natural scotland
SCOTTISH GOVERNMENT

SEPA
Scottish Environment Protection Agency

Water use
WAT-PS-10-01

Assigning groundwater assessment criteria for pollutant inputs

Version: 1.0
Released: March 2010

Copyright and legal information

Disclaimer

While every effort has been made to ensure the accuracy of this document, SEPA cannot accept and hereby expressly excludes all or any liability and gives no warranty, covenant or undertaking (whether express or implied) in respect of the fitness for purpose of, or any error, omission or discrepancy in, this document. Reliance on contents is hereof entirely at the user's own risk.

Registered trademarks

All registered trademarks used in this document are used for reference purpose only.

Other brand and product names maybe registered trademarks or trademarks of their respective holders.

Update summary

Version	Description
1.0	First draft for Water Use reference using approved content

Table of contents

1 Key points 4

2 Introduction 8

3 Purpose and scope 9
- 3.1 Purpose 9
- 3.2 Scope 9

4 Background 10
- 4.1 European directives 10
- 4.2 Inputs and discharges 10
- 4.3 Prevent or limit 12
- 4.4 Exemptions 13
- 4.5 Land contamination 13

5 General principles 14
- 5.1 The assessment process 14
- 5.2 Groundwater and groundwater bodies 14
- 5.3 Receptors 15
- 5.4 Assessment limits 16
- 5.5 Capacity 17
- 5.6 Upgradient concentrations 17
- 5.7 Assessment and compliance 18
- 5.8 Compliance and multiple receptors 19
- 5.9 Control measures 20

6 Inputs of hazardous substances 21
- 6.1 Assessment points and assessment limits for inputs of hazardous substances 21
- 6.2 Assessing inputs of radioactive substances 22

7 Inputs of non-hazardous substances 24
- 7.1 Key components 24
- 7.2 Assessment points and assessment lmits for surface, transitional, and coastal water receptors 26
- 7.3 Assessment points and limits for the groundwater resource (eg abstractions) 28
- 7.4 Assessment points and limits for groundwater dependent terrestrial ecosystems 31

8 Glossary 32

Annex 1 Legislative background 34

Annex 2 Determination of a groundwater body 42

Annex 3 Polluting substances 44

Annex 4 Minimum reporting values 45

Annex 5 Limits of detection 48

Annex 6 Resource protection values – non-hazardous substances 49

Annex 7 Resource protection values – land contamination significant pollution 51

9 References 56

1 Key points

This document describes how the requirements of the Water Framework Directive (Directive 2000/60/EC – or 'WFD') to prevent or limit the input of pollutants into groundwater should be applied to assess potentially polluting high risk point sources. For example, large discharges to soakaway of sewage or trade effluents or the percolation of leachate through the basal liner of landfills, where a quantitative assessment is being carried out. The Water Framework Directive (WFD) 'prevent or limit' objective protects groundwater from unacceptable inputs of pollutants at a local scale.

Using this guidance to regulate inputs to groundwater will enable most of the groundwater quality objectives of both the Groundwater Directive and the Water Framework Directive to be achieved.

Following the 'limit' parts of this guidance for inputs from areas of land contamination will allow assessment of compliance of non-hazardous and hazardous substances with the seven measures of significant pollution defined in the Contaminated Land Statutory Guidance.

The principles described in this document are based upon guidance produced by the European Commission for the Water Framework Directive[1] and the UK Technical Advisory Group[2]. The objective of these principles is to derive an assessment point and assessment limit[3] for each identified receptor.

This document is designed to inform how these assessment points and assessment limits are derived. As such, other work elements essential to the regulatory process (see Figure 1) are not covered.

