They should also consider the impact of their system on the ground and groundwater, such as causing ground instability or groundwater flooding throughout the lifetime of the scheme. Developers should also be aware that even when schemes are not regulated they may be liable for any pollution resulting from their activity or impacts on third party assets.

Legal framework

Both EU and UK legislation recognise that heat can cause pollution and should be controlled. However, there is no detail in the legislation on how this may be achieved.

Water Resources Act 1991 as amended by the Water Act 2003

This act regulates abstractions over 20 m^3 per day.

Environmental Permitting (England and Wales) Regulations (EPR) 2010

EPR requires permitting of activities that may lead to the input into groundwater of hazardous substances or non-hazardous pollutants. Permits must only be issued after there has been adequate prior examination and must be subject to requisite surveillance.

Discharge of water with a significantly changed temperature may cause pollution and so an environmental permit will be required. If the water discharged contains any added substances to the abstracted water, an environmental permit will be required.

These regulations also allow us to serve a notice to prevent pollution, for example, if hazardous substances were proposed to be used in a closed loop scheme in a SPZ1.

Groundwater Daughter Directive and Water Framework Directive

The WFD (2000/60/EC) and Groundwater Daughter Directive (2006/60/EC) both state that energy/heat can cause pollution and pollution should be prevented.

The Conservation of Habitats and Species Regulations 2010

These regulations require us to have specific regard to potential adverse effects on protected species and/or ecosystems when regulating activities.

This document is out of date was withdrawn 14/03/2017

S. Flooding from groundwater

Introduction

Groundwater flooding occurs when water levels in the ground rise above surface levels. It is most likely to occur in areas underlain by permeable rocks (aquifers). These can be extensive regional aquifers (such as chalk or sandstone) or more local sand or river gravels in valley bottoms underlain by less permeable rocks. This is not a significant source of flooding in Wales.

Flooding from groundwater arises from:

- natural, exceptional rises in groundwater level, re-activating springs and intermittent watercourses (such as bournes) This is often referred to as 'clearwater' flooding);
- rising groundwater (rebound) following reductions in historic, usually industrial abstraction;
- minewater recovery;
- local shallow drainage/flooding problems unrelated to deep groundwater responses.

Rises in groundwater level close to or above ground level can result in interference to property and infrastructure. Flooding from groundwater can be a significant source of flooding at a limited number of geographical locations and has attracted an increasing amount of public concern in recent years.

There are more than 5.5 million properties at risk from flooding from all sources across England and Wales. Although flooding from groundwater accounts for a small portion of this figure, when it does occur it usually lasts longer than flooding from rivers, the sea or surface water. It is also one of a number of components of flooding in some locations where there are multiple sources of flooding. The 382,000 properties located on the exposed chalk aquifers in southern England are thought to be some of the most vulnerable, as groundwater levels fluctuate widely in this area.

In low-lying areas of the country the management of groundwater levels and other land drainage activities can be important in managing wider flood risk. These activities are normally carried out by internal drainage boards (IDBs); approximately 10 per cent of the land area in England is currently managed in this way.

We are continuing to develop:

- greater understanding of groundwater flood risk on a national scale;
- tools and approaches to understand these risks.

Responsibility for managing such risks rests with local authorities.

This document is out of date was withdrawn 14/03/2017

Our role

Flood risk management

We have a strategic overview role for flooding from all sources including rivers, the sea, groundwater, reservoirs and surface water in England and Wales.

Under the Flood and Water Management Act 2010, lead local flood authorities (LLFAs) are responsible for mapping, modelling and managing the risk of flooding from groundwater. LLFAs are the unitary authority or (if there is no unitary authority), the county council for the area. LLFAs work in partnership with other organisations – including the Environment Agency, district councils, and water and sewerage companies – to manage this risk

We are responsible for providing and maintaining the warning services we developed in the past for flooding from groundwater. We do not have powers, duties or resources to control groundwater levels to prevent flooding of land, property or infrastructure.

Monitoring groundwater levels

We have established observation borehole networks to monitor groundwater levels. These are generally not designed or instrumented for 'real-time' groundwater flood warning in the majority of locations, although in some locations we use these existing boreholes to provide a flood warning service.

There are locations where groundwater levels in aquifers rise in correlation with high river levels or extreme tidal conditions. In some of these locations we do monitor the correlation between groundwater and river levels; once we have a better understanding of the correlation, we may consider expanding the river flood warning service to include such situations. However, we do not routinely monitor groundwater levels in perched or secondary aquifers for flood warning purposes.

Many river and tidal catchments use models to predict flooding and to support flood warning. Conceptual and numerical models also commonly cover principal aquifers. Although numerical groundwater modelling is available across significant parts of the country affected by groundwater flooding, this is not presently in a suitable form to be used for groundwater flood forecasting.

Advice on 'water problems' affecting property

We receive many enquiries from the public about basement flooding and other water-related problems affecting their properties. These are often attributed to 'rising groundwater'. We have no specific remit to investigate these problems or the causes, though we may collect this information in some places to help our understanding of groundwater flooding and may use some features within a catchment as an indicator for groundwater flood warnings. Your LLFA should be able to pick up any identified local flood risk problems. We also do not provide specific advice on, or implement solutions to, such problems but have developed some general guidance (Environment Agency 2011e). Similarly, our groundwater level monitoring networks are usually not relevant to resolving site-specific issues.

Background information

Groundwater flooding was highlighted by the Pitt Review of the summer 2007 floods as an area where there was no clear responsibility (Pitt 2008). This concern has now been addressed by the Floods and Water Management Act 2010.

Types of groundwater flooding can be broadly categorised into the following types:

- **Groundwater or 'clearwater' flooding**. This is an entirely natural phenomenon caused by water emerging from beneath the ground surface from permeable strata – usually some time after periods of higher than average rainfall. It can occur over different scales of time (ranging from days to months) and space, depending on the near surface and deeper geology, and the antecedent climatic conditions. In terms of principal aquifers, it is

This document is out of date was withdrawn 14/03/2017

mainly restricted to low storage, rapid response aquifers (Chalk and limestone). Widespread flooding of this type occurred in the chalk aquifers within our Thames and Southern regions during the exceptionally wet winter of 2000–2001, and again in 2002–2003.

- **Groundwater rebound**. This is often loosely referred to as 'rising groundwater'. Here, groundwater levels are recovering to natural conditions following a decline in the volume of long-term industrial and/or public supply abstraction. This is often in urban environments (for example, in Liverpool, Birmingham and London). In many instances these can be much slower responses than 'clearwater' flooding in fractured aquifers. However, recent evidence has shown in certain circumstances levels can rise rapidly (tens of metres) in only a few years (see section N - general groundwater resources for information on how we deal with this).
- **Minewater rebound, or 'rising minewater'**, when mining and associated de-watering has ceased, this allows old workings to become flooded. Groundwater levels then recover to higher natural levels, often discharging at surface. Again, the timescale for rebound is slow and can typically be measured in decades (see section K - mining induced pollution for more information on minewater pollution).

There are many other localised and site-specific reasons for water to emerge at the surface or to appear in basements. Examples include:

- leaking water mains and sewers;
- blocked drains;
- impedance of natural drainage routes by urban development;
- deepening of cellars to below the natural water table.

The causes of and risks associated with these different groundwater and site drainage issues are often poorly understood or accounted for. There is a need for increased awareness by these parties of the processes, and possible solutions and mitigation options.

Position statement

S1 - Our role in flooding from groundwater
We provide a risk-based groundwater flood warning service for those locations at highest risk which have experienced flooding from groundwater in the past. Although we cannot provide a warning service for each individual property, we do provide generic information on flooding from groundwater. This can be found on our website. Lead local flood authorities (LLFAs) have powers to carry out risk management activities associated with flooding from groundwater. LLFAs are either the unitary authority or the county council for the area. LLFAs work with other organisations, including the Environment Agency, to manage this risk. If you would like further information about flooding from groundwater you should contact your lead local flood authority. Please also see N12 - rising groundwater levels.

This document is out of date was withdrawn 14/03/2017

Legal framework

Flood and Water Management Act 2010

LLFAs are responsible for groundwater flooding under this act.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

7 Legislation

This chapter provides lists the key European and domestic legislation (with links to the original source) that provides the framework within which we manage groundwater quality and resources. It also puts our position statements in context with the legislation under which we operate.

Topics

This document is out of date was withdrawn 14/03/2017

Key European legislation

- Avian Influenza Directive (2005/94/EC)
- Animal By Products Regulations (EC) No. 1069/2009 and Animal By Products Regulation (EC) No. 142/2011
- Biocidal Products Directive (98/8/EC)
- Environmental Liability Directive (2004/35/EC)
- Groundwater Directive (80/68/EEC) (to be repealed in December 2013)
- Groundwater Daughter Directive (2006/118/EC)
- Integrated Pollution Prevention and Control Directive (2008/1/EC)
- Industrial Emissions Directive (2010/75/EC)
- Landfill Directive (99/31/EC)
- Mining Waste Directive (2006/21/EC)
- Nitrates Directive (91/676/EEC)
- Plant Protection Products Directive (91/414/EEC) and Regulation (EC) No. 1107/2009 from June 2011)
- REACH (European Community Regulation on chemicals and their safe use (EC 1907/2006)
- Sustainable Use of Pesticides Directive (2009/128/EC)
- Waste Framework Directive (2008/98/EC)
- Water Framework Directive (2000/60/EC)

Key domestic legislation

- The Animal By-Products (England) Regulations 2005
- The Animal By-Products (Wales) Regulations 2006
- Animal Health Act 1981
- The Anti-Pollution Works Regulations 1999
- The Biocidal Products Regulations 2001
- The Control of Major Accident Hazards Regulations 1999
- The Conservation of Habitats and Species Regulations 2010
- The Environmental Damage (Prevention and Remediation) Regulations 2009
- The Environmental Permitting (England and Wales) Regulations 2010
- Environmental Protection Act 1990
- Flood and Water Management Act 2010
- The Flood Risk Regulations 2009
- The Major Accident Off-Site Emergency Plan (Management of Waste from Extractive Industries) (England and Wales) Regulations 2009
- The Nitrate Pollution Prevention Regulations 2008
- The Plant Protection Products Regulations 2005
- The Sludge (Use in Agriculture) Regulations 1989
- The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999
- Town and Country Planning Acts and Regulations (various dates)
- Water Act 2003
- Water Resources Act 1991
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003
- The Water Supply (Water Quality) Regulations 2000 (Amendment) Regulations 2007
- The Water Supply (Water Quality) Regulations 2010

Defra directions

- The Chemical Analysis of Water Status (Technical Specifications) Directions 2011
- Groundwater (Water Framework Directive) Direction 2006
- River Basin Districts Surface Water and Groundwater Classification (Water Framework Directive) (England and Wales) Direction 2009
- The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010

This document is out of date was withdrawn 14/03/2017

Legislative drivers

This section seeks to put our position statements in context with the legislation under which we operate. Note that it is not an exhaustive or detailed description of our statutory powers and duties relating to groundwater. Note also that groundwater protection legislation may differ between England and Wales

Transposition of European legislation into domestic legislation

Our powers and duties arise from domestic legislation in England and Wales, which is increasingly being driven by European legislation. Unless otherwise indicated we are the competent authority for implementing the legislation listed in Table 7.1.

Our environmental permitting programme has simplified the application of environmental legislation in England and Wales. The EPR regime implements European legislation but streamlines the domestic regulations. The result is a single environmental permit with a common approach to permit applications, maintenance, surrender, compliance and enforcement. This increases clarity, minimises the administrative burden on both operators and the Environment Agency and encourages risk-based, proportionate regulation.

Table 7.1 Summary of European legislation relating to groundwater and its transposition in England and Wales

EU directive	Requirements	England and Wales transposition	Other regulators
Groundwater Directive (80/68/EEC) – to be repealed in December 2013 and now largely superseded by the Water Framework Directive (2000/60/EC) and Groundwater Daughter Directive (2006/118/EC)	Permitting of discharges and disposals of listed substances	The Environmental Permitting (England and Wales) Regulations 2010	
	Other appropriate measures to control the release of listed substances to groundwater	The Environmental Permitting (England and Wales) Regulations 2010	Local authorities lead for contaminated land except for special sites
		Section 161A WRA 1991 and Anti-Pollution Works Regulations 1999 (works notices)	
		Section 93 WRA 1991 (Water Protection Zones)	
		Part 2A EPA 1990 and associated regulations – contaminated land regime	
		Planning regime	Local planning authorities lead

This document is out of date was withdrawn 14/03/2017

This document is out of date was withdrawn 14/03/2017

EU directive	Requirements	England and Wales transposition	Other regulators
Water Framework Directive and Groundwater Daughter Directive – in combination replace former Groundwater Directive	Status objectives (good status and no deterioration) Classification of groundwater, setting of threshold values Identification and implementation of measures to achieve trend reversal Prevention and control of groundwater pollution (prevent inputs of hazardous substances and limit inputs of non-hazardous pollutants)	The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 River Basin Districts Surface Water and Groundwater Classification (Water Framework Directive) (England and Wales) Direction 2009 The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010 The Groundwater (Water Framework Directive) Direction 2006 The Environmental Permitting (England and Wales) Regulations 2010	
Water Framework Directive (2000/60/EC)	Protected area objectives	The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 Water Resources Act 1991	
		The Conservation of Habitats and Species Regulations 2010	Natural England and Countryside Council for Wales
Water Framework Directive (2000/60/EC)	Monitoring River basin planning	The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003	
Nitrates Directive (91/676/EEC)	Control of diffuse nitrate pollution from agriculture Monitoring, identification of vulnerable zones and enforcement of action plans	The Nitrate Pollution Prevention Regulations 2008	
Plant Protection Products Directive	Authorisation of substances for use in	The Plant Protection Products Regulations	Chemicals Regulation

EU directive	Requirements	England and Wales transposition	Other regulators
(91/414/EEC) – Regulation (EC) 1107/2009 from June 2011	Plant protection products	2005	Directorate (part of HSE)
Biocides Directive (98/8/EC)	Authorisation for marketing and use of biocidal products	The Biocidal Products Regulations 2001	Chemicals Regulation Directorate
Environmental Liability Directive (2004/35/EC)	Prevention and remedying of environmental damage	The Environmental Damage (Prevention and Remediation) Regulations 2009 – England	
Integrated Pollution Prevention and Control Directive (2008/1/EC) (Industrial Emissions Directive 2010/75/EC from January 2014)	Permitting of industrial and agricultural activities with a high pollution potential	The Environmental Permitting (England and Wales) Regulations 2010 Note these also transpose the groundwater directives.	Local authorities for some sites
Waste Framework Directive 2008/98/EC	Recovery or disposal of waste without causing danger to humans or the environment Planned waste management	The Environmental Permitting (England and Wales) Regulations 2010	
Landfill Directive (1999/31/EC)	Control of disposal of waste to landfill to prevent or reduce negative effects on the environment	The Environmental Permitting (England and Wales) Regulations 2010	

Summary of relevant European directives

Groundwater Directive (80/68/EEC)

The former Groundwater Directive targeted the prevention of groundwater pollution via controls over the release of substances listed within it. Although the directive is not repealed until December 2013, it has been effectively superseded by the WFD and in particular the Groundwater Daughter Directive (GWDD) and its transposition in England and Wales are now via the Environmental Permitting Regulations (EPR).

Water Framework Directive (2000/60/EC)

The Water Framework Directive (WFD) establishes an integrated approach to the protection, improvement and sustainable use of Europe's surface waters and

This document is out of date was withdrawn 14/03/2017

groundwater. It provides a framework in the form of a river basin planning system with the aim of:

- preventing further deterioration of and protecting and enhancing aquatic ecosystems and other water dependent ecosystems;
- promoting sustainable water use based on long term protection of water resources;
- progressively reducing the releases to the aquatic environment of priority substances and the phasing out of releases of priority hazardous substances;
- ensuring the progressive reduction of pollution of groundwater and prevent its further pollution;
- contributing to mitigating the effects of floods and droughts.

We are the competent authority for implementing the WFD in England and Wales. The first river basin planning cycle of the WFD commenced in December 2009 with the publication of the first river basin management plans for each river basin district.

WFD objectives

The WFD establishes objectives for the water environment. As it is a framework directive, in some cases, the pre-existing directive is repealed and its requirements become WFD requirements. For example, the WFD repeals the former Groundwater Directive in December 2013 and member states must ensure at least an equal level of protection to groundwater under WFD measures. In other cases the original directive remains (for example, the Nitrates Directive) so there is a dual requirement to implement controls. Areas subject to both the requirements of a pre-existing directive and the WFD are known as protected areas (for example, nitrate vulnerable zones).

The objectives for groundwater in the WFD are set out in Figures 7.1 and 7.2. Objectives for groundwater quality are subject to a more detailed description and criteria in the Groundwater Daughter Directive (GWDD).

This document is out of date was withdrawn 14/03/2017

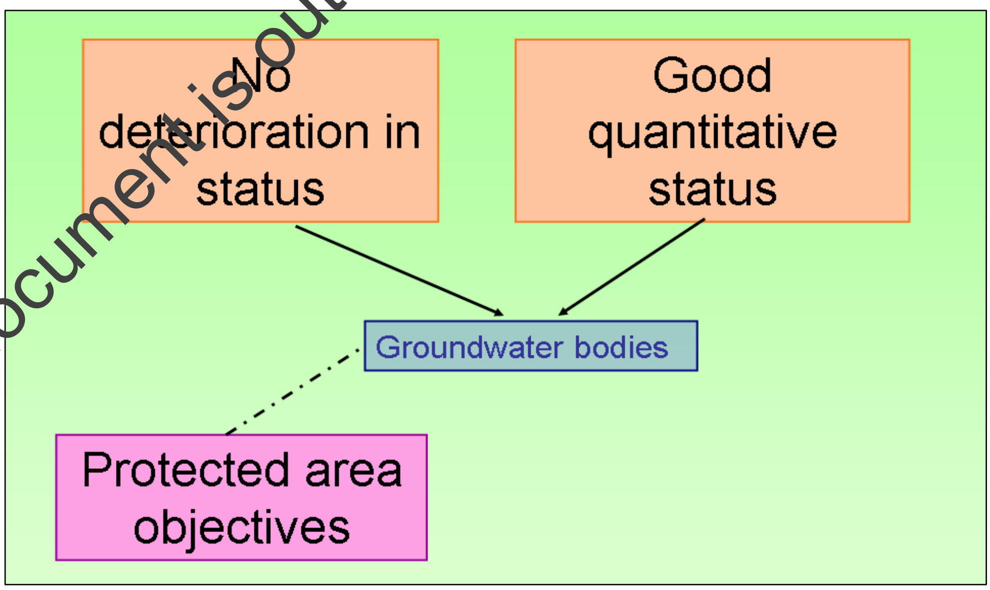


Figure 7.1 WFD objectives for groundwater quantity

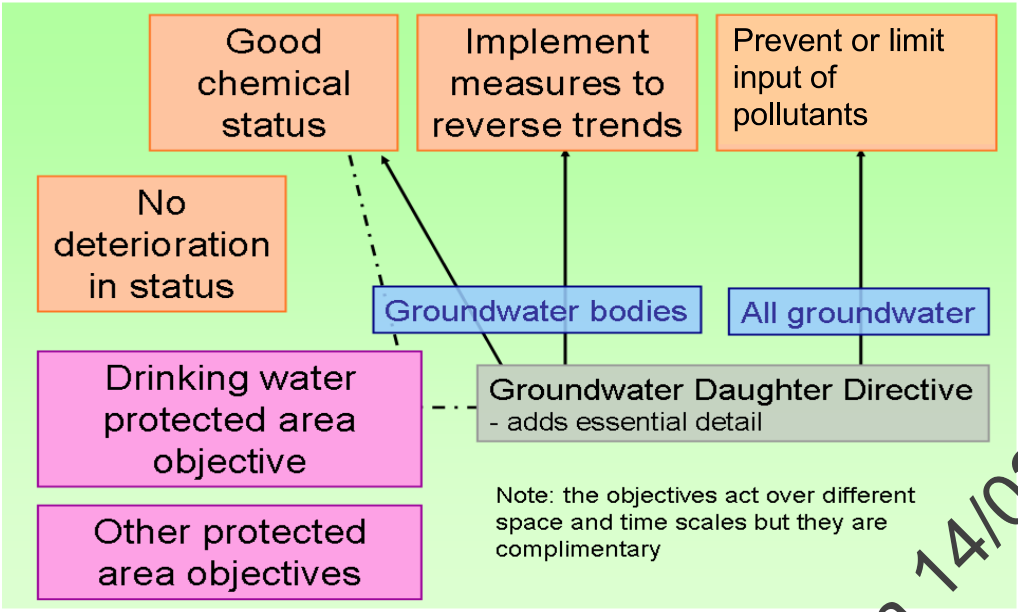


Figure 7.2 WFD objectives for groundwater quality and relationships with GWDD

Our position statements contribute to meeting WFD/GWDD requirements through the application of a number of key concepts. These include:

- **Classification and status.** All groundwater bodies (generally large, distinct volumes of groundwater within an aquifer or aquifers) must be assessed to determine whether they are meeting good status. The criteria for good chemical and quantitative status are given in Table 7.2. Status is assessed primarily using monitoring data from our monitoring networks (also required under the WFD). The relationships between groundwater quality objectives and monitoring are illustrated in Figure 7.3. The scale of assessment means that groundwater status is mainly influenced by larger scale effects such as significant abstractions or widespread/diffuse pollution.
- **Significant and sustained upward trends**. We are required to identify upward trends in concentrations of pollutants in groundwater that represent a significant risk of harm to the quality of aquatic ecosystems or terrestrial ecosystems (wetlands) dependent on groundwater, to human health or to potential legitimate uses of the water environment. These are also assessed at points in the operational monitoring network (Figure 7.3). Measures must be implemented to reverse such upward trends.
- **Prevent or limit**. We are obliged to prevent inputs of hazardous substances into groundwater and to limit any inputs of all other pollutants into groundwater to prevent pollution, deterioration in status or any significant and sustained upward trends.

This document is out of date was withdrawn 14/03/2017

Table 7.2 Classification elements to meet good groundwater status

Classification element (from WFD)	Test
Common to both quantitative and chemical status	
No saline or other intrusion	
Alterations to flow direction resulting from level changes may occur temporarily or continuously in spatially limited areas, but such reversals do not cause salt water or other intrusion and do not indicate a sustained and clearly identified anthropogenically induced trend in flow direction likely to result in such intrusions.[1] Changes in conductivity are not indicative of saline or other intrusion into the groundwater body.[2]	Entry into the groundwater body of either saline water of substantially higher conductivity or salinity from connate or seawater; or water of substantially different chemical composition from other groundwater bodies or surface waters and which is liable to cause pollution as a result of abstraction.
Surface water	
Not subject to 'failure to achieve the environmental objectives specified[3] for associated surface waters' nor 'any significant diminution in the status of such waters'	No significant diminution of surface water chemistry and ecology
Groundwater-dependent terrestrial ecosystems (GWDTE)	
Not subject to any significant damage to wetlands which depend directly on the groundwater body.	No significant damage to GWDTEs
Quantitative status only	
Water balance	The total abstraction is less than the recharge less the ecological needs of river bodies.
Chemical status only	
No deterioration in quality of waters for human consumption[4]	Meet the requirements for drinking water protected areas.[5]
No significant impairment of human uses[6]	General quality assessment: assessment of the quality of the groundwater body as a whole
No significant environmental risk from pollutants across a groundwater body[7]	

Notes
[1] WFD Annex V 2.1.2
[2] WFD Annex V 2.3.2
[3] Under Article 4 of WFD
[4] GWDD Article 4.2 b(iii)) and paragraph 4, Annex III
[5] Under Article 7(3) of WFD
[6] GWDD Article 4.2 b(iv)
[7] GWDD Article 4.2 b(i) and paragraph 3, Annex III

This document is out of date was withdrawn 14/03/2017

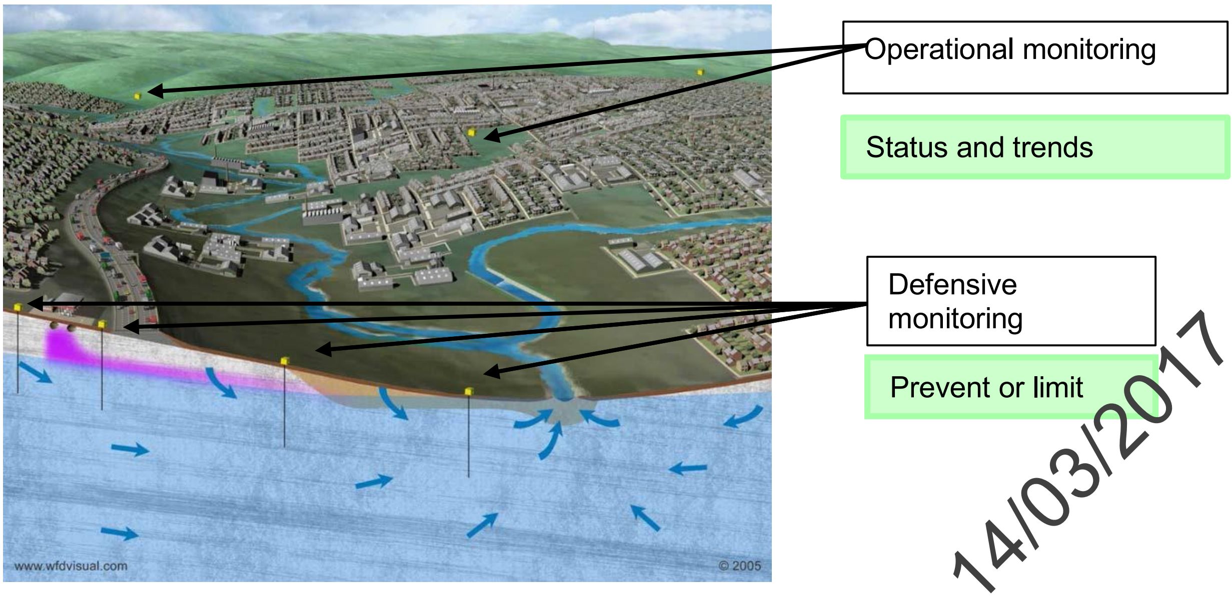


Figure 7.3 Relationships between groundwater quality objectives and monitoring (www.wfdvisual.com)

The classification and status, and trend requirements are new obligations under the Water Framework Directive. The Groundwater Directive already contained 'prevent or limit' requirements, though for a limited range of substances and activities. These restrictions on substances have been widened with the implementation of the Groundwater Daughter Directive. Box 7.1 describes the links between the concepts of pollution, 'prevent or limit' and status, while Box 7.2 sets out our interpretation of the prevention of inputs of hazardous substances and the limiting of inputs of non-hazardous pollutants to avoid pollution.

Box 7.1 The links between pollution, 'prevent or limit' and status

Pollution is defined in the WFD as:

> 'the direct or indirect introduction, as a result of human activity, of substances or heat into the air water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment'.

The receptors in this definition are much broader than those in the definition of good chemical status (Table 7.2). To affect a receptor, an input of a pollutant must physically move through the groundwater system. This movement will vary with the physical and chemical characteristics of the aquifer, and the pollutant may be diluted or attenuated along the flow path to a receptor. Many inputs of pollutants may therefore have only localised effects and may have little or no impact on the receptors in the definition of good groundwater chemical status; however, these inputs may still result in localised pollution. Under the WFD/GWDD, it is possible to have localised pollution within a groundwater body that is at good chemical status. However, the more widespread the pollution becomes, the more likely the groundwater body will be at poor status.

In contrast to the requirements for good chemical status, the 'prevent or limit' objective in the WFD/GWDD provides protection to all groundwater, to the wider range of receptors as in the definition above and at a more localised scale. In principle, 'prevent or limit' measures are our first line of defence in preventing unacceptable inputs of pollutants to all groundwater (and thereby avoiding pollution). In contrast, our assessment of status provides a review of the condition of groundwater bodies once

This document is out of date was withdrawn 14/03/2017

every river basin planning cycle (that is, every six years).

Figure 7.4 shows how all groundwater is protected by ‘prevent and limit’ but only groundwater within groundwater bodies is required to meet the ‘prevent and limit’, status and trends objectives.

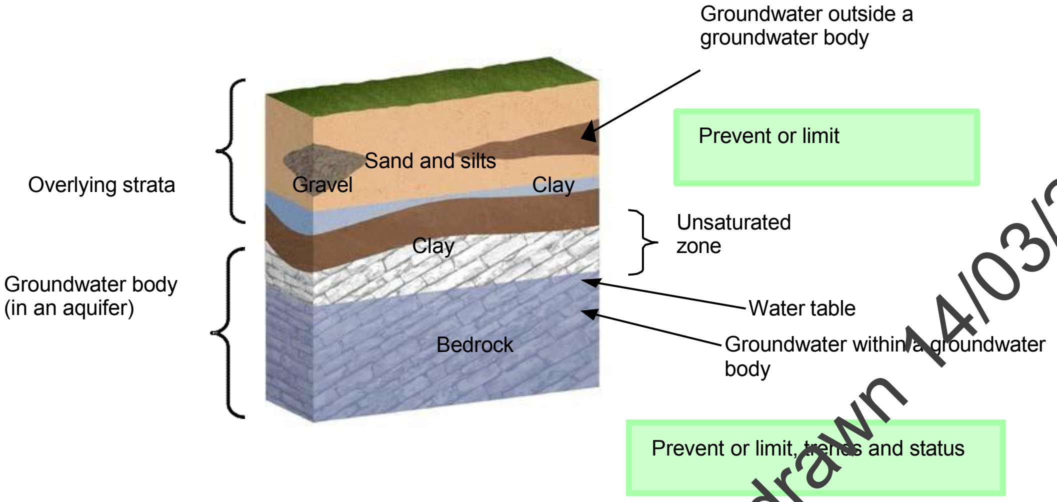


Figure 7.4 Applying groundwater quality objectives to groundwater and groundwater bodies (UKTAG/Nathan Fletcher)

If all ‘prevent or limit’ requirements were met everywhere within a groundwater body (GWB) and given time to allow the historical legacy of prior releases to be degraded or dispersed, the body would be at good chemical status. Conversely, failure to apply ‘prevent or limit’ measures to all sources of pollution could eventually result in failure to meet good status.

Box 7.2 Preventing inputs of hazardous substances and avoiding pollution from non-hazardous pollutants under the WFD/GWDD as implemented by EPR 2010

We consider an unacceptable input to groundwater to have occurred when the requirement to prevent the input of hazardous substances, or to limit the input of non-hazardous pollutants so as to avoid pollution, has not been satisfied.

Input of hazardous substances

Under EU and UK legislation the entry of hazardous substances should (subject to any relevant exemptions) be prevented. An input of hazardous substances would be prevented if the conditions below are met.

- There is no discernible concentration in the discharge; or
- There are no discernible concentrations of hazardous substances attributable to the discharge in groundwater immediately down-gradient of the discharge zone, subject to adequate monitoring (or in the case of new discharges a detailed predictive hydrogeological impact assessment); or
- There are (or are predicted to be) discernible concentrations in the groundwater down-gradient of the discharge zone attributable to the discharge but all the following apply:
  - Concentrations will not result in any actual pollution or a significant risk of

This document is out of date was withdrawn 14/03/2017

pollution in the future.

- There will not be any progressive increase in the concentration of hazardous substances outside the immediate discharge zone, that is there will be no statistically and environmentally significant and sustained upward trend or significant increasing frequency in pollutant ‘spikes’.
- There is evidence that all necessary and reasonable measures to avoid the entry of hazardous substances into groundwater have been taken.

It is technically difficult to demonstrate that no hazardous substances will enter groundwater. There is always a lower reporting limit for analyses and predictive assessments often produce progressively lower risk results but cannot define no risk, or zero input. We use minimum reporting values (MRVs) to represent the limit for input.

Pollution by non-hazardous pollutants

To avoid pollution by non-hazardous pollutants, inputs of these pollutants into groundwater must be limited to ensure that:

- there is no deterioration in the status of the groundwater body;
- there is no significant and sustained upward trend in the concentrations of pollutants in groundwater;
- the concentrations of pollutants remain below a level such that harm to a receptor does not occur, or that local maximum allowable concentrations (such as quality standards to protect a drinking water source) are not exceeded.

The entry of a substance into groundwater or a slight deterioration in groundwater quality is not in itself pollution under WFD and GWDD. Pollution will only result where the entry or deterioration is linked to a harmful effect at a receptor. A broad definition of a receptor may be adopted, including the groundwater resource itself. Existing uses and all plausible future uses of the groundwater should be considered.

Groundwater Daughter Directive (2006/118/EC)

The name, Groundwater Daughter Directive (GWDD), is used to distinguish it from the former Groundwater Directive which remains in force in parallel until it is repealed under the Water Framework Directive in December 2013.

Although the GWDD on the protection of groundwater against pollution and deterioration does not add to the objectives of the WFD, it clarifies the requirements for:

- assessing groundwater chemical status;
- identifying significant and sustained upward trends in pollutants and for the definition of starting points for trend reversal;
- measures to prevent or limit inputs of pollutants into groundwater.

The GWDD requires us to determine threshold values for assessing good groundwater chemical status. These are triggers for further assessment to determine if the criteria for good status (Table 7.2) have been met. However, they are not necessarily the regulatory standards and conditions we will use, for example, on permits; these will tend to reflect the ‘prevent or limit’ requirements in the first instance for the reasons noted in Box 7.1. In future, the standards and conditions in regulatory regimes will need to reflect all the WFD objectives as described in more detail in the GWDD.

This document is out of date was withdrawn 14/03/2017

Nitrates Directive (91/676/EEC)

The purpose of the Nitrates Directive is to reduce groundwater pollution from agricultural sources and prevent further pollution by establishing Nitrate Vulnerable Zones (NVZs) and putting action plans into place. It also provides general protection through a code of good agricultural practice. The directive uses a value of 50 mg/l nitrate to define which aquifers should be considered to be within NVZs.

The Nitrates Directive is the principal legislative driver for dealing with agricultural sources of nitrate, but with the transposition of the WFD and GWDD, all sources of nitrate are now subject to control to meet WFD objectives.

Plant Protection Products Directive and Regulation

The Plant Protection Products Directive (91/414/EEC) PPPD and Regulation (EC) No. 1107/2009 (from June 2011) jointly control the marketing and use of pesticides and other biocides. They were introduced to ensure a common market for pest control products across all EU member states.

Under the PPPD, active substances used in plant protection products are approved at EU level and placed on a 'positive list' in Annex 1 of the PPPD. Member states can then authorise products containing these active substances according to a set of common rules. The approval regime requires that leaching tests be conducted with standard soils; at approved rates of application there must be no more than 0.1 µg per litre of the active substance at 1 m below ground level.

The application of the directive and regulation (particularly the PPPD) has led to the progressive withdrawal from the market of a number of pesticides that are persistent in groundwater (for example, atrazine and simazine) with consequential observed reductions in their concentrations in groundwater. More recently, use of diuron in the EU has been restricted, including withdrawal of products used in the amenity sector, and isoproturon failed to gain re-registration in the UK. Reductions in groundwater concentrations should therefore be observed for these substances in the future.

Habitats Directive (92/43/EEC)

The directive on the conservation of natural habitats and wild flora and fauna (known as the Habitats Directive), is implemented by the Conservation of Habitats and Species Regulations 2010 (the Habitats Regulations).

The Habitats Directive seeks to contribute towards protecting biodiversity through the conservation of natural habitats and wild plants and animals. Recognising that wildlife habitats are under pressure from increasing demands on the environment, the directive creates a network of protected areas across the European Union known as 'Natura 2000' sites. This internationally important network includes special areas of conservation (SACs) and special protection areas (SPAs).

We are the competent authority under the Habitats Regulations. We have a legal duty to ensure that none of the activities or permissions we are responsible for (including those affecting groundwater) result in an adverse effect, directly or indirectly, on the integrity of protected areas.

Judgements of adverse effect of activities must be made in relation to the features of interest at the European site and considering their conservation objectives.

Abstraction licences and environmental permits require review under the Habitats Regulations to ensure no adverse effect is occurring.

This document is out of date was withdrawn 14/03/2017

Sustainable Use of Pesticides Directive (2009/128/EC)

The overall objective of this directive is to establish a framework to achieve the sustainable use of pesticides by reducing the risks and impacts of pesticide use on human health and the environment. This should be done by promoting:

- the use of integrated pest management;
- alternative approaches or techniques such as non-chemical alternatives to pesticides.

Environmental Liability Directive (2004/35/EC)

Under the directive on environmental liability with regard to the prevention and remedying of environmental damage (ELD), operators of economic activities that cause serious damage to the environment will have to pay for the remediation of this damage. The ELD is in addition to existing directives to protect the environment and applies to serious environmental damage caused to species and habitats, the water environment and land.

Other relevant domestic legislation

How we control discharges to groundwater

On 6 April 2010 the controls to protect groundwater quality formerly dealt with under the transitory Groundwater Regulations 2009 (which superseded the Groundwater Regulations 1998) came within phase 2 of environmental permitting regime via the Environmental Permitting (England and Wales) Regulations 2010. EPR 2010 implements the requirements for controls on discharges to groundwater imposed by the WFD.

EPR also replaces the offences under previous regulations and the Water Resources Act 1991 for the discharge of pollutants without a permit. Anything defined as a groundwater activity now requires either an environmental permit or must be an exempt groundwater activity. It is an offence to operate a regulated facility or to cause or knowingly allow a groundwater activity to take place without an environmental permit or an exemption.

Under EPR, we may technically determine that a discharge, or an activity that might lead to a discharge, is not a groundwater activity (and therefore needs neither a permit nor an exemption) if the input of the pollutant:

- is the consequence of an accident or exceptional circumstances of natural cause that could not reasonably have been foreseen, avoided or mitigated;
- is or would be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater; or
- is or would be incapable, for technical reasons, of being prevented or limited without using:
  - measures that would increase risks to human health or to the quality of the environment as a whole: or
  - disproportionately costly measures to remove quantities of pollutants from, or otherwise control their percolation in, contaminated ground or subsoil.

This document is out of date was withdrawn 14/03/2017

We are required to keep a record of all such decisions. [Interpreting groundwater activity exclusions] explains how we technically define these exclusions.

Under EPR we may serve a notice on any person who is carrying out or intends to carry out an activity on or in the ground that may lead to a discharge of pollutants to groundwater. The notice can either prohibit the activity or require the person making the discharge to hold an environmental permit or exemption. Notices may also be served on holders of environmental permits or exemptions in specified circumstances to avoid or remedy pollution (enforcement and suspension notices).

Further information about EPR and groundwater activities may be found in the EPR core guidance (Defra 2010b) and groundwater activities guidance (Defra 2010a).

Water resource management

Other than the Water Framework Directive, none of the directives noted in Table 7.1 deals explicitly with groundwater resource management.

Our role as the body responsible for the management of groundwater resources in England and Wales arises from the requirements of the Water Resources Act 1991, as amended by the Water Act 2003. This legislation requires the control of abstraction via temporary, transfer or full abstraction licences. These existing controls, together with our CAMS form the framework that will assist in achieving the groundwater quantitative aspects of the WFD. Our position statement on the section N - management of groundwater resources gives more details.

Land contamination

The UK has developed an approach to dealing with land contamination, built around three principles:

- ensuring new development and land uses are protected from existing contamination – mainly via the planning system (described below) or voluntary remediation;
- ensuring that existing development and land uses are protected from existing contamination – the contaminated land regime (Part 2A);
- ensuring that no new contamination is created by major industries – now under EPR but formerly the Pollution Prevention and Control Regime (PPC).

Part 2A of the Environmental Protection Act 1990 was introduced as a means of dealing with the legacy of contaminated land arising from the historical use of land. The legislation requires a risk-based approach to dealing with contaminated sites, which is consistent with the general good practice approach to managing land contamination. Part 2A requires local authorities to inspect their areas to identify and then deal with contaminated land. Local authorities are the regulators for contaminated land other than special sites (identified using criteria in the Contaminated Land Regulations 2000), which we regulate.

Progressive implementation of the PPC regime, now superseded by EPR, has brought in new industrial and more recently agricultural sectors and waste into the regime over a number of years. The regime requires site operators to investigate the condition of their land and to provide a baseline site report against which to measure any future pollution. They must return the site to its baseline condition when they relinquish their permits.

This document is out of date was withdrawn 14/03/2017

Planning system

The planning system reconciles the benefits of development with the costs it can impose. The system can play a key role in controlling land use and in promoting sustainable development. Planners must determine planning applications in accordance with development plans produced by local authorities unless material considerations indicate otherwise.

Many developments can pose a direct or indirect threat to groundwater. Where planning permission is required (for example, chemical stores, residential development, mineral extraction and industrial development), in our role as a statutory consultee we may seek conditions on the permission document or an obligation (agreement or undertaking) under section 106 of the Town and Country Planning Act 1990 or recommend refusal of the application in order to protect groundwater. We will only seek to do this where we cannot manage risks through our own regulatory regimes (for example, EPR) either because the activity is not permitted or there are inherent risks in the activity that cannot be managed via a permit.

We provide technical advice to central government, local government, developers and landowners on planning and the environment. We also provide local standing advice to local planning authorities (LPAs). This approach helps to establish the level of environmental risk involved with planning applications and deals with low risk applications without the need to consult us directly. At the local level, GP3 forms the basis for our submissions to the local planning process.

Biodiversity

The Conservation of Habitats and Species Regulations 2010 ('Habitats Regulations') require us to have specific regard to potential adverse effects on European protected species and/or designated sites when consenting projects.

For example, the British cave shrimp (*Niphargus glenniei*) is UK Biodiversity Action Plan (BAP) priority species that is endemic to the groundwater environment of parts of south-west England. One of UK BAP actions for this species is the prevention of pollution and over-abstraction of groundwater within Devon and Cornwall.

Further legislation

- Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) – require employers to control the risks to safety from fire and explosions.
- Control of Substances Hazardous to Health Regulations 2002 (COSHH) – require employers to control substances that are hazardous to health.
- Wildlife and Countryside Act 1981 – consolidates and amends existing national legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and Directive 79/409/EEC on the conservation of wild birds (Birds Directive) in Great Britain (NB Directive 79/409/EEC has now been replaced by Directive 2009/147/EC). Various amendments have occurred since the original enactment.
- Countryside and Rights of Way Act 2000 (CRoW Act 2000) – applies to England and Wales only. It received Royal Assent on 30 November 2000 with its provisions being brought into force in incremental steps over subsequent years. The act provides for public access on foot to certain types of land, amends the law relating to public rights of way, increases measures for the

This document is out of date was withdrawn 14/03/2017

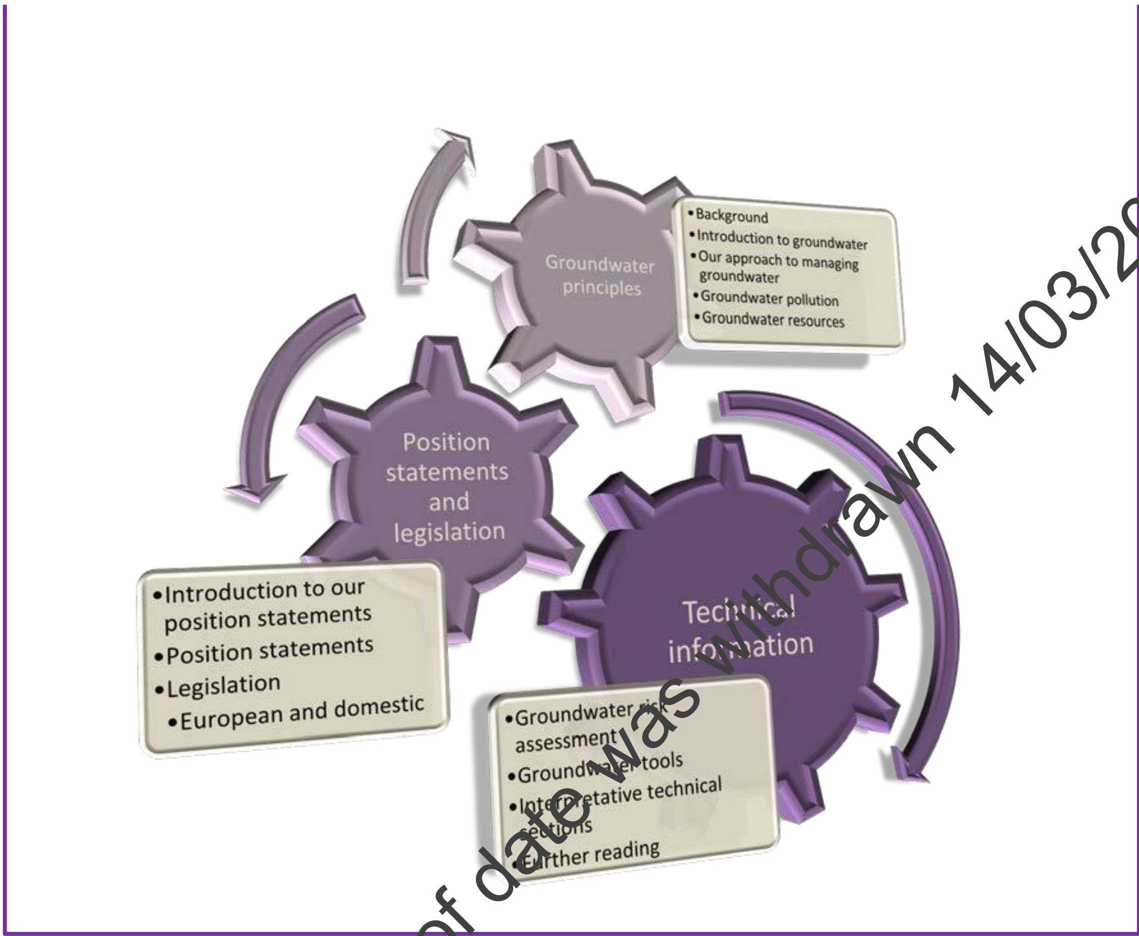
management and protection for SSSIs, strengthens wildlife enforcement legislation and provides for better management of Areas of Outstanding Natural Beauty (AONBs).

- Localism Act 2011 – shifts power from central government back into the hands of individuals, communities and councils. Includes information on planning, building and the environment.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

Part 3: Technical information



This document is out of date was withdrawn 14/03/2017

8 Tools and technical guidance

This chapter contains information on the tools we use for groundwater management and our guidance on a series of technical issues for groundwater specialists.

Topics

This document is out of date was withdrawn 14/03/2017

Risk assessment

Our approach to risk assessment

Wherever groundwater is present there is the potential for human activity to affect it. No soil or rock is completely impermeable, no pollutant completely immobile.

Our overall approach to risk assessment follows Green Leaves III – the latest edition of the Government's *Guidelines for Environmental Risk Assessment and Management* (Defra 2011a). This explains in more detail the risk assessment framework within which we operate and the associated terminology (see Box 8.1 for a summary of some of these terms).

Due to the complexity of the natural environment, conducting a full risk assessment can often be very time-consuming. A pragmatic approach to environmental risk assessment as detailed in Green Leaves III can turn an extremely detailed, complex and resource-intensive process into a practical aid for decision-making.

We are usually forced to use incomplete or uncertain information when we are deciding whether a threat from an activity will impact on the environment. This is a particular issue for groundwater. Subsurface processes are complex and inaccessible and it is costly to obtain data to confirm our conceptual understanding. This introduces a degree of uncertainty that most non-specialists find difficult to accept. We use risk assessment as the formal mechanism or framework to deal with these uncertainties.

Our horizontal guidance on environmental risk assessment (H1) is designed to help you assess the risks to the environment when applying for a bespoke permit under

EPR. Annex J Groundwater provides guidance on how to undertake a groundwater risk assessment and points to supporting sector-specific annexes that deal with different types of activities.

We use the same approach for land contamination. Our Remedial targets methodology (RTM) provides us with a standardised, practical approach to determining what needs to be done to clean up soil and groundwater in order to protect water resources. The methodology can be applied on a site-by-site basis and is based on a tiered risk assessment, with the level of analysis and detail increasing at each stage (Environment Agency 2006c). A RTM worksheet and user manual are available from our website.

We use the risk assessment approach set out in Model procedures for the management of land contamination (CLR 11) (Environment Agency and Defra 2004) for structured decision-making about land contamination affecting groundwater.

Box 8.1 Key definitions

Hazard – a situation or biological, chemical or physical agent that may lead to harm or cause adverse risks.

Risk – the potential consequence(s) of a hazard combined with their likelihoods/probabilities.

Risk assessment – the formal process of evaluating the consequence(s) of a hazard and their likelihoods/probabilities.

Risk management – the process of appraising options for responding to risk and deciding which to implement.

Uncertainty – limitation in knowledge about environmental impacts and the factors that influence them. Uncertainty originates from randomness (aleatory uncertainty) and incomplete knowledge (epistemic uncertainty).

Source: Green Leaves III (Defra 2011a)

Technical framework for groundwater risk assessment

A groundwater risk assessment has identical meaning to hydrogeological risk assessment. Our technical framework for groundwater risk assessment includes:

- the source–pathway–receptor (S-P-R) approach;
- a conceptual model;
- a tiered approach from qualitative risk screening to detailed quantitative risk assessment;
- identification of sources or potential hazards, examining consequences and evaluating the significance of any risk;
- dealing with uncertainties and sensitivity analysis;
- risk management.

The experience and effort that needs to be used to meet these requirements depends on the source term, the potential receptors and the hydrogeological complexity of the area in which the activity and the potential receptors are situated.

This document is out of date was withdrawn 14/03/2017

Source–pathway–receptor approach

For a groundwater risk assessment, the source–pathway–receptor (S-P-R) approach has the following terms:

- The **source** is the activity (for example, the discharge of sewage effluent to an infiltration system, a landfill and so on).
- The **pathway** is through engineered measures (for example, a landfill lining system, infiltration system and so on) and the migration of contaminants through the unsaturated zone and saturated zone to an agreed receptor incorporating all the processes of attenuation that may be present.
- The **receptor** is a groundwater dependent ecosystem or use of groundwater and/or the groundwater resource itself or any other identified conservation site that may be at risk (such as an SSSI).

We use the S-P-R concept to visualise the factors involved in groundwater protection. In Figure 8.1, the 'source' equates to the hazard as defined in Box 8.1, the 'receptor' is groundwater and the 'pathway' represents the means by which the receptor could be exposed to the hazard.

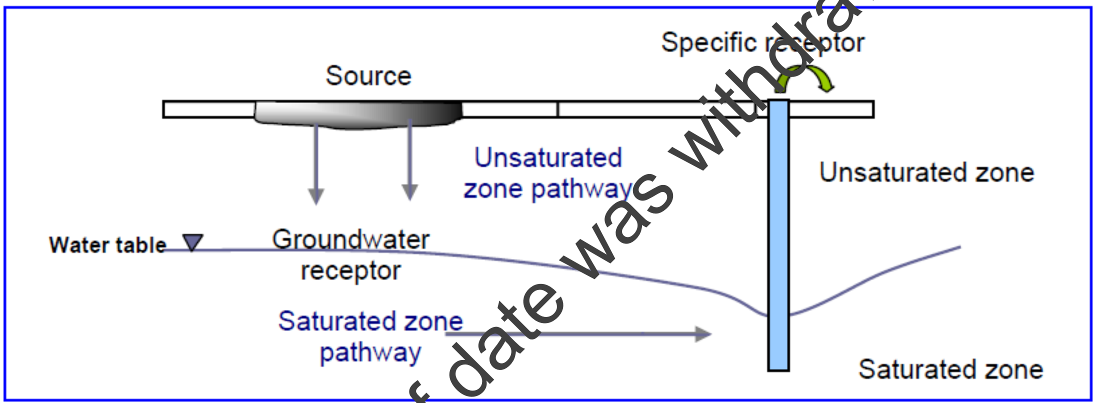


Figure 8.1 Source–pathway–receptor concept

Groundwater can be protected by:

- removing the source (for example, by removing contaminated soil);
- breaking the linkage between source and receptor (that is, blocking the potential pathways). An example would be using an engineered lining system under a landfill.

For harm (groundwater pollution) to occur, there must be a source and an active pathway.

Conceptual model

Once you have identified an S-P-R linkage, you will need to develop a conceptual model. A conceptual model is a simplified representation or working description of what we believe to be the physical, chemical and biological processes operating at a site or study area.

Conceptual models use available information to produce a 'picture' of how the groundwater flows and interacts with the environment. It shows geology, flow paths, pollution sources, abstractions and receptors. The conceptual model is then tested against reality; if necessary, any initial conceptual model should be updated and

This document is out of date was withdrawn 14/03/2017

refined accordingly throughout the assessment or on-going activity as more site-specific data becomes available or parameters change (Figure 8.2).

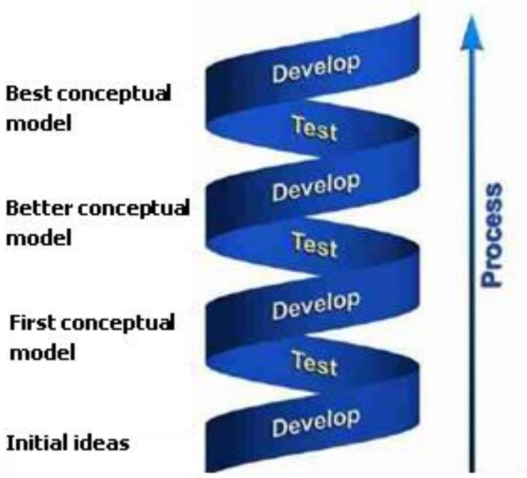


Figure 8.2 The conceptual model process

One of the clearest ways of demonstrating the understanding of your hydrogeological conceptual model is to illustrate how water moves and the attenuating processes on an annotated hydrogeological conceptual model plan/map and cross-section. The cross-section should be orientated in the direction of groundwater flow. In the example cross-section shown in Figure 8.3, the source is a leaking storage tank, the pathway is the ground between the source and the water table, and the receptor is the groundwater (which is also a pathway) and a water supply borehole.

Where there is continuing uncertainty on key pollutant linkages, conservative assumptions will have to be made with more precaution used in the assessment.

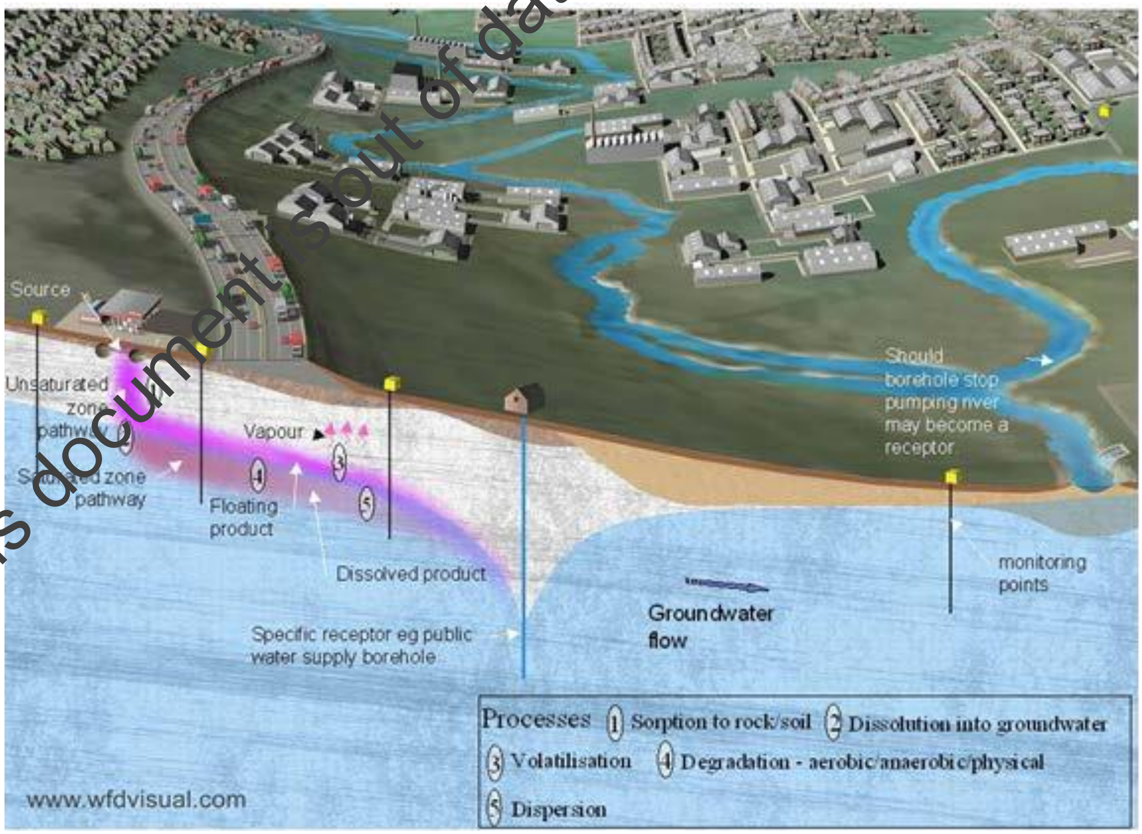


Figure 8.3 Example of a conceptual model

This document is out of date was withdrawn 14/03/2017

Tiered approach

Some activities will be low risk and will normally be dealt with by us. With increasing complexity and site sensitivity we would expect more detailed information. This is why we adopt a tiered approach to assessing the risks.

A tiered approach is needed so that the cost, time and effort in undertaking a risk assessment are proportional to the effort or measures required to make the risks from an activity acceptable. The three tiers are:

- **Tier 1 Qualitative risk screening (QRS):** Qualitative risk screening helps work out whether the activity needs more detailed assessment
- **Tier 2 Generic quantitative risk assessment (GQRA):** A generic quantitative risk assessment (Tier 2) should be carried out when the previous qualitative risk screening (Tier 1) is insufficient for us to make an informed decision on the risk posed by the site.
- **Tier 3 Detailed quantitative risk assessment (DQRA):** Detailed quantitative assessments should be carried out where it is clear that there are definite S-P-R linkages. In particular where:
    - the site setting is sensitive – for example, on permeable strata (such as principal or secondary A aquifers), within an SPZ or close to sensitive surface water bodies;
    - the uncertainty in aspects of the source, pathway and receptor terms cannot be overcome using conservative assumptions because those assumptions lead to an unsatisfactory outcome in terms of risks to groundwater.

A detailed quantitative risk assessment will typically use a probabilistic approach to assess the impact of uncertainties in input data (often being provided by site investigations). They may also be needed where the quantity and quality of the discharge from an activity may change significantly through time (as is the case with non-inert landfills).

Sensitivity analysis

Sensitivity analysis is an important tool in risk assessment and allows us to understand how different sources of uncertainty contribute to the overall variability of the final risk estimates used and gives a credible basis for decision-making. In addition, it:

- helps identify the most important factors affecting the outcome and consequently allows variability in these factors to be identified;
- looks at how the parameters used in the risk assessment are likely to vary. These parameters could be ranges in water levels, chemical concentrations of source pollutants and/or aquifer properties.

This is an essential part of a DQRA. Some parameters and their input values have a much bigger influence on the predicted effect of the discharge/activity on groundwater and related receptors.

This document is out of date was withdrawn 14/03/2017

Hydrogeological tools

We use different tools for particular activities. Each tool has its own method of use, underlying assumptions and limitations. It is vital that users have the appropriate training and are technically competent.

We use various frameworks, maps, software and methods of numerical analysis to support our management and protection of groundwater. Over the years we have developed a number of tools founded on risk-based regulation and conceptual modelling, and are supported by sound science. Hydrogeologists use many other tools on a daily basis. These include geological maps, proprietary models and basic groundwater flow equations.

Screening tools give an initial risk assessment of the impact on groundwater. In general, screening is used to determine which hazards should be investigated in more detail. Screening is based on generic descriptions of activities and often relies on mapped properties (for example, groundwater vulnerability maps). Risk screening assesses all hazards even where there is no detailed quantitative information available.

Generic risk assessment tools tend to use a combination of generic data obtained from empirical or calculated properties in combination with some site-specific details.

As the assessment moves into generic or detailed quantitative risk assessment, increasing amounts of site-specific data are needed. The tools used for detailed quantitative risk assessment are often tailored to the circumstances of a particular site and may need a large amount of site-specific data and technical expertise.

In most cases the scale of the site reduces as the assessment process moves towards detailed quantitative risk assessment. However, numerical models may cover significant areas but nevertheless require large amounts of detailed data specific to the area being modelled.

We hold extensive information on water levels, river gauging, abstractions, discharges, water quality and more. Some of this information is available to the public via the interactive maps in the What's in your backyard section of our website. Other information is available on request (we may sometimes make a charge in order to cover our costs).

What tools are available?

The approved tools that we use are listed below. Some are suitable for a quick risk-screening exercise, while others are complex and provide detailed information on the risks to groundwater. Note that this list is not an exhaustive listing of hydrogeological tools.

- geological maps;
- soil maps and associated reports;
- hydrogeological maps;
- thematic maps;
- source protection zone maps;
- groundwater vulnerability maps;
- prior examination Level 1 and 2 assessments (Annex J1 of our H1 horizontal guidance);
- infiltration spreadsheet (Annex J5 of our H1 horizontal guidance);

This document is out of date was withdrawn 14/03/2017

- RTM (Environment Agency 2006c);
- LandSim;
- ConSim;
- Impact of Groundwater Abstractions on River Flows (IGARF) spreadsheet tool;
- Resources assessment methodology (RAM) and worksheet;
- nitrogen and phosphorus loadings tools (Entec 2010) including rural catchment nitrogen and phosphorus calculator (Excel spreadsheet).

General guidance on the selection and use of groundwater tools

Before selecting any of the assessment model or tool, it is vital to have a sound conceptual model of the site. It is also important that you are satisfied the tool you select to model the site is appropriate, that is, it represents the conceptual model and performs analyses appropriate to the quality of the input data.

The necessary level of training and expertise will vary with the complexity of the tool. In all cases the user must assess objectively the limitations of the tool and the experience needed to use it. For example, if you are using SPZ maps, you require relatively little training but a good appreciation of their limitations. In contrast, a more complex tool such as ConSim requires a thorough understanding of the fate and transport mechanisms of chemicals in groundwater, chemistry and probability density functions.

The quality and availability of data are limiting factors in the application of tools. Often a user can apply a tool in a screening mode to establish some basic ideas and to assess the quality of available information before progressing to more detailed analysis. The screening may highlight the need to collect better information or even the need for a different approach.

It is essential to use the appropriate tool and to interpret the results with a clear understanding of the applicability, accuracy, precision and relevance of its inputs and outputs.

Groundwater vulnerability maps for England and Wales

We have updated the groundwater vulnerability maps for England and Wales using recently revised national datasets and a new approach to risk-based decision making. The core 'groundwater vulnerability map' shows the intrinsic vulnerability of groundwater to pollution (as high, medium or low) in a grid format at a 1 kilometre square resolution. The 'combined groundwater vulnerability map' shows the vulnerability class (as high, medium or low) and resource status (principal aquifer, secondary aquifer and unproductive strata) for superficial and bedrock aquifers. Figure 8.4 shows an extract from the combined groundwater vulnerability map.

The maps can be used for an initial screening assessment of the vulnerability of groundwater to an activity where a pollutant is applied to the soil surface. They provide summary information about the principle factors affecting intrinsic vulnerability within each 1 kilometre square. Caution will be needed where the water table is close to the ground surface as the thickness of the unsaturated zone is not considered due to changes over time and a lack of good quality data coverage.

This document is out of date was withdrawn 14/03/2017

The maps can also be used to guide the assessment where a pollutant is released below the soil zone (such as a septic tank) by considering the degree of protection provided by factors other than the soil layer. This information is held within the attribute tables of the interactive maps. The vulnerability is likely to be higher than shown on the maps since there is no protective soil layer.

The maps have been processed to a one kilometre scale and do not provide all information relevant to the determination of specific vulnerability such as the influence of human activities (such as quarrying) or the depth to water table. Site-specific information is always necessary for a detailed assessment of vulnerability at a given location.

To be consistent with the WFD and the need for a more flexible approach, we have changed our aquifer designations to reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and their role in supporting surface water flows and wetland ecosystems. The aquifer maps available on our website are split into two different types of aquifer designation:

- Superficial (drift) – permeable unconsolidated (loose) deposits (for example, sands and gravels);
- Bedrock – solid permeable formation (for example, chalk and limestone).

In addition we no longer use the major, minor and non-aquifer designations used in the previous version of GP3 and instead refer to principal aquifers, secondary aquifers and unproductive strata (see Where is groundwater found?). These descriptions derive from the importance of these different types of aquifer in terms of groundwater as a resource that supports both abstraction and ecosystems. The previous designations of major and minor aquifer have largely transferred to principal aquifer and secondary aquifer, while some of the aquifers previously designated as non-aquifers have been subdivided into secondary aquifers and unproductive strata.

We have also developed a new and more sophisticated approach to assessing groundwater vulnerability. This considers groundwater vulnerability to be a function of:[2]

- the amount of contaminant reaching the water table, which will be a function of infiltration through the soil zone, soil leaching class and drift cover.
- attenuation and degradation of the contaminant, which will be a function of soil leaching class, thickness of drift, thickness of the unsaturated zone and flow mechanism.

The factors that have been taken into account in assessing intrinsic groundwater vulnerability are summarised in Table 8.1.

Interactive aquifer maps and groundwater vulnerability maps for England and Wales are available in the 'Groundwater' section of the What's in your backyard section of our website.

This document is out of date was withdrawn 14/03/2017

[2] Groundwater vulnerability is also a function of other factors such as organic content, moisture content, permeability, clay content and geochemical conditions (Griffiths et al. 2011), but it is not feasible to consider all these factors with the available datasets.

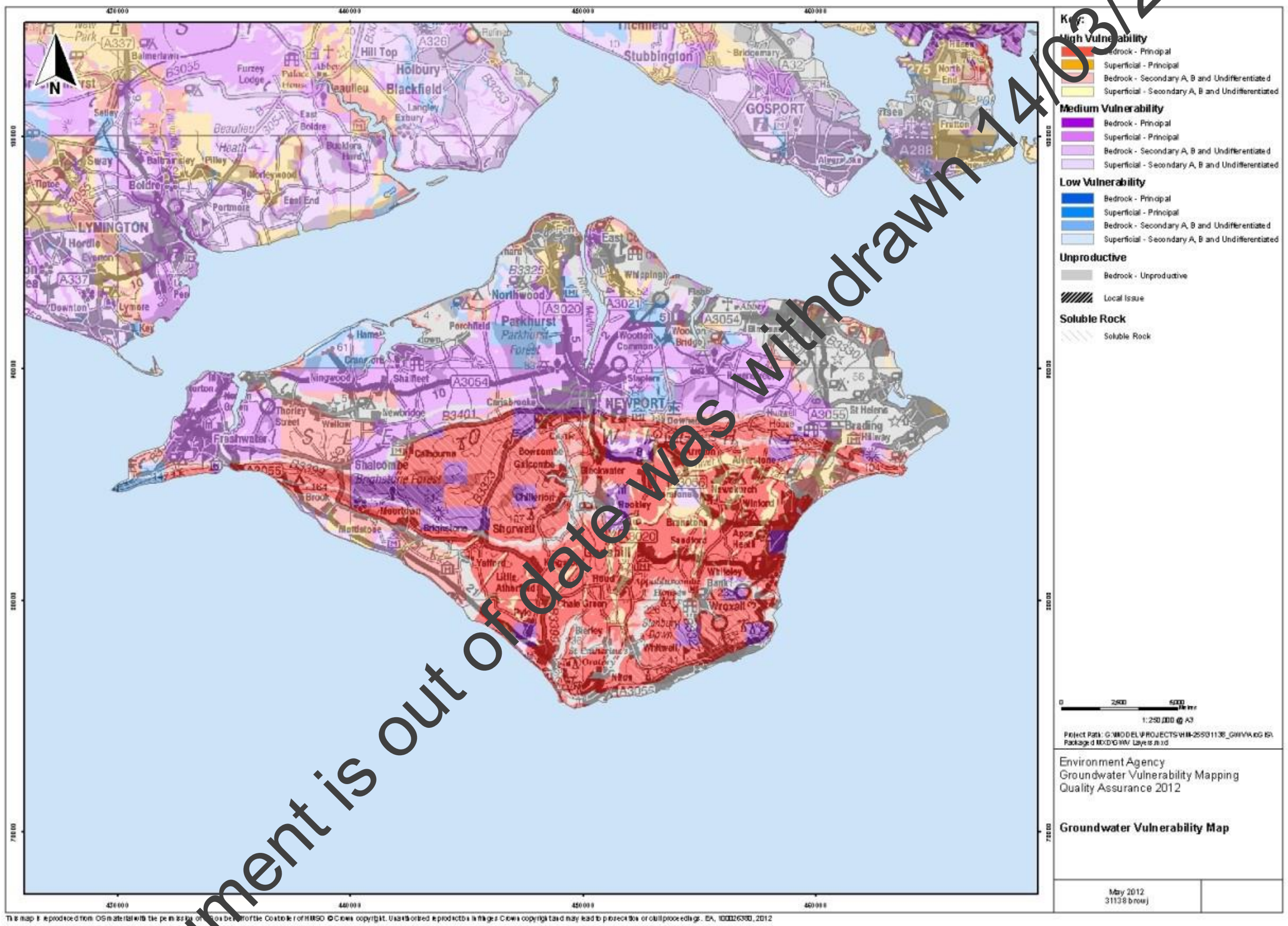


Figure 8.4 Extract from groundwater vulnerability map showing the Isle of Wight and surrounding area

This document is out of date was withdrawn 14/03/2017

Table 8.1 Summary of factors influencing intrinsic groundwater vulnerability and whether they have contributed to the aquifer maps

Physical characteristic or layer	Attribute	Aquifer	
		Superficial	Bedrock
Dilution by rainfall	Effective rainfall (available water)	Y	Y
Proportion of available water infiltrating to groundwater	Base flow index	Y	Y
Soil	Leaching class	Y	Y
Drift (poorly permeable deposits)	Patchiness (cover)		Y
	Thickness		Y
	Recharge potential (function of permeability of drift)		Y
Unsaturated zone	Flow mechanism (fracture, mixed, intergranular)		Y

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

Assessing geological formations permanently unsuitable for other purposes

This document is out of date was withdrawn 14/03/2017

Constraints imposed by EPR 2010

Schedule 22 paragraphs 8(a) and 8(c) of EPR 2010 require us to take all necessary measures to prevent the input of hazardous substances into groundwater and to limit the input of non-hazardous pollutants so as to avoid the pollution of groundwater.

However, provided it does not compromise the objectives set out in Article 4 of the Water Framework Directive, we may grant a permit for the injection of water containing hazardous substances from hydrocarbon or mining activities or the injection for storage of natural gas or liquefied petroleum gas – but only where the strata have been determined as permanently unsuitable.

The geological formation must be examined before being deemed permanently unsuitable. EPR 2010 states that the geological formation must for natural reasons be permanently unsuitable for other purposes. Contamination of the formation as a result of human activity would not be cause for its determination as permanently unsuitable.

Assessing the receiving geological formation

A geological formation should not be regarded as being ‘permanently unsuitable for other purposes’ if:

- it is being exploited or capable of being exploited for mineral or other purposes such as managed aquifer recharge;
- the groundwater is being abstracted or capable of being abstracted;
- the groundwater supports a spring;
- the groundwater contributes to base-flow to support surface watercourses;
- the groundwater supports wetlands and their ecosystems.

If there are any concerns about the contribution to the surface water or groundwater environment, we will not permit the discharge.

The following should be considered:

- the impact of the injection on existing or potential use of ground resources;
- the hydraulic properties of the rock strata;
- the quality of any receiving groundwater.

These factors need to take account of the likely changes in circumstances during the timescale over which the injection will have an effect.

Applicants should apply the principles of risk assessment set out in Green Leaves III (Defra 2011a).

A screening exercise based on published sources may be sufficient to identify whether the concept of permanently unsuitable should be pursued taking account of the key factors described below. Unless basic information from geological and hydrogeological mapping and calculation based on conservative values can adequately demonstrate suitability at a screening level, we will expect the prior examination of the formation to include an appropriate level of quantified risk assessment supported by site-specific data.

Ground resources and other environmental systems

These include the mineral and agricultural resources associated with the geological formation. Any change brought about by the injection must not impede the exploitation of these resources either now and in the future. Applicants should include mineral planning documentation and records of past uses in their assessments to identify any potential future exploitation.

Any discharge of pollutants must be isolated from the soil zone or vegetation. When setting conditions we will therefore give particular consideration to:

- the depth of the capillary zone in the soil;
- the maximum depth of roots in the future.

Groundwater quantity

Applicants should consider the hydraulic properties of the geological formation and in particular whether:

- the yield of a rock type is minimal;
- the groundwater is isolated or inaccessible.

We would not regard any formation as permanently unsuitable for other purposes where groundwater ultimately discharges to another aquatic system – even if the circulation occurs over extremely long time periods. This means the only applicable situations are likely to be:

- very deep, isolated permeable strata (such as former oil-bearing strata kilometres below the surface);
- very low permeability environments;
- certain isolated lenses with minimal resource value.

This document is out of date was withdrawn 14/03/2017

Groundwater quality

When groundwater is naturally of poor quality, it can be categorised by the effort required to bring it back to a quality suitable for human consumption using drinking water standards as a guide.

If the groundwater would still be unsuitable for human consumption even after intense physical and chemical treatment using best available techniques, the geological formation may be a candidate for permanently unsuitable status provided there are no other conceivable uses (for example, industrial uses such as cooling). However, we would not designate a geological formation as permanently unsuitable purely because such treatment of the groundwater would be excessively costly. The assessment should be based on whether it is possible regardless of cost.

If the groundwater is treatable to drinking water standards, the geological formation cannot be classified as permanently unsuitable unless the quantity of water is extremely low or the groundwater is inaccessible.

Note: EPR states that the reasons for a formation to be permanently unsuitable must be natural. Therefore, we would not consider designation of permanently unsuitable on the basis of poor quality as a result of human activity. In virtually all cases, man-made pollution will exist in groundwater that connects with other ground or surface waters. There is potential for the quality of the groundwater to improve in the long term. Even where there is no connection, previous introduction of contaminants is no reason for further inputs. The justification must be made on the merits of the natural geology and groundwater conditions.

Managed aquifer recharge

Site-specific conditions will determine whether MAR can be developed in the aquifer. Even if an aquifer with poor water quality is not naturally usable, it could be used to store good quality water by:

- injecting water from another relatively clean source; or
- re-injecting after abstracting and treating the groundwater at the surface.

In both cases, good quality water is stored on top of or within poor quality groundwater. If an aquifer can be developed in this way, it is important that this potential is not lost.

Yield characteristics will be a significant factor in the determination as a low yielding aquifer will not necessarily be suitable for MAR. You also need to consider:

- the overall storage potential;
- the connectivity to other controlled waters;
- the ability to control the water once put in place;
- its location with respect to potential sources of demand.

Application and determination

Application

Our permitting team will work with the local groundwater and contaminated land teams to assess the supporting information in the application. If required, advice will be sought from our geoscientists.

This document is out of date was withdrawn 14/03/2017

Our permitting and groundwater teams are advised to discuss any proposal to designate formations as permanently unsuitable with the national geoscience team at an early stage to avoid unnecessary work.

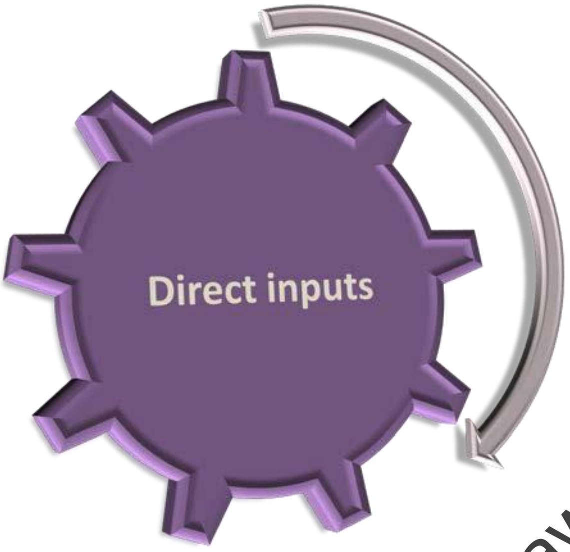
Determination of permanently unsuitable for other purposes

Once local teams are satisfied with the application they must refer it to the national geoscience team along with the findings from the prior examination process and any relevant site-specific information. The national team will then discuss the application as necessary with our Environment and Business team, which will decide whether the permanently unsuitable determination can be made.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

Interpreting ‘direct input’ into groundwater



This document is out of date was withdrawn 14/03/2017

Definition of direct input

‘Direct input’ into groundwater is defined in Schedule 22 of EPR 2010 as ‘the introduction of a pollutant to groundwater without percolation through soil or subsoil’.

Direct input is equivalent to the term ‘direct discharge’ in the Water Framework Directive and the definition supersedes that in the former Groundwater Directive. While the new definition does not specifically refer to rock unsaturated zones you should assume this is included.

When is an input direct?

An input to groundwater is direct (that is, there is no percolation) if any of the following apply:

- Where the discharge is made into an open man-made structure such as a shaft, borehole or well that extends down to or into the water table, so that the input is directly into the groundwater. An input is considered ‘indirect’ if an operator can backfill the structure with a suitable material to create an artificial unsaturated zone (such action could adversely affect the operation of the discharge).
- Where the discharge is made into a natural feature (for example, a swallow hole) when it is known or reasonable to deduce that flow to a saturated zone occurs via uninterrupted cascade or very rapidly down open, vertical or near vertical conduits. In cases of discharge into natural features, you only need to consider whether or not there is rapid flow or direct cascade to the water table (for example, a travel time of minutes). In situations where existing data/judgement are uncertain, the prior examination process should be used to obtain sufficient data to enable a decision to be made. This would normally be the responsibility of the applicant; any requests from us for more data should be precise and proportionate to requirements. The assessment will

normally be site-specific and it is reasonable to factor in the volume of the discharge and the stability of any natural infill (in swallow holes). Where necessary, a range of direct and indirect investigation techniques are available; for example, geophysical techniques may be an option.

- Where leachate arising from the deposit of any waste material below the water table moves into surrounding ground without the presence of a geological barrier compliant with the requirements set out in our regulatory guidance, LFD1 Understanding the Landfill Directive (Environment Agency 2010b).

When is an input indirect?

An input to groundwater is indirect (that is, percolation does occur – see note below) if any of the following apply:

- Where the discharge is made into a natural feature, even though it may involve rapid conduit flow, when:
  - best judgement and available information indicates that the connection between surface and the saturated zone is tortuous, that is it is gradual rather than a cascade; and
  - there is some potential for attenuation, however limited.
- Provided an unsaturated zone is maintained, in all other intergranular or fissure flow geological environments when the discharge infiltrates a natural soil or rock either at the surface or via a soakaway, drainage field or other similar feature.
- Where leachate arising from deposit of any waste material below the water table moves into surrounding ground across a natural or constructed geological barrier fulfilling the requirements of our regulatory guidance LFD 1, Understanding the Landfill Directive.

Note: A discharge could be to periodically saturated ground where water tables fluctuate naturally or the input causes mounding of the water table. If this only occurs from time to time and the transition from indirect to direct does not alter the technical acceptability of the discharge, you may consider the input indirect. In cases where saturation predominates, you should regard the input as direct. You should apply site-specific judgement of the groundwater situation and also consider whether the design of the infiltration/drainage field needs to be altered to minimise the occurrence such as replacement of borehole 'soakaways' with a drainage field. (This note does not apply to sub water table waste deposits).

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

Assessing the 'discernibility' of hazardous substances from discharges into groundwater

This document is out of date was withdrawn 14/03/2017

The following advice applies when permitting or applying to permit any disposal that could result in the input of hazardous substances to groundwater.[3] This includes:

- landfills;
- the discharge of sewage and trade effluents into infiltration systems;
- the landspreading of waste sheep dip and agricultural pesticides.

It is essential to read the guidance given here in conjunction with all other relevant guidance, particularly:

- Defra's Environmental permitting guidance: groundwater activities for the Environmental Permitting (England and Wales) Regulations 2010 (Defra 2010a) – refer in particular to section 4;
- Common Implementation Strategy (CIS) for the Water Framework Directive Guidance Document No. 17, Guidance on preventing or limiting direct and indirect inputs in the context of the Groundwater Directive 2006/118/EC. 2007 – refer in particular to section 3.4 'What is prevent and limit?').

Although the principles set out below may also be applicable to compliance monitoring and the setting of compliance limits, the aim of this section is determining whether or not an activity may be permitted in the first place.

What is a hazardous substance?

A hazardous substance is defined in Schedule 22 paragraph 4(1) of EPR 2010 as 'any substance or group of substances that are toxic, persistent and liable to bioaccumulate.' This includes in particular the following when they are toxic, persistent and liable to bioaccumulate:

[3] Unless the discharge is excluded under EPR 2010 Schedule 22.

- organohalogen compounds and substances which may form such compounds in the aquatic environment;
- organophosphorous compounds;
- organotin compounds;
- substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties which may affect steroidogenic, thyroid, reproduction or other endocrine-related functions in or via the aquatic environment;
- persistent hydrocarbons, and persistent and bioaccumulable organic toxic substances;
- cyanides;
- metals (in particular, cadmium and mercury) and their compounds;
- arsenic and its compounds;
- biocides and plant protection products.

The UK is required under the Groundwater Daughter Directive to publish a list of substances it considers hazardous. This list is determined by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) of which the Environment Agency is a member. Based on draft government guidance and preliminary determination by JAGDAG, you can assume that all former List 1 substances under the former Groundwater Directive, and as previously confirmed by JAGDAG, are hazardous substances. The final list of hazardous substances will be a wider group as it will include radionuclides.

Why do we need to consider discernibility?

Schedule 22 of EPR 2010 requires us to take all necessary measures to:

- prevent of the input of any hazardous substance to groundwater;
- limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.

Defra's environmental permitting guidance covering groundwater activities and the CIS Guidance Note No. 17 set out the meaning of 'prevent' and link this to the discernibility of hazardous substances.

Input of hazardous substances would be prevented, for example, if there are no discernible concentrations of hazardous substances attributable to the discharge in the groundwater immediately down-gradient of the discharge zone.

If there are or are likely to be discernible concentrations in the groundwater, the input may still be regarded as having been prevented if, among other conditions, 'all necessary and reasonable measures' have been taken to avoid it. Section 4 of Defra's environmental permitting guidance sets out the conditions that must apply and explains 'necessary and reasonable measures'.

What is discernible?

Subject to the practical considerations set out here, we take the view that a substance would be discernible if its concentration at a defined point exceeds:

(a) the natural background quality of the groundwater, or

This document is out of date was withdrawn 14/03/2017

(b) a minimum reporting value (MRV), usually the limit of quantification (see Box 8.2) or other value prescribed by legislation,

whichever of (a) or (b) has the highest concentration.

For example, a discharge concentration such as 0.02–0.03 μg per litre that is consistently more than double the MRV of 0.01 μg per litre may be considered discernible. However, it would not be discernible if the substance is present naturally at for example, 0.1 μg per litre. Appropriate judgement will be required to decide whether a substance should be considered discernible or whether exceedances are trivial.

Box 8.2 Limit of quantification

The limit of quantification is defined in the Chemical Analysis of Water Status (Technical Specifications) Directions 2011 as:

> 'a stated multiple of the limit of detection at a concentration of the determinand that can reasonably be determined with an acceptable level of accuracy and precision. The limit of quantification can be calculated using an appropriate standard or sample, and may be obtained from the lowest calibration point on the calibration curve, excluding the blank'. The limit of detection is defined as 'the output signal or concentration above which it can be affirmed, with a stated level of confidence, that a sample is different from a blank sample containing no determinand of interest'.

Where do we measure discernibility?

We assess the discernibility of hazardous substances at a point just below the water table adjacent to the edge of the discharge area (for example, the limits of a drainage field or the boundary of a landfill site). That is to say, the substance must not be discernible after the immediate dilution that occurs after the discharge enters the groundwater. Immediate dilution would be at most that arising from groundwater flowing across the width of the discharge area (measured perpendicular to the direction of groundwater flow) and within the expected vertical mixing depth (Figure 8.5).

This document is out of date was withdrawn 14/03/2017

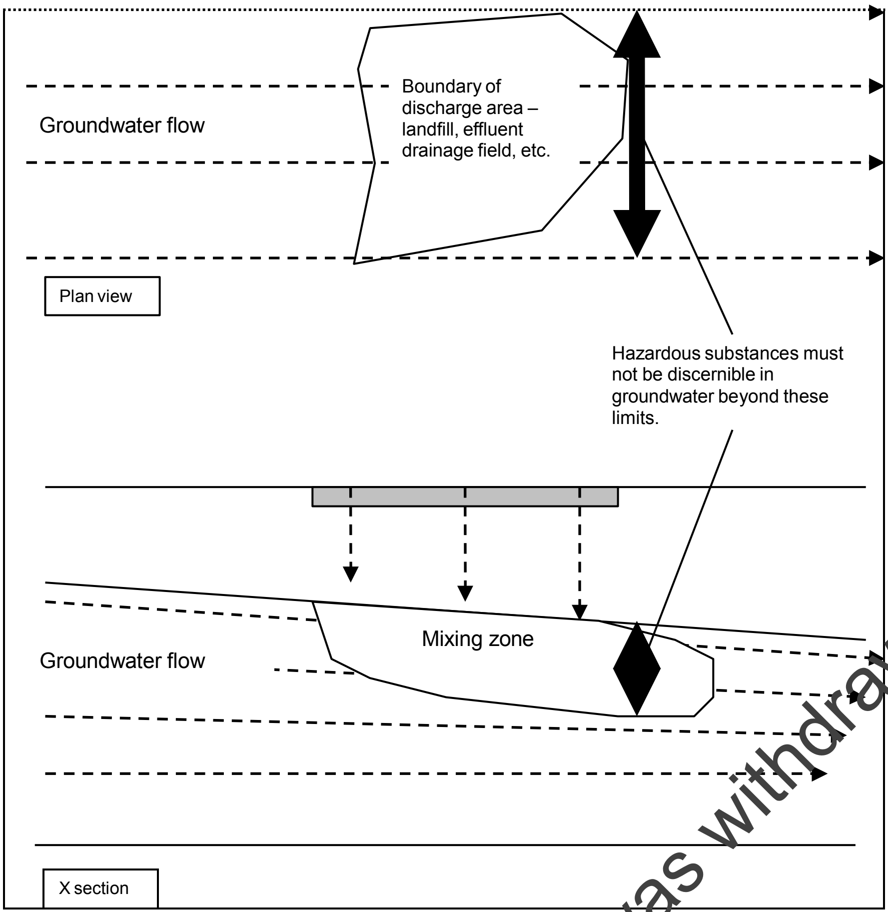


Figure 8.5 Discharge area and cross-section of a mixing zone showing the point beyond which hazardous substances must not be discernible

In assessing discernibility, you should not rely on:

- dispersion of contaminants beyond the boundary of the discharge area;
- higher dilution ratios (for example, by including flow in the aquifer below the expected mixing zone or by including the outcrop area beyond the discharge area);
- downstream attenuation in the saturation zone and consideration of impacts to more distant receptors.

Predictive assessments of discernible input to the groundwater, particularly from effluent discharges, may be unreliable because of the range of uncertainties associated with attenuation mechanisms in the unsaturated zone. In cases of established effluent discharges, it may be possible to observe a historical impact and discernibility can be assessed more reliably from monitoring boreholes. If so, measurement must be as near as reasonably possible to the point of entry within the uppermost flow horizon.

The design of monitoring points should conform as far as possible to the principles set out above. Discernibility should not be assessed on samples from boreholes that extend below the immediate mixing zone and introduce additional dilution. It is also necessary to consider whether pumping or purging the boreholes prior to sampling is likely to induce additional dilution, particularly if the boreholes are not directly down-gradient.

Compliance points that have been put in place to assess pollution by non-hazardous pollutants should not be used to assess the discernibility of hazardous substances unless they fully comply with the requirements set out above.

This document is out of date was withdrawn 14/03/2017

Trivial exceedances in monitoring boreholes

If discernibility is to be based on measured concentrations in monitoring boreholes, it is important to make the distinction between small exceedances that are significant in terms of the requirement to 'prevent' input and those that might result in disproportionate measures at the point of discharge when they are effectively trivial and have no environmental significance.

Trivial exceedance might include situations where:

- detections of hazardous substances are not regarded as representative (random spikes, sampling errors, contamination and so on); or
- the concentration is extremely close to the MRV (for example, where 2–3 values out of 10 are between 0.12 and 0.15 μg per litre compared with an MRV of 0.1 μg per litre).

No exceedance can be regarded as trivial in any situation where:

- it results in harm to receptors (existing or potential), even if these are sited adjacent to the discharge;
- it causes a sustained and statistically significant increasing trend (including increased frequency of pollutant spikes) at the monitoring point.

Deciding what is trivial and what is not calls for local judgement and interpretation of the data.

Discernibility and historically polluted groundwater

In areas where the groundwater is already polluted with the substance in question, it may not be possible to measure discernibility in downstream borehole samples. In such cases discernibility needs to be based on predictive assessments using the MRV or surrounding clean groundwater as the guide on the pre-existing background quality. It would not be acceptable to allow additional inputs of a hazardous substance even though the input quality is better than the existing polluted groundwater. The only potential exception is the situation where re-injection of hazardous substances occurs after abstraction and treatment as part of a remedial scheme to improve groundwater quality or the input is specifically exempted by regulation.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

This document is out of date was withdrawn 14/03/2017

Meaning of groundwater activity exclusions under EPR 2010

Under EPR 2010 there are certain exclusions whereby a discharge or activity is not classed as a groundwater activity and therefore an environmental permit is not required. Schedule 22 paragraph 3(3) sets out the different cases where an exclusion would apply.

Schedule 22 paragraph 3(4) requires us to record all exclusions granted under paragraph 3(3). We will do this by recording either individual situations or classes of cases that can be grouped together generically. These exclusions need to be reported to the European Commission though they do not need to be on a public register.

If you believe a paragraph 3 exclusion applies, you should ask our local groundwater and contaminated land team to make an assessment. You will need to provide us with details of the discharge (volume, type and so on), the location of the discharge point and the reasons why you think an exclusion applies.

If an activity falls into one of the classes of case described below, our groundwater and contaminated land teams are able to agree that the activity is not a groundwater activity under EPR without the need to report it. In some cases they may need to consult our national geoscience team about the interpretation.

If we find there are numerous site-specific determinations of a similar type, we may be able to expand the classes and reduce further the need for individual reporting. If you are making a determination, please check the latest version of this document for up-to-date information.

The four exclusions in Schedule 22 are discussed in more detail below.

Exclusion in paragraph 3(3)(a) of Schedule 22

The exclusion in paragraph 3(3)(a) refers to an input of a pollutant that:

> 'is the consequence of an accident or exceptional circumstances of natural cause that could not reasonably have been foreseen, avoided or mitigated'.

This exclusion would not apply to any situation where standard pollution prevention measures and good practice would have prevented the input had they been taken. For example, it is unlikely to apply to the consequences of a fire or vehicle accident on an active industrial site or the consequences of poor maintenance or design.

Classes of case already identified as meeting the requirements of this exclusion are:

- input of pollutants as the result of an unpredictable occurrence such as a traffic accident on a public road or the consequence of a train or plane crash;
- input of pollutants resulting from extreme weather events that are outside the normal bounds of prediction.

Exclusion in paragraph 3(3)(b) of Schedule 22

The exclusion in paragraph 3(3)(b) refers to an input of a pollutant into groundwater:

> 'of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater.'

This is commonly referred to as the 'de minimis' exclusion. Use the following criteria to determine individual cases:

- A discharge to ground of a hazardous substance in such small concentration and/or quantity that it is self-evident (without the need for investigation) that the resulting input of that substance to groundwater would not cause it to be discernible against the natural background quality or to exceed any relevant minimum reporting value. Such consideration may take into account the possible beneficial effects of the unsaturated zone and the immediate dilution upon entry to the water table.
- A discharge to ground of a non-hazardous pollutant in such small concentration and/or quantity that it is self-evident (without the need for investigation) that any elevation in concentration caused by the input of that pollutant into groundwater would be environmentally trivial. Such consideration may take into account the possible beneficial effects of the unsaturated zone and the immediate dilution upon entry to the water table.

If you are unsure whether the input of a pollutant is environmentally trivial under the second bullet above it may be useful to consider this in context of the classes of case.

Classes of case already identified as meeting the requirements of this exclusion are:

- recirculation back into the same strata of water abstracted at natural background quality and unaltered;
- selective groundwater tracer tests and remediation schemes - direct input into groundwater of the equivalent of 10 litres of any non-hazardous pollutant for the scientific purpose of groundwater testing or promoting remediation at a

This document is out of date was withdrawn 14/03/2017

concentration not greater than 10 times the concentration at which it is suitable for human consumption (see H1 Annex J2)

- discharge onto land of disinfectant footbaths for human use;
- discharge onto land of disinfectant footbaths for animal use of 10 litres or less – all substances;
- discharge onto land of disinfectant footbaths for animal use of greater than 10 litres – non-hazardous pollutants only and only via admixture with farm slurry or dirty water subject to good practice guidance;
- very small quantities of substances arising from essential use and maintenance of equipment (for example, lubrication of screw threads when drilling boreholes);
- rinses of pesticide spraying equipment and containers and sheep 'pour-on' containers (for example, the third flush);
- discharge of mains water of drinkable quality not containing any discernible hazardous substances;
- non-hazardous pollutants arising from the emergency treatment of water for drinking supply (for example, military water decontamination systems);
- individual animal carcass burial made according to good practice guidelines;
- small quantities of clean water distillate from boilers;
- scattering of ashes from individual human or animal cremations;
- burial of ashes from individual human or animal cremations, as long as the burial is not directly into groundwater;
- discharge onto land from low-use waterless urinals of 10 litres a day or less (for example, on golf courses);
- discharge onto land of 5 m^3 per day or less of swimming pool drain down water, of drinking water quality, with no discernible hazardous substances or concentrations of non-hazardous pollutants above drinking water standards. The discharge must have been left to dechlorinate for at least 2–5 days and must not contain concentrations of chlorine above 0.2 mg per litre.
- discharge of filter backwash waters, derived as part of the maintenance of abstraction equipment, which consequently contain elevated levels of iron, manganese and other non-hazardous metals. The elevated levels of metals must originate from non–anthropogenic sources, derived from the process of abstraction of groundwater on site. Discharge should be via a sub-surface infiltration system and must not be direct to groundwater. Discharge volumes should not exceed 1 m^3 within any 24 hour period.

This document is out of date was withdrawn 14/03/2017

Exclusion in paragraph 3(3)(c)(i) of Schedule 22

The exclusion in paragraph 3(3)(c)(i) refers to an input of a pollutant into groundwater that, for technical reasons, is incapable:

> 'of being prevented or limited without using measures that would increase risks to human health or to the quality of the environment as a whole'.

So, we may need to prioritise in favour of human health or wider environmental needs if the measures needed to protect groundwater would in themselves cause greater harm.

This exclusion may apply to some sustainable drainage schemes where low concentrations of pollutants are involved. The exclusion may also be relevant to one or more individual substances within a permitted effluent discharge. For example, it may not be possible to employ reasonable measures to remove certain substances at a sewage works and the only alternative would be to make an unacceptable discharge to surface water. However, there must be a compelling argument for the need for such a discharge at that location.

Classes of case already identified as meeting the requirements of this exclusion are:

- carcass burials up to two tonnes made according to best practice;
- discharge of substances/pollutants resulting from the use of foams for the purpose of emergency fire fighting, subject to good practice (not including training exercises or non-emergency use).

Exclusion in paragraph 3(3)(c)(ii) of Schedule 22

The exclusion in paragraph 3(3)(c)(ii) refers to an input of a pollutant into groundwater that, for technical reasons, is incapable of being prevented without using:

> 'disproportionately costly measures to remove quantities of pollutants from, or otherwise control their percolation in, contaminated ground or subsoil'.

This is only applicable to land contamination, although the need for bespoke determination will be rare as passive discharges from contaminated soils are not regarded as discharges for the purposes of EPR. Passive discharges from land contamination will continue to be controlled via a combination of voluntary remediation, the development planning system, Part 2A of the Environmental Protection Act 1990 and anti-pollution works notices under section 161A of the Water Resources Act 1991.

No classes of case have yet been identified as meeting the requirements of this exclusion.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

Selecting compliance points for use in land contamination risk assessments

This document is out of date was withdrawn 14/03/2017

The identification, selection and location of compliance points and target concentrations during quantitative groundwater risk assessments are important issues in risk assessment and in deriving remedial targets for contaminated soils and groundwater.

This section provides guidance on the selection of compliance points in groundwater systems as part of the risk management process for pollution of controlled waters from historically contaminated sites. It supplements the guidance presented in RTM (Environment Agency 2006c).

The approach complements established methods used to control the deliberate discharge of effluents into the ground, through the permitting process. When issuing permits for new discharges, we seek to:

- control the discharge to prevent pollution in accordance with legislation;
- protect groundwater resources as set out in our position statements.

In the case of contaminated sites (including some instances of contamination from recent as well as old activities), we recognise that pollutants may have already entered groundwater. Our objective is then to manage impacts to the wider environment to tolerable levels in a sustainable and risk-based manner.

Despite the fundamental differences between groundwater that is already polluted and groundwater that is not, similar principles can be used to help gauge an acceptable level of impact.

Within legislative constraints, the identification of remedial criteria should result in remediation and risk management that:

- protects human health;
- protects groundwater and other controlled waters;
- protects the wider environment including nature conservation sites and ecological receptors, property and other designated receptors;
- is practicable and reasonable;
- contributes to sustainable development.

Derivation of remedial targets

This section of GP3 is concerned with the derivation of remedial targets applicable to existing contamination. It applies principally to decisions made under:

- voluntary remediation schemes.
- redevelopment of contaminated sites through the Planning and Development Control regime;
- Section 161A of the Water Resources Act 1991 and the Anti-pollution Works Regulations 1999 (works notices);
- Part 2A of the Environmental Protection Act 1990.

The information here is aimed at practitioners involved with groundwater risk assessments for land contamination. It is not applicable to situations where contamination is arising due to a breach of an environmental permit. Under Schedule 5, Part 1, paragraph 14(1) of EPR 2010 and our position statement J1 - promptly clean up new contamination, pollution resulting from a breach of an environmental permit condition should be remediated, as far as is possible, to the conditions that existed prior to the breach of the permit.

Our objectives when deriving remedial targets

Our objectives when deriving remedial targets can be summarised as follows.

Where pollutants have not yet entered groundwater, all necessary and reasonable measures must be taken to:

- prevent the input of hazardous substances into groundwater. Hazardous substances are determined by the JAGDAG and are likely to include those previously classed as List I substances under the Groundwater Directive;
- limit the entry of other (non-hazardous) pollutants into groundwater so as to:
  - avoid pollution of groundwater;
  - avoid deterioration of the status of groundwater bodies;
  - prevent sustained and upward trends in pollutant concentrations in a groundwater body.

Where hazardous substances or non-hazardous pollutants have already entered groundwater, the priority is to:

This document is out of date was withdrawn 14/03/2017

- minimise further entry of hazardous substances and non-hazardous pollutants into groundwater as above (where there is a defined source to the groundwater contamination);
- take necessary and reasonable measures to limit the pollution of groundwater or impact on the status of the groundwater body from the future expansion of a contaminant 'plume', if necessary by actively reducing its extent.

Box 8.4 sets out what we mean by 'hazardous substances' and 'non-hazardous pollutants'.

Box 8.4 Hazardous substances and non-hazardous pollutants

The former Groundwater Directive defined two lists of substances deemed to pose the greatest risk to groundwater quality. These were referred to as List I and List II, with substances on List I being of most concern. The WFD and the Groundwater Daughter Directive consider a wider range of potential pollutants and refer to them as hazardous substances or non-hazardous pollutants. This terminology is used in EPR 2010.

Hazardous substances

Hazardous substances are defined in the WFD as:

> 'substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances which give rise to an equivalent level of concern'.

Under EPR 2010, we are required to publish a list of hazardous substances and the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) is the body that confirms these determinations. All substances previously confirmed to be on List I are automatically considered to be hazardous substances. List I substances may, however, be considered for reclassification (as non-hazardous pollutants) where new data or evidence have become available since their original determination. Reclassification is possible where evidence indicates the substance poses a lesser hazard to health and the environment than is appropriate for hazardous substance classification.

Further information on the classification status of substances will be published on JAGDAG website as assessments are carried out. All radioactive substances are classed as hazardous substances.

Non-hazardous pollutants

A non-hazardous pollutant is any substance capable of causing pollution that has not been classified as a hazardous substance. The non-hazardous list of pollutants does not simply replace the old List II but is wider. For example, nitrate is now classed as a non-hazardous pollutant whereas before it was not included in either List I or List II.

All substances liable to cause pollution that are not considered hazardous are deemed non-hazardous pollutants.

This document is out of date was withdrawn 14/03/2017

Water Framework Directive/Groundwater Daughter Directive

The Water Framework Directive states that measures should be adopted to prevent and control groundwater pollution. These measures are set out in the Groundwater Daughter Directive. Guidance Note No. 17 of the Common Implementation Strategy for the Water Framework Directive explains that:

- it is often too costly or not technically feasible to completely clean up groundwater back to pristine conditions;

- it would be unreasonable to expect member states to undertake further measures to clean up all pollution.

These issues are allowed for in the GWDD under the measures to prevent and limit inputs of pollutants into groundwater set out in Article 6(3):

> 'Without prejudice to any more stringent requirements in other Community legislation, member states may exempt from the measures required by paragraph 1 inputs of pollutants that are: …
>
> (e) in the view of the competent authorities incapable, for technical reasons, of being prevented or limited without using: …
>
> > (ii) disproportionately costly measures to remove quantities of pollutants from, or otherwise control their percolation in, contaminated ground or subsoil; …'

Our view is that the exemption aligns with the current approach to managing land contamination in England and Wales. This effectively means that existing groundwater protection; risk assessment and remediation methodologies for land contamination can still be followed.

The WFD and Groundwater Daughter Directive are enacted in England and Wales by EPR 2010. We do not consider that a passive release of pollutants from land contamination is a discharge that needs to be permitted under this regime as there is no surface activity to control. Only if there is activity that disturbs the contamination and subsequently causes a new discharge of pollutants to groundwater would we consider that an environmental permit might be required.

We consider that voluntary remediation schemes and measures such as the Planning and Development Control regime, Anti-Pollution Works and Part 2A give us the necessary controls over passive discharges from land contamination. We will therefore continue to seek remediation on sites according to our established risk-based methodology, taking account of the costs, benefits and sustainability considerations where appropriate.

General principles

Section 4.3 of our RTM identifies a number of general principles for the selection of compliance points linked to setting remedial targets for soil. Here, we clarify how compliance point selection should work for groundwater protection and remediation in England and Wales, taking into account our objectives for groundwater protection and remediation. Box 8.5 defines and explains the terms 'compliance point', 'target concentration' and 'remedial target' as used in our RTM.

Box 8.5 Compliance point, target concentration and remedial target

Compliance point

The compliance point is the point along the contaminant pathway where the target concentration should not be exceeded, as this would represent an unacceptable risk of harm to the receptor. The compliance point may be the receptor itself or a specified point along the source–pathway–receptor linkage (for example, within an aquifer nearer to the contamination source). Alternatively, it may represent pore water in the soil zone.

The location of the compliance point will depend on the circumstances and the level of assessment. Depending on the situation, the compliance point may be a virtual point for the purpose of predictive assessments. Alternatively it may be a physical monitoring point.

This document is out of date was withdrawn 14/03/2017

Target concentration

The target concentration is a concentration at the compliance point that should not be exceeded. Provided the target concentration is met, the relevant environmental standard for the receptor(s) should also be met. Where the compliance point is the receptor, the target concentration will be set as the relevant environmental standard or background groundwater quality.

The target concentration is used in Level 1–4 calculations to derive a remedial target against which soil or groundwater concentrations are compared. Soil or groundwater concentrations exceeding the remedial target drive the need for remedial action. The selected target concentration at a given compliance point remains constant during the assessment process – see section 4.2 of the RTM.

Remedial target

The remedial target is the derived soil or groundwater concentration above which remediation is required. This may be set as the target concentration or the target concentration multiplied by a dilution and/or attenuation factor (depending on the level of assessment).

The reason for setting compliance points within a risk assessment and remedial strategy is to protect receptors from a source of contamination. By comparing the actual or predicted groundwater quality at the compliance point with pre-determined criteria, we can identify whether soil or groundwater remedial measures are necessary to prevent future pollution at the receptor. If the pollution has already occurred, the same principles can be used to establish the necessary degree of remediation.

The starting point for any assessment is to obtain an understanding of the receptors and the environmental standards that need to apply at these receptors. It is then possible to select an appropriate location for a compliance point and the relevant water quality criteria that should apply to it (Figure 8.6).

This document is out of date was withdrawn 14/03/2017

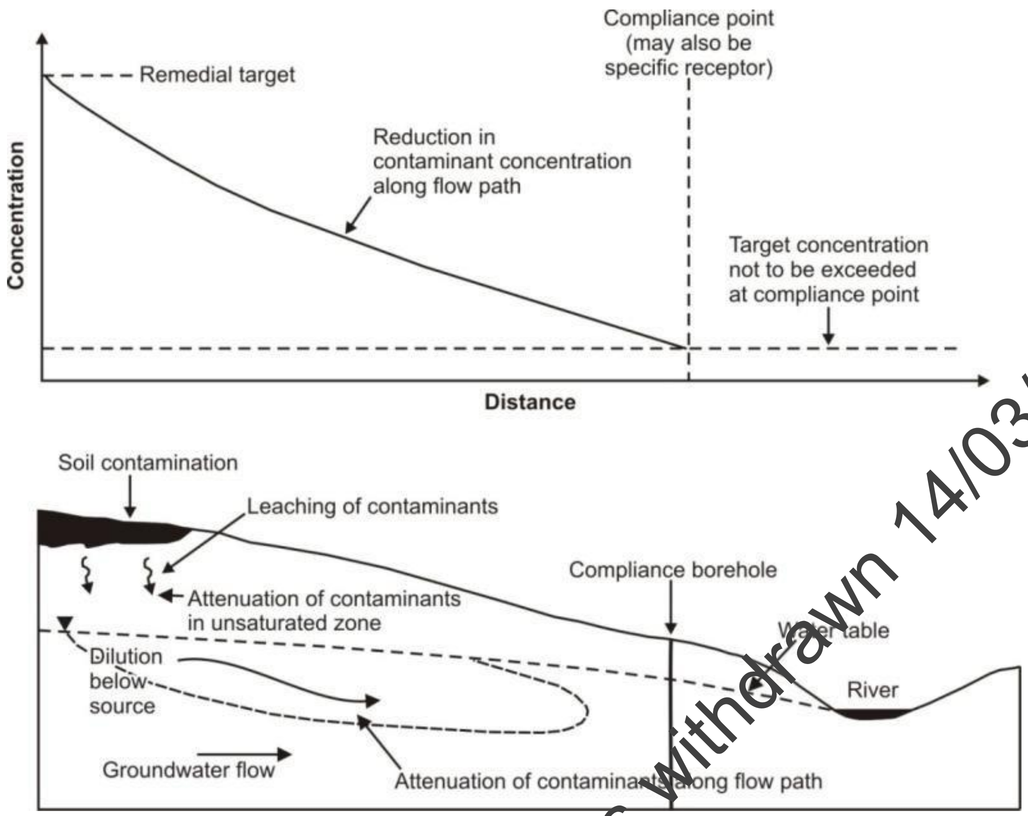


Figure 8.6 Compliance point relationship with RTM

Scenarios

Below we consider the two most important scenarios that commonly occur during the assessment of risks to groundwater from land contamination.

Scenario 1: Leaching of contaminants from soils into groundwater (level 1, 2 and 3 soil and groundwater in RTM)

In this case, the objective is to identify soil remedial targets to reduce leaching from the soils to provide acceptable levels of future protection to groundwater and other receptors.

Although groundwater contamination might have already occurred from the site, these remedial targets set for the contaminated soil should:

- seek to prevent or limit the continued input of pollutants into groundwater;
- not take any account of historical groundwater contamination unless this is overridden by sustainability considerations.

Pollutants that have already entered the groundwater from the leaching of soils are addressed separately below.

Scenario 2: Existing groundwater contamination whether or not related to a known source (level 3 and 4 groundwater in RTM)

In this case, the objective is to assess the need for separate groundwater remedial targets to deal with an existing plume of groundwater contamination. It is assumed that,

This document is out of date was withdrawn 14/03/2017

if there is any linkage with overlying contaminated soils, this linkage has been addressed separately above. However, it is acknowledged that there may be limited circumstances where residual inputs arise from soils where they cannot be prevented. It is also assumed there is no further input from the original source such as an area of land contamination or an incident/spillage.

The objective here is to:

- avoid groundwater contamination causing harm to human and/or ecological users of the water (for example, borehole abstractions, springs and rivers);
- avoid expansion of contaminant plumes beyond default down-gradient distances to protect usable groundwater resources (see also resource protection at RTM Level 3);
- assess whether it is necessary to carry out groundwater remediation to manage unacceptable risks to defined receptors and to the groundwater resource.

Conceptual model

In order to set appropriate compliance points to address these scenarios, you need to develop a clear conceptual model based on an understanding of:

- location and type of all receptors including:
  - existing and plausible future groundwater uses;
  - groundwater-dependent surface waters and ecosystems;
- source–pathway–receptor relationships;
- environmental standards applicable to each receptor;
- hydrogeological properties and groundwater flow regime;
- predicted fate and transport of contaminants as they move along the source-pathway-receptor linkage.

Selection of compliance point location

For both scenarios, you need to decide which of the risk assessment levels of the RTM should apply.

The four levels are as follows:

- **Level 1 (applicable only to soil leaching).** A precautionary approach is adopted requiring nominal data collection whereby the soil pore water quality data, or leaching test results, are compared directly with the target concentration in the soil zone or via soil remedial target concentrations derived from theoretical soil–water partitioning relationships.
- **Level 2 (unsaturated zone attenuation and dilution by infiltrating rainwater and groundwater).** Achievement of the target concentration is required within the groundwater flow pathway at, or immediately downstream of, the source zone. This means that the assessment takes account of dilution by infiltrating rainwater and groundwater flow. The source of contamination may be either leaching soils or an area of contaminated groundwater or both. Where the source of contamination is leaching soils, it may also take account of attenuation in the unsaturated zone. Level 2 does not take account of natural attenuation in the saturated zone.

This document is out of date was withdrawn 14/03/2017

- **Level 3 (with attenuation in the aquifer).** This is similar to level 2 but takes additional account of natural attenuation processes along the pathway within the saturated aquifer.
- **Level 4 (dilution in the receptor).** As for level 3, but in this case account is taken of any additional dilution available at the receptor such as from deeper within an abstraction borehole or from upstream flow in a surface water body. (A level 4 assessment must demonstrate that any impact on groundwater does not jeopardise future use of the resource or that the cost of remediation is unreasonable in relation to improvement of groundwater or surface water quality).

At level 1 the compliance point will be within the soil zone.

Level 2 does not include any assessment of attenuation processes in the saturated zone. The compliance point will typically be the groundwater below the site.

In both levels 1 and 2, the target concentration will usually be the same as the environmental standard that would apply to the most sensitive receptor at risk.

For level 3, the compliance point may be located at an existing or planned receptor, or at some point between the receptor and the contaminant source along the source–pathway–receptor linkage, provided the target concentration will afford adequate protection to all identified receptors (Figure 8.6).

Level 4 considerations are similar to those for level 3, but since this takes account of dilution in the receptor itself, the compliance point is located at the receptor itself (see section 5.7 of the RTM for further explanation).

Hazardous substances

Hazardous substances demand special consideration as the requirement is to prevent their entry into groundwater (Box 8.6). Level 3–4 compliance points should only be applied to hazardous substances where:

- the contaminant has already entered groundwater and it can be shown that returning impacted groundwater to its natural background quality is not achievable or warranted following due consideration of technical feasibility, or sustainability considerations;
- remediation to prevent entry of the contaminant at the water table is impractical due to the distribution and nature of contamination, or could be achieved only at unreasonable cost and that those costs cannot be mitigated/recouped through other measures.

In both cases, you need to provide proper justification that explains why the compliance point should not be set at, or as close as practically possible to, the point at which the contaminants are entering the saturated zone.

This document is out of date was withdrawn 14/03/2017

Box 8.6 Interpretation of the phrase 'prevent inputs into groundwater' of a hazardous substance as stated in the Groundwater Daughter Directive

In practical terms we interpret 'prevent' as meaning that reasonable and practical measures are taken to stop hazardous substances entering groundwater such that they are not discernible in groundwater above whichever is the highest of the following concentrations:

- the natural background quality of the groundwater;
- a minimum reporting value (MRV) – usually the lowest level of quantification that a laboratory can reliably measure/report a concentration for a substance in the medium being analysed;
- another value prescribed by legislation.

That is, where a release is unavoidable, the concentration should be environmentally trivial immediately downstream in the groundwater flow system.

The substance must not be discernible after the immediate dilution that occurs after the discharge enters the groundwater. Immediate dilution is, at most, that arising from groundwater flowing across the width of the discharge area (measured perpendicular to the direction of groundwater flow) and within the expected vertical mixing depth.

When making an assessment, do not rely on any of the following:

- dispersion of contaminants beyond the boundary of the discharge area;
- higher dilution ratios (for example, by including flow in the aquifer below the expected mixing zone or by including the outcrop area beyond the discharge area);
- downstream attenuation in the saturation zone and consideration of impacts to more distant receptors.

See *Environmental permitting guidance: groundwater activities for EPR* (Defra, 2010a) for further information.

Resource protection at RTM level 3

In some cases, the location of compliance points is dictated by the presence of known receptors such as rivers, springs or abstractions, or the planned or likely uses of groundwater.

In other cases, there may be no specifically identifiable groundwater receptor in the vicinity of the contaminant source and the objective becomes one of providing protection to the groundwater resource. In this case, level 4 of the RTM will not apply.

To derive a level 3 compliance point for the purposes of resource protection, a surrogate receptor such as a hypothetical abstraction borehole is selected at which the environmental standard applicable to that aquifer must be met. To achieve this, it is reasonable and practicable to identify areas of groundwater downstream from the source of contamination within which a degree of dilution and attenuation is allowable – assuming there is no nearer, feasible or likely future use of the groundwater identified.

The recommended default compliance point distance to protect groundwater resources is linked to:

- the type of contaminant (legal status as hazardous/non-hazardous);

This document is out of date was withdrawn 14/03/2017

- the aquifer classification (that is, its significance as a strategic water resource).

We are committed to contributing to the achievement of sustainable development and seek to ensure that remediation is consistent with sustainable development principles. This requires consideration of environmental, social and economic aspects and the selection of a remedial strategy or remediation techniques that optimise the overall benefits.

We therefore consider that, as part of a strategy of sustainable environmental management, it is reasonable and practicable to suggest strategically set 'default' compliance distances for groundwater resource protection based on contaminant and aquifer type. These default distances are based on experience and practice developed over time in standard groundwater management tools used in England and Wales (for example, source protection zones) and are consistent with criteria set out in our Common Incident Classification Scheme (CICS) for a Category 1 pollution incident.

There are four main types of aquifer (Table 2.1). Aquifers can be categorised as:

- having strategic groundwater resource potential;
- having local groundwater resource potential;
- being unproductive strata.

Aquifers with strategic groundwater resource potential are principal aquifers. It may be appropriate to include some of the more productive secondary aquifers (Secondary A) within this group, especially where these support significant local water supply.

Aquifers with local groundwater resource potential include all other secondary A and secondary B aquifers.

Unproductive strata are low permeability deposits that are unable to support significant water abstraction or base flow to rivers. They should be regarded as a potential pathway for contaminant migration rather than a potential receptor, since they have no current or future water resource potential.

Step 1: Define the 'default' compliance point

For the leaching of hazardous substances (where this cannot be prevented) and non-hazardous pollutants from a soil source (Scenario 1), the basis for deriving remedial targets at level 3 into groundwater with a strategic resource potential is the environmental standard applicable to a hypothetical groundwater abstraction at a default distance of 50 metres from the boundary of the source (Table 8.2). Where Scenario 1 involves groundwater of local resource potential, a distance greater than 50 metres may be agreed for non-hazardous pollutants according to local circumstances but this should not normally exceed 250 metres.

Where groundwater has already been contaminated (Scenario 2) the following apply:

- The aim is to avoid contaminant plumes extending beyond the distances (measured from the boundary of the original pollutant source) as set out in Table 8.2. Box 8.7 sets out the definition of 'plume' used in this document.
- The greater the risk that this will occur, the greater the effort required to investigate, assess and if necessary take remedial action to either reduce the source term, stabilise the migrating front of the plume or reduce its expansion.
- A sustainability assessment (or similar as outlined in Step 2) must be provided to justify extending the default distances in cases where the plume is at or near the relevant 50 or 250 metre maximum or has already exceeded it.

This document is out of date was withdrawn 14/03/2017

- These distances do not apply if there are specific receptors located closer to the source.

In either of these situations, it may be appropriate to modify the default distances according to the circumstances. A number of possible considerations are listed under Step 2.

Table 8.2 Down-gradient default compliance distances for resource protection

Type of pollutant and aquifer	Default compliance distance (from contaminant source)[1]
For all hazardous substances in all aquifers (that is, those already in the groundwater or inputs from soils which cannot be prevented)	50 metres
For non-hazardous pollutants in groundwater with strategic resource potential	50 metres
For non-hazardous pollutants in groundwater with local resource potential	A distance greater than 50 metres may be agreed according to local circumstances but this should not normally exceed 250 metres.

Note: Compliance point should be located less than 50/250 metres as specified above from the source if a discrete receptor (for example, a borehole, spring or river) is nearer.

This document is out of date was withdrawn 14/03/2017

Box 8.7 Definition of plume and source

For the purposes of this document, a 'plume' is defined as the volume of aquifer down-gradient of a source within which groundwater is contaminated to a level that exceeds the relevant environmental standard that would apply to any likely or feasible future use of the groundwater.

The source is the 'location or feature from which contamination is, or was, derived' (BS 10175) (BSI 2011). Model procedures (CLR11) describes the approach to 'Hazard identification – establishing contaminant sources' (Environment Agency and Defra 2004, p. 15). It also details sources of technical guidance and tools to assist in applying the risk assessment process in particular circumstances.

The aims of any agreement to allow plume expansion beyond the relevant 50 or 250 metre default distance should be consistent with those set out in our guidance on natural attenuation (Environment Agency 2000a, section 1.4). That is, further expansion of the plume into uncontaminated groundwater should be minimised as far as possible while taking account of:

- the sensitivity of the environment;
- the impact of any pollution;
- the likely costs and benefits of preventing plume expansion, including the sustainability of remedial actions.

If the site in question is shown to overlie unproductive strata, it is assumed that:

- only a limited plume is possible;
- the strata are likely to act as a pathway rather than a potential receptor;
- no groundwater-dependent receptors are at risk.

If there is still concern, we advise setting a compliance point using the guidelines for an aquifer with local groundwater resource potential. However, you would still need to carry out an assessment to demonstrate that no existing uses of the aquifer could be affected by the contamination.

Step 2: Define site-specific compliance points

The 'default' compliance distance for resource protection may be altered according to the following additional considerations:

- WFD. Objectives to achieve and maintain the good status of water bodies in line with river basin management plans may result in the need for tighter constraints on setting compliance point distances.
- **Plausible future use of groundwater**. The default distance of 50 or 250 metres may be extended where there is credible information to demonstrate a significant physical constraint on the ability to use the groundwater resource. Examples of physical constraints include:
  - **Existing and future land use**. For example, an area designated for use as domestic housing with mains supplies might reasonably be regarded as a constraint to developing that area of the groundwater resource.
  - **Land ownership**. There may be factors governing the long-term control of land or access to adjacent land that constrain the potential for future

This document is out of date was withdrawn 14/03/2017

water abstraction (for example, private estate, park land, major infrastructure development, extensive industrial complex).

- **Topography**. Steep or inaccessible land or areas with unsuitable access may reasonably influence the identification of areas where groundwater might never be developed.
- **Natural conditions**. Constraints on the future development of groundwater may also exist due to the limitations of the groundwater resource (for example, potential yield) or the natural background groundwater quality.

- **Natural attenuation**. Attenuation can have a significant effect on contaminant concentrations and the calculated remedial target. The selection of a compliance location over the default distance outlined above may be a consideration within the risk assessment process if supported by an appropriate sustainability assessment. Evidence would needed as to whether natural attenuation processes are actually occurring and that there is confidence in an acceptable environmental outcome being achieved – see section 4.3 of the RTM. A strong evidence base is particularly required where natural attenuation is being used as a key environmental factor in the confidence that concentrations will reduce. Evidence of natural attenuation will need to be provided using a lines-of-evidence approach. Where natural attenuation is being considered as set out in our guidance on natural attenuation (Environment Agency 2000), site-specific monitoring evidence (including appropriate monitoring points that show no impact down-gradient of the compliance point) will need to be provided.
- **Sustainability assessment**. An increase of the distance to compliance point location, over and above the distances outlined in Table 8.2 may also be justified if supported by a sustainability assessment; this may include a qualitative, semi-quantitative or quantitative sustainability appraisal as described by SuRF-UK (2010).
- **Environmental standards**. This is the water quality value chosen to protect a receptor. As there are currently no statutory groundwater quality standards in EU or UK legislation, the chosen environmental standard may be derived using other standards such as the drinking water standard (DWS) or environmental quality standard (EQS). However, it is important to consider their relevance otherwise this may result in over- or under-protection of the groundwater resource. In addition, the choice of target concentration needs to be appropriate to ensure protection of the receptor for the use(s) to which it is put. Further guidance is given in section 4.2 of the RTM.

Non-aqueous phase liquids

Where the source of contamination is a non-aqueous phase liquid (NAPL) present on or below the water table – as either a mobile or residual light NAPL (LNAPL) or dense NAPL (DNAPL) – we consider the contamination to have already entered controlled waters. In such circumstances, you should follow the requirements for setting compliance points described above to minimise:

- further entry of hazardous substances to groundwater from the overlying unsaturated zone;
- expansion of the groundwater contaminant plume to prevent further pollution.

In addition to the indirect risk to receptors due to the dissolution of constituent compounds and their subsequent transport (dissolved phase), mobile NAPL may itself

This document is out of date was withdrawn 14/03/2017

represent a direct threat to receptors via its movement through the unsaturated/saturated zone. You therefore need to consider the management of this on-going secondary source of contamination to ensure:

- the removal and/or control of mobile NAPL where its migration could present an unacceptable risk;
- the removal or control of residual (immobile) NAPL where its dissolution or volatilisation could present an unacceptable risk;
- the remediation of dissolved phase or vapour phase hydrocarbons where they could give rise to an unacceptable risk.

Further guidance on dealing with NAPLs is given in:

- An illustrated handbook of DNAPL transport and fate in the subsurface (Environment Agency 2003);
- *An Illustrated Handbook of LNAPL Transport and Fate in the Subsurface* (CL:AIRE, in preparation);
- Section 6 of RTM;
- Evaluating LNAPL remedial technologies for achieving project goals (ITRC 2009a);
- Evaluating natural source zone depletion at sites with LNAPL (ITRC 2009b);
- Selecting and assessing strategies for remediating LNAPL in soil and aquifers (CRC CARE 2010);
- LNAPL Resource Center of the American Petroleum Institute (API).

Sustainability assessment

Remediation of contaminated groundwater can be technically difficult, financially expensive, and give rise to environmental and social impacts (such as atmospheric emissions and traffic nuisance).

In deciding whether and how to exercise our discretionary powers, we have a duty to 'take account of the likely costs'[4] and to make 'a contribution towards attaining the objective of sustainable development'. We are therefore committed to ensuring that, where remediation of groundwater and soils is carried out, it is consistent with sustainable development principles. In addition, we encourage consideration of the environmental, social and economic aspects to ensure net benefits are maximised. Further advice on this issue is given in:[5]

- Statutory guidance for contaminated land (Defra 2012);
- Contaminated land statutory guidance (Welsh Government 2012).

Work by the Sustainable Remediation Forum-UK (SuRF-UK) produced A framework for assessing the sustainability of soil and groundwater remediation (SuRF-UK 2010), which is consistent with and complements our earlier guidance, Model procedures for the management of land contamination (Environment Agency and Defra 2004). The SuRF-UK framework presents a tiered approach for assessing the sustainability of remedial strategies and options, which we recommend.

As part of the SuRF-UK framework, a tiered approach to sustainability appraisal is described, starting with simple qualitative methods, then semi-quantitative methods

[4] Environment Act 1995 section 4(1)
[5] In particular see section 6 of these documents.

This document is out of date was withdrawn 14/03/2017

(such as multi-criteria decision analysis), and finally quantitative analysis (such as cost-benefit analysis or life-cycle analysis). The simplest tier of sustainability appraisal should normally be used that allows a robust and clear management decision (in line with SuRF-UK principles).

If quantitative analysis is appropriate (typically for large and complex projects), our guidance includes:

- Costs and benefits associated with the remediation of contaminated groundwater: a review of the issues (Environment Agency 1999);
- Costs and benefits associated with the remediation of contaminated groundwater: a framework for assessment (Environment Agency 2000b).

This approach is illustrated in Costs and benefits associated with the remediation of contaminated groundwater: application and example (Environment Agency 2002) and is supported by information in Assessing the value of groundwater (Environment Agency 2007).

This series of reports adopts a tiered approach in which clear decisions can be made on the basis of an initial qualitative screening phase. More complex problems may require further quantitative information.

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

Further reading

Groundwater general

- *Introducing Groundwater* by Michael Price, 2nd edition, 1996, Nelson Thornes. A comprehensive introduction to groundwater aimed at non-specialist readers.
- *Groundwater: Our Hidden Asset*, edited by R.A. Downing, 1998, BGS and UK Groundwater Forum. A highly illustrated introduction to groundwater, aimed at non-specialist readers.

Land contamination

- RTM. Our Remedial targets methodology identifies the key factors for deciding on remedial targets for land contamination risk assessment.
- Guiding principles for land contamination (GPLC) – a package of three documents providing generic guidance for those with problems and their advisors:
  - GPLC1 – Overview
  - GPLC2 – FAQs, technical information, detailed advice and references
  - GPLC3 – Reporting checklists

  The main aims of GPLC are to:
  - help clarify roles and responsibilities;
  - encourage good practice to promote compliance with the requirements, or avoid the need for regulation;
  - guide customers to guidance and advice in other documents.
- Piling into contaminated sites, Environment Agency, 2002. Our guidance provides useful information on piling and penetrative ground improvement methods on land affected by contamination.
- Piling and penetrative ground improvement methods on land affected by contamination: guidance on pollution prevention, Environment Agency, 2001. Guidance on the risks associated with pollution from piling and penetrative ground improvement methods on contaminated land and how to prevent pollution from these processes.

Decommissioning boreholes

- Good practice for decommissioning redundant boreholes and wells, Environment Agency, 2010. A useful summary guide to decommissioning boreholes or wells that are no longer used.

This document is out of date was withdrawn 14/03/2017

Ground source heat pumps

- Environmental good practice guide for ground source heating and cooling, Environment Agency, 2011. This guidance covers both open and closed loop GSHC schemes.

Abstractions

- Managing water abstraction, Environment Agency, 2010. Sets out the national policy and regulatory framework within which we manage water resources in England and Wales.

Defra codes of practice

- Protecting our water, soil and air: a code of good agricultural practice for farmers, growers and land managers (CoGAP)
- Code of practice for using plant protection products.
- Groundwater protection code: use and disposal of sheep dip compounds
- Groundwater protection code: petrol stations and other fuel dispensing facilities involving underground storage tanks;
- Groundwater protection code: solvent use and storage;

Permitting groundwater activities

Our horizontal guidance on environmental risk assessment (H1) is designed to help you assess the risks to the environment when applying for a bespoke permit under EPR. We have developed a series of sector-specific groundwater guidance documents as annexes to H1:

- H1 Annex J Groundwater. This document provides guidance on how to undertake a groundwater risk assessment and points to supporting sector specific annexes that deal with different types of activities.
- H1 Annex J1 Prior examination for discharges to land of waste sheep dip and pesticide washings. This document explains the risk assessment process we will use before we can issue an environmental permit to cover a liquid or solid discharge to ground/groundwater (for example, the disposal of certain agricultural wastes such as pesticide washings and waste sheep dip by spreading them on to land. This prior examination will demonstrate that there will be no unacceptable discharge to groundwater.
- H1 Annex J2 Guidance on the discharge of small quantities of substances for scientific purposes. This guidance is aimed at groundwater tracer tests and quantities of substances for scientific purposes as part of a specified groundwater remediation scheme. You should read this if you are undertaking any of the above activities. Most can be either excluded from control or registered as exempt.
- H1 Annex J3 Additional guidance for hydrological risk assessments for landfills and the derivation of groundwater control levels and compliance limits. The guidance describes a tiered approach to assessing the risk to groundwater from landfills.

This document is out of date was withdrawn 14/03/2017

- H1 Annex J4 Groundwater risk assessment for treated effluent discharges. The guidance is primarily focused on discharges of treated sewage effluent (domestic and non-domestic) and trade effluent to constructed infiltration systems (drainage fields).
- H1 Annex J5 Infiltration worksheet user manual and H1 Annex J5 Infiltration worksheet. The infiltration spreadsheet and accompanying user manual are used to assess those discharges discussed in Annex J4.

Useful web links

Environment Agency

Groundwater pages

Water resources abstraction pages

Pollution prevention advice and guidance

Other organisations

UKTAG – United Kingdom Technical Advisory Group

JAGDAG – Joint Agencies Groundwater Directive Advisory Group

This document is out of date was withdrawn 14/03/2017

Return to detailed contents

References

APEA & EI, 2011. *Guidance for design: construction, modification and decommissioning of filling stations.* Saffron Walden. Jointly published by the Association for Petroleum and Explosives Administration and Energy Institute.

BGS, 1994. *National groundwater levels monitoring network review. hydrogeology series.* Technical Report WD/94/41C. British Geological Survey study for the National Rivers Authority.

BSI, 2008. *BS6297:2007+A1:2008. Code of practice for the design and installation of drainage fields for use in wastewater treatment*. London: British Standards Institution.

BSI, 2011. *BS10175:2011 Investigation of potentially contaminated sites: Code of practice.* London: British Standards Institution.

CRC CARE, 2010. *Selecting and assessing strategies for remediating LNAPL in soil and aquifers*. Technical Report No. 18. Adelaide: CRC CARE.

DEFRA, 2005. *The UK Government sustainable development strategy*. CM 6467. London: TSO.

DEFRA, 2010a. *Environmental permitting guidance: groundwater activities for the Environmental Permitting (England and Wales) Regulations 2010*. London: Defra.

DEFRA, 2010b. *Environmental permitting guidance: core guidance for the Environmental Permitting (England and Wales) Regulations 2010*. London: Defra.

DEFRA, 2011a. *Guidelines for environmental risk assessment and management. Green Leaves III.* London: Defra.

DEFRA, 2011b. *Water for life*. CM 8230. London: TSO.

DEFRA, 2011c. *Derogations from the Animal By-Product Controls under Regulation (EC) 1069/2009 and Commission Regulation (EU) 142/2011. Authorisations by the Secretary of State to enable derogations to be used in England*. London: Defra.

DEFRA, 2012. *Statutory guidance for contaminated land*. London: Defra.

DOWNING, R. A. (ed.), 1998. *Groundwater – our hidden asset.* An Earthwise Publication Series. Keyworth, Nottingham: British Geological Survey and UK Groundwater Forum.

DWI, 2011a. *Drinking water 2010. Private water supplies in England. July 2011. A report by the Chief Inspector of Drinking Water.* London: Drinking Water Inspectorate.

DWI, 2011b. *Drinking water 2010. Private water supplies in Wales. July 2011. A report by the Chief Inspector of Drinking Water.* London: Drinking Water Inspectorate.

ENERGY NETWORK ASSOCIATION AND ENVIRONMENT AGENCY, 2007. *Guidance on the national operating code for the management of fluid-filled cables.* London: Energy Networks Association.

ENTEC, 2010. *Cumulative nitrogen and phosphorus loadings to groundwater.* Report prepared for the Environment Agency, SEPA and NIEA. Shrewsbury: Entec Limited.

ENVIRONMENT AGENCY, 1999. *Costs and benefits associated with remediation of contaminated groundwater: a review of the issues.* Technical Report P278. Bristol: Environment Agency.

This document is out of date was withdrawn 14/03/2017

ENVIRONMENT AGENCY, 2000a. *Guidance on the assessment and monitoring of natural attenuation of contaminants in groundwater*. R&D Publication 95. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2000b. *Costs and benefits associated with the remediation of contaminated groundwater: a framework for assessment.* R&D Publication 279. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2001. *Water supply borehole construction and headworks: guide to good practice.* Solihull: National Groundwater & Contaminated Land Centre.

ENVIRONMENT AGENCY, 2002. *Costs and benefits associated with the remediation of contaminated groundwater: application and example*. R&D Technical Report P2-078/TR. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2003. *An illustrated handbook of DNAPL transport and fate in the subsurface*. R&D Publication 133. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2004. *Assessing the groundwater pollution potential of cemetery developments.* Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2005. *Groundwater–surface water interactions in the hyporheic zone*. Science Report SC030155/SR1. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2006a. *The State of groundwater in England and Wales*. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2006b. *Funeral practices, spreading ashes and caring for the environment.* Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2006c. *Remedial Targets Methodology. Hydrogeological risk assessment for land contamination*. Bristol: Environment Agency

ENVIRONMENT AGENCY, 2007. *Assessing the value of groundwater*. Science Report SC040016/SR1. Bristol: Environment Agency

ENVIRONMENT AGENCY, 2009a. *Water resources strategy for England and Wales*. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2009b. *Near-surface disposal facilities on land for solid radioactive wastes. Guidance on requirements for authorisation*. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2010a. *Managing water abstraction*. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2010b. *Understanding the Landfill Directive.* Regulatory Guidance Series No. LFD 1. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2010c. *Setting standards for environmental protection.* Regulatory Guidance Series No. RGN 4. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2010d. *GPLC1 – Guiding principles for land contamination – overview.* Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2010e. *GPLC2 – Guiding principles for land contamination – FAQs, technical information, detailed advice and references.* Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2010f. *GPLC3 – Guiding principles for land contamination – reporting checklists.* Bristol: Environment Agency.

This document is out of date was withdrawn 14/03/2017

ENVIRONMENT AGENCY, 2011a. *H1 Annex J3: Hydrogeological risk assessments for landfills and the derivation of groundwater control levels and compliance limits*. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2011b. *Guidance for the registration of small sewage effluent discharges.* Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2011c. *H1 Annex J4: Groundwater risk assessment for treated effluent discharges to infiltration systems.* Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2011d. *Environmental good practice guide for ground source heating and cooling*. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2011e. *Flooding from groundwater: practical advice to help you reduce the impact of flooding from groundwater*. Bristol: Environment Agency.

ENVIRONMENT AGENCY, 2012. *Good practice for decommissioning redundant boreholes and wells*. Bristol: Environment Agency.

ENVIRONMENT AGENCY AND DEFRA, 2004. *Model procedures for the management of land contamination. Contaminated Land Report 11. Bristol:* Environment Agency.

GRIFFITHS, K.J., MACDONALD, A.M., ROBINS, N.S., MERRITT, J., BOOTH, S.J., JOHNSONM D. AND MCCONVEY, P.J., 2011. Improving the characterization of Quaternary deposits for groundwater vulnerability assessments using maps of recharge and attenuation potential. *Quarterly Journal of Engineering Geology and Hydrogeology*, 44, 49-61.

HM GOVERNMENT, 2008. *Fire and Rescue Manual. Volume 2: Fire Service Operations – environmental protection*. Norwich: TSO.

HOME OFFICE, 2007. P*lanning for a possible influenza pandemic – a framework for planners preparing to manage deaths*. London: Home Office.

ITRC, 2009a. *Evaluating LNAPL remedial technologies for achieving project goals*. Washington DC: Interstate Technical & Regulatory Council.

ITRC, 2009b. *Evaluating natural source zone depletion at sites with LNAPL*. Washington DC: Interstate Technical & Regulatory Council.

LORD, E.I., HUGHES, G.O., WILSON, L., GOODAY, R., ANTHONY, S.A., CURTIS, C. AND SIMPSON, G., 2008. *Updating previous estimates of the load and source apportionment of nitrogen to waters in the UK*. Final Report for Defra Project WQ0111. London: Defra.

NATIONAL RIVERS AUTHORITY, 1992. Policy and practice for the protection of groundwater (PPPG).

NHBC AND ENVIRONMENT AGENCY, 2008. *Guidance for the safe development of housing on land affected by contamination.* R&D Publication 66. Bristol: Environment Agency.

PITT, M., 2008. *Learning Lessons from the 2007 floods: An independent review by Sir Michael Pitt.* London: The Pitt Review.

PRICE, M., 1996. *Introducing Groundwater,* 2nd ed. Cheltenham: Nelson Thornes.

SuRF-UK, 2010. *A framework for assessing the sustainability of soil and groundwater remediation.* London: Contaminated Land: Applications in Real Environments (CL:AIRE).

This document is out of date was withdrawn 14/03/2017

UKWIR, 2004. *Implications of changing groundwater quality for water resources and the UK Water industry – Phase 3: Financial and water resources impact.* London: UK Water Industry Research Ltd.

USEPA, 2004. *Evaluation of impacts to underground sources of drinking water by hydraulic fracturing of coal bed methane reservoirs.* EPA/816/R-04/003. Washington, DC: US Environmental Protection Agency, Office of Water.

WELSH GOVERNMENT, 2012. *Contaminated land statutory guidance – 2012*. Cardiff: Welsh Government.

This document is out of date was withdrawn 14/03/2017

List of abbreviations

ANOB	Area of outstanding natural beauty
ARR	Artificial recharge and recovery
ASR	Aquifer storage and recovery
BAP	Biodiversity action plan
BAT	Best available techniques
BGS	British Geological Society
BSI	British Standards Institution
CAMS	Catchment abstraction management strategies
CBM	Coal bed methane
CED	Common end date
CFE	Campaign for the Farmed Environment
CIS	Common Implementation Strategy
CLR	Contaminated land report
CRD	Chemicals Regulation Directorate [HSE]
CSF	Catchment sensitive farming
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DQRA	Detailed quantitative risk assessment
DrWPA	Drinking water protected area
DWI	Drinking Water Inspectorate
ELD	Environmental Liability Directive
EPA	Environmental Protection Act 1990
EGPG	Environmental good practice guide [for ground source heating and cooling]
EPR	Environmental Permitting Regulations
ETBE	Ethyl *tert*-butyl ether
GAEC	Good agricultural and environmental conditions
GIC	Groundwater investigation consent
GP3	Groundwater protection: Principles and practice
GPLC	Guiding principles for land contamination
GQRA	Generic quantitative risk assessment
GSHC	Ground source heating and cooling

This document is out of date was withdrawn 14/03/2017

GWB	Groundwater body
GWDD	Groundwater Daughter Directive
GWDTE	Groundwater dependent terrestrial ecosystems (groundwater dependent wetlands)
HoF	Hands off flow
HoL	Hands off level
HRA	Hydrogeological risk assessment
HSE	Health & Safety Executive
IDB	Internal drainage board
IED	Industrial Emissions Directive
IPPC	Integrated Pollution Prevention and Control
ISO	International Organization for Standardization
JAGDAG	Joint Agencies Groundwater Directive Advisory Group
LFD	Landfill Directive
LLFA	Lead local flood authority
LPA	Local planning authority
MAR	Managed aquifer recharge
Ml/d	Million litres per day
MNA	Monitored natural attenuation
MRV	Minimum reporting value
MTBE	Methyl tertiary butyl ether
NAPL	Non-aqueous phase liquid
NIEA	Northern Ireland Environment Agency
NORMs	Naturally occurring radioactive materials
NVZ	Nitrate vulnerable zone
ONR	Office for Nuclear Regulation
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PPC	Pollution prevention and control
PPG	Pollution prevention guideline
PPPD	Plant Protection Products Directive
QRS	Qualitative risk screening
RPA	Rural Payments Agency
RBMP	River basin management plan

This document is out of date was withdrawn 14/03/2017

RSA	Restoring sustainable abstraction
RTM	Remedial targets methodology
SAB	SuDS approving body
SAC	Special area of conservation
SEPA	Scottish Environment Protection Agency
SgZ	Safeguard zone
SMR	Statutory management requirement
SPA	Special protection area
S-P-R	Source–pathway–receptor
SPZ	Source protection zone
SSSI	Site of special scientific interest
STP	Sewage treatment plant
SuDS	Sustainable drainage systems
UCG	Underground coal gasification
UKTAG	UK Technical Advisory Group (of the WFD)
UKWIR	UK Water Industry Research
WFD	Water Framework Directive
WPA	Waste planning authority
WPZ	Water protection zone
WRA	Water Resources Act 1991

This document is out of date was withdrawn 14/03/2017

Glossary

Aquifer	‘A subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater’ (source: Water Framework Directive 2000/60/EC).
Abstraction	Removal of water from surface water or groundwater, usually by pumping.
Abstraction licence	A licence issued by the Environment Agency under the Water Resources Act 1991 to permit water to be abstracted.
Attenuation	Break down or dilution of a contaminant.
Baseflow	That part of the flow in a watercourse made up of groundwater and discharges. It sustains the watercourse in dry weather.
Baseline quality	The concentration of a given element, species of chemical substances present in solution which is derived from natural, geological, biological or atmospheric sources.
Best practicable environmental option (BPEO)	‘The outcome of a systematic consultative and decision making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes for a given set of objectives, the option that provides the most benefits or the least damage to the environment, as a whole, at acceptable cost, in the long term as well as in the short term’ (Source: Royal Commission on Environmental Pollution)
Borehole	A hole driven into the ground (for example, to obtain geological information, to release water, to extract oil).
Cesspool/cesspit	Sealed tank used to collect sewage. It has no outlet and requires periodic emptying.
Conceptual model	A simplified representation of how the real system is thought to behave. It is based on a qualitative analysis of field data. A quantitative conceptual model includes preliminary calculations for key processes.
Confined	Aquifer where permeable strata are covered by a substantial depth of impermeable strata such that the cover prevents infiltration.
Contamination	With respect to groundwater, contamination is the presence of substances or heat above the normal natural background. For anthropogenic contamination, the term is used to describe increased substances or heat below a level where harm may occur and which is therefore not pollution. Where elevated concentrations of naturally occurring substances that are not from human activity have the potential to cause harm, this is considered to be contamination but not pollution.

This document is out of date was withdrawn 14/03/2017

Controlled waters	Defined by the Water Resources Act 1991 section 104. They include all groundwater and inland waters and estuaries.
Degradable pollutants	Pollutants that break down readily.
De minimis	Pollutants of a quantity and concentration so small as to not pose any present or future danger of deterioration in the quality of the receiving groundwater.
Derogation	Term used for loss of water resources or deterioration in water quality (usually relating to a particular source).
Diffuse source pollution	Pollution from widespread activities with no one discrete source.
Direct inputs	These can be identified by one of the following properties: • They bypass the unsaturated zone; • The pollution source is in the saturated zone (or discharges directly into the saturated zone); • Fluctuations in the water table (for example, seasonal changes or those influenced by changes in abstraction rates, tidal influence or recharge over time) mean that the pollution source will be in direct contact with groundwater, for a significant period of time.
DNAPL	Dense non-aqueous phase liquid. Liquids that are immiscible with and denser than water.
Dual porosity aquifer	Aquifer with a primary intergranular porosity in rock matrix and secondary permeability due to fractures or solution features.
Ecosystem	A functioning, interacting system composed of one or more living organisms and their effective environment, in a biological, chemical and physical sense.
Effective porosity	That part of the total porosity which can transmit water.
Environmental permit	A permit issued under the Environmental Permitting (England and Wales) Regulations (EPR).
Fissure/fracture flow	Groundwater movement through fissures rather than between grains in the rock. There may be a combination of fissure and intergranular flow in some aquifers.
Fractures/fissures	Natural cracks in rocks that enhance rapid water movement.
Groundwater	'All water which is below the surface of the ground in the saturation zone (below the water table) and in direct contact with the ground or subsoil' (source: Water Framework Directive 2000/60/EC).
Hazard	Refers to a situation or biological, chemical or physical agent that may lead to harm or cause adverse effects (after Defra 2011a).
Hazardous substances	'Substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances that give rise to an equivalent level of concern' (source: Water Framework Directive 2000/60/EC).

This document is out of date was withdrawn 14/03/2017

Hydraulic conductivity	A measure of the ability of a material (usually a geological stratum) to transmit water. It is effectively a measure of how well pore spaces are interconnected.
Hydrological cycle	Circulation of the Earth's water in atmosphere, surface water, oceans and groundwater, and their relationship. Also known as the water cycle.
Hyporheic zone	A complex area of enhanced biological and geochemical activity at the interface between groundwater and surface water.
Indirect inputs	These are characterised by the discharge into groundwater after percolation through the soil or subsoil.
Infiltration system	Series of infiltration pipes, placed in either single trenches or one large bed, used to discharge effluent in such a way that it percolates into the disposal area. Also known as a soakaway.
Inputs	Any entry of a substance into groundwater from an activity or discharge, whether accidental or deliberate, point source or a diffuse source, that causes a release of a pollutant into groundwater (source: Water Framework Directive CIS Guidance No. 17).
Intrinsic vulnerability	The vulnerability of groundwater to pollution from activities at the undisturbed ground surface.
Karst	A type of geologic terrace underlain by carbonate rocks where significant solution of the rock has occurred due to the flow of groundwater. Karst often represents areas of significant groundwater flow (often via fissures) and can result in the rapid transmission of pollutants.
Leaching	Removal of soluble substances by action of water percolating through soil, waste or rock.
List I and II substances	The former Groundwater Regulations 1998 specified two lists of dangerous substances (that is, toxic substances that pose the greatest threat to the environment and human health). List I covers those which are particularly toxic, persistent, and which may tend to accumulate in the environment. List II covers substances whose effects are still toxic, but less serious. List I and List II have now been replaced by hazardous substances and non-hazardous pollutants respectively.
LNAPL	Light non aqueous phase liquid Liquids that are immiscible with and less dense than water.
NAPL	Non aqueous phase liquid Liquids that are immiscible with water.
Natural attenuation	Naturally occurring subsurface processes that reduce the mass, toxicity, volume or concentration of organic and inorganic contaminants in both the unsaturated and saturated zones.
Necessary and	Measures where the technical precautions to prevent inputs to groundwater are technically feasible, not

This document is out of date was withdrawn 14/03/2017

reasonable measures	disproportionately costly and are within the control of the operator. In addition any measures taken should result in a net environmental benefit. If there is actual pollution, or a substantial risk of such pollution, remedial measures must be taken. Cost–benefit assessment is not a factor in deciding whether to take action in such cases but may be a consideration in determining which precautions will be imposed as conditions on a permit.
Non-degradable pollutants	Pollutants that do not readily break down.
Non-hazardous pollutant	All pollutants not defined as hazardous.
Perched water table	Water level supported by a low permeability layer above the main water table.
Permeable	A material that will allow the transmission of a fluid.
Permeability	The physical attribute of a material that allows a fluid to flow through it. In geology, usually the ability of a rock to transmit water.
Point source pollution	From a discrete source (for example, petrol station, septic tank, landfill).
Potable water	Water intended for human consumption. Defined as: (a) All water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers; (b) All water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form (source: Directive 98/83/EC). Potable water does not include water that is used for the irrigation of the crops.
Pollutant	Any substance liable to cause pollution (source: Water Framework Directive 2000/60/EC).
Pollution	'The direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land, which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment' (source: Water Framework Directive 2000/60/EC).
Porosity	Ratio of volume of void space to the total volume of the rock.
Precautionary principle	'Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent

This document is out of date was withdrawn 14/03/2017

	environmental degradation' (source: Rio Declaration on Environment and Development, Principle 15).
Principal aquifer	Geological strata that exhibit high permeability and usually provide a high level of water storage. They are capable of supporting water supply on a strategic scale and are often of major importance to river base flow (formerly known as major aquifer).
Prohibition notice	A notice served under section 86 of the Water Resources Act 1991 to prevent or control a discharge of effluent. May also refer to a notice served under EPR to prohibit or control discharges of hazardous substances or non-hazardous pollutants.
Ramsar sites	Internationally important wetland sites adopted from the Convention of Wetlands of International Importance especially as water flow habitats (1971) and ratified by the UK government in 1976.
Recharge water	Water that percolates downward from the surface into groundwater.
Remediation	Restoring good quality by natural or artificial means.
Requisite surveillance	The monitoring of groundwater (as indicated in EPR) and is only part of the monitoring activity that is necessary to ensure that a permit complies with the requirements of EPR. For example, if monitoring of soil and/or the unsaturated zone is to be carried out, this should be under the general requirements for monitoring of the permit rather than the heading of 'requisite surveillance'.
Risk	The consequence(s) of a hazard(s) being realised, and their likelihoods/probabilities (after Defra 2011a)
River augmentation	The use of groundwater to support river flows.
River basin planning	Continuous process of planning to develop river basin management plans for each river basin district, every six years. The Water Framework Directive introduced a formal series of six-year cycles, with the first cycle running from 2009 until 2015.
Safeguard zone	Safeguard zones (SgZs) are one of our main tools for delivering the objectives of the WFD. Member states may establish safeguard zones for those bodies of water identified with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water. Safeguard zones are based on SPZ1 and SPZ2.
Saturated zone	Zone of aquifer where all fissures and pores contain water (that is, below the water table).
Secondary aquifer	A wide range of geological strata with a correspondingly wide range of permeability and storage. Depending on the specific geology, these subdivide into permeable formations capable of supporting small to moderate water supplies and base flows to some rivers, and those with generally low

This document is out of date was withdrawn 14/03/2017

	permeability but with some localised resource potential. (Includes the former minor aquifers but also some of the former non-aquifers).
Septic tank	Small tank receiving and treating sewage by bacteria where effluent overflows. With respect to groundwater, a sewage treatment plant is a septic tank discharging to an infiltration system with or without additional treatment form a package sewage treatment plant (a PTP) or other further treatment such as reed bed.
Source (of abstraction)	Point of abstraction of water (for example, well, borehole, spring).
Source protection zones (SPZs)	• SPZ1 Inner protection zone – 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres around the source. • SPZ2 Outer protection zone – 400 day travel time from a point below the water table. This zone has a minimum radius of 250 or 500 metres around the source depending on the size of the abstraction. • SPZ3 Source catchment protection zone (also referred to as the total capture zone or total catchment) – the area around a source within which all groundwater recharge is presumed to be discharged at the source.
Special area of conservation (SAC)	Areas designated under the EC Habitats Directive (92/43/EEC) for their conservation value. An internationally important site for the conservation of habitats and/or species.
Special protection area (SPA)	An area classified as such under the EC Birds Directive to provide protection to birds, their nests, eggs and habitats: areas that are internationally important sites designated under the EEC Wild Birds Directive.
Specific vulnerability	Considers the nature of the activity under scrutiny and the characteristics of the contaminant that is posing a threat to groundwater and may also consider the removal or bypass of soil or drift and the unsaturated zone, compared to intrinsic vulnerability.
Spring	Natural emergence of groundwater at surface.
Strata	Layers of rock, including unconsolidated materials such as sands and gravels.
Sustainable drainage system (SuDS)	Sustainable drainage systems are a natural approach to managing drainage in and around properties and other developments. SuDS work by slowing and holding back the water that runs off from a site, allowing natural processes to break down pollutants.
Unproductive strata	Geological strata with low permeability that have negligible significance for water supply or river base flow (formerly formed part of the non-aquifers).
Unsaturated zone	Zone of aquifer between soil and water table that is partly saturated (that is, that part of the aquifer above the water

This document is out of date was withdrawn 14/03/2017

	table).
Vulnerability	Considers the nature of the activity under scrutiny and the characteristics of the contaminant that is posing a threat to groundwater and may also consider the removal or bypass of soil or drift and the unsaturated zone, compared to intrinsic vulnerability.
Water cycle	Circulation of the Earth's water in atmosphere, surface water, oceans and groundwater, and their relationship. Also known as the hydrological cycle.
Water protection zones (WPZs)	A regulatory mechanism to address diffuse water pollution and hydromorphological damage that will lead to failure of Water Framework Directive objectives. We will be able to use measures to manage or prohibit activities which cause or could cause damage or pollution of water. Any proposed WPZ will need sign off by the Secretary of State.
Water table	Top surface of the saturated zone within the aquifer.
Wetland	The Ramsar Convention uses a broad definition of the types of wetlands, including lakes and rivers, swamps and marshes, wet grasslands and peatlands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans (see Ramsar site).
Specific yield	Also known as the drainable porosity, specific yield is an indication of the amount of actual groundwater an aquifer can yield.

This document is out of date was withdrawn 14/03/2017

This document is out of date was withdrawn 14/03/2017

Would you like to find out more about us, or about your environment?

Then call us on
03708 506 506 (Mon-Fri 8-6)

Calls to 03 numbers cost the same as calls to standard geographic numbers (i.e. numbers beginning with 01 or 02).

email
enquiries@environment-agency.gov.uk

or visit our website
www.environment-agency.gov.uk

incident hotline 0800 80 70 60 (24hrs)
floodline 0845 988 1188

This document is out of date was withdrawn 14/03/2017

Environment first: Are you viewing this on screen? Please consider the environment and only print if absolutely necessary. If you are reading a paper copy, please don't forget to reuse and recycle if possible.