Figure 1: Input regulation

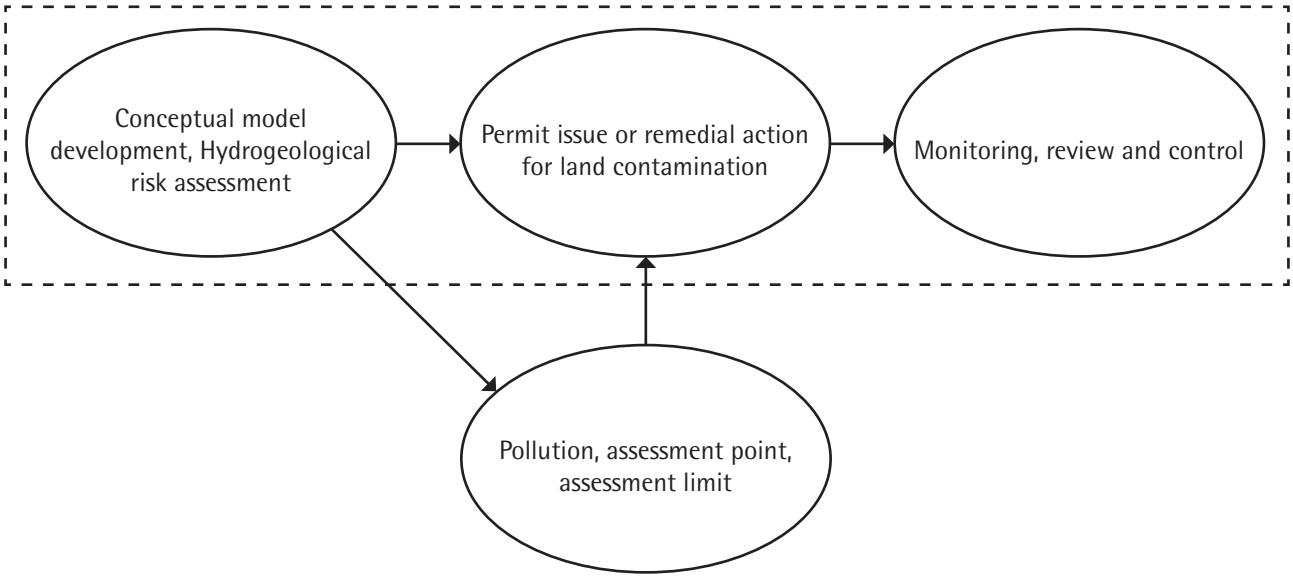
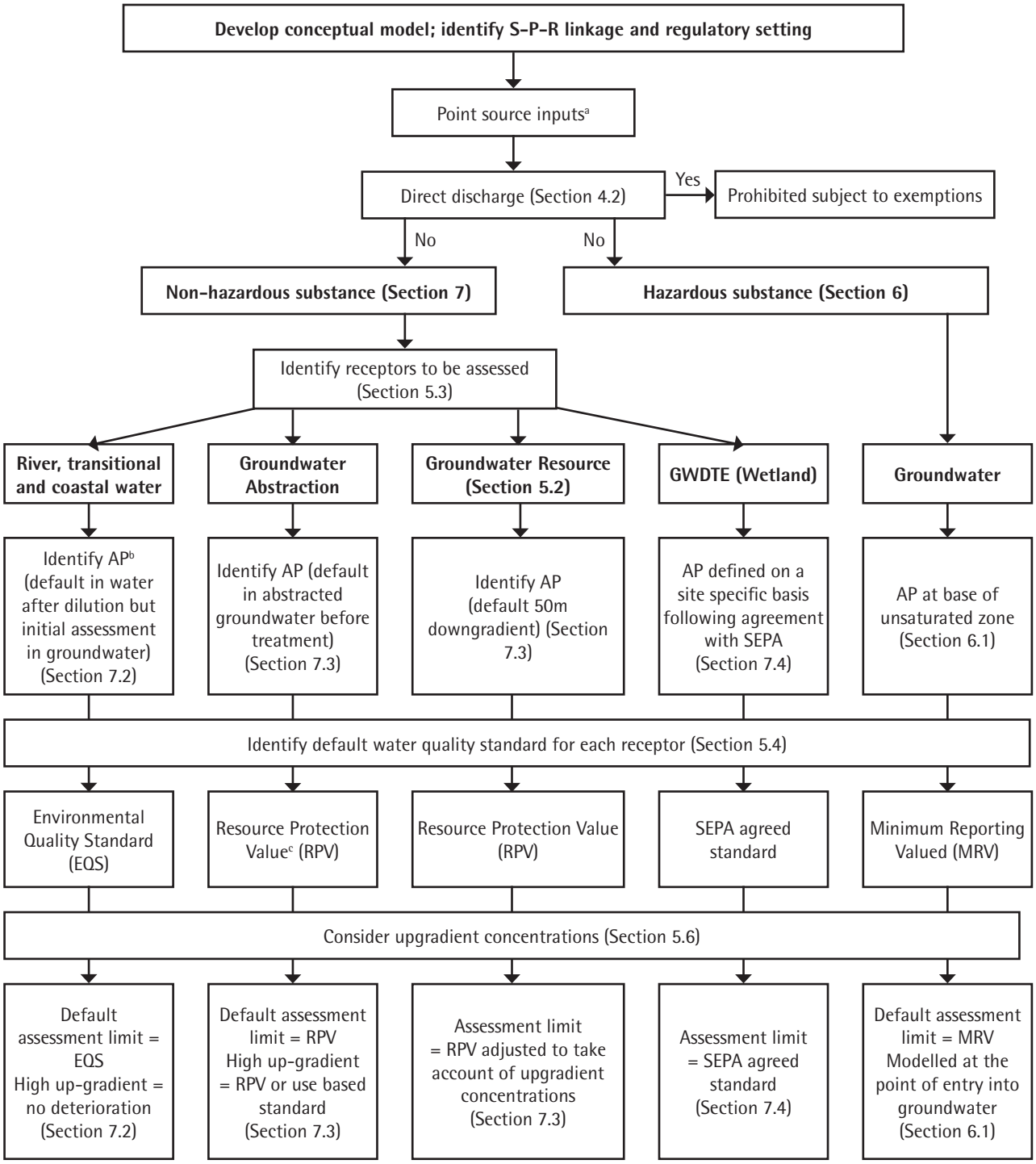


Figure 2 examines the assessment process in more detail and shows how the appropriate assessment point and assessment limit can be derived in any particular case.

[1]Common Implementation Strategy Guidance Document 17, *Guidance on Preventing or Limiting Inputs in the context of the Groundwater Directive 2006/118/EC.*
[2]Technical Report 11 b (iii) *Application of Groundwater Standards to Regulation.*
[3]The meaning of these and other terms used in this guidance is defined in the Glossary.

Figure 2: Assessment process



a These include passive inputs arising from some previous activity, for example inputs from land contamination remediated under Part IIA, planning and voluntary action, and active inputs arising from an ongoing activity, often referred to as a discharge.
b AP = assessment point.
c RPV = Values derived from human health risk based standards.

Please note that the flow chart is intended only to explain the approach that SEPA will follow when setting assessment points and assessment limits for inputs to groundwater for achieving 'prevent or limit' requirements. It does not describe the approach used to assess significant pollution for contaminated land, or define the regulatory and decision-making process. Specific guidance relating to regulatory regimes is available on the Water Manual.

Diagrams 3, 4 and 5 on the following pages illustrate the important points described in detail in the text.

Figure 3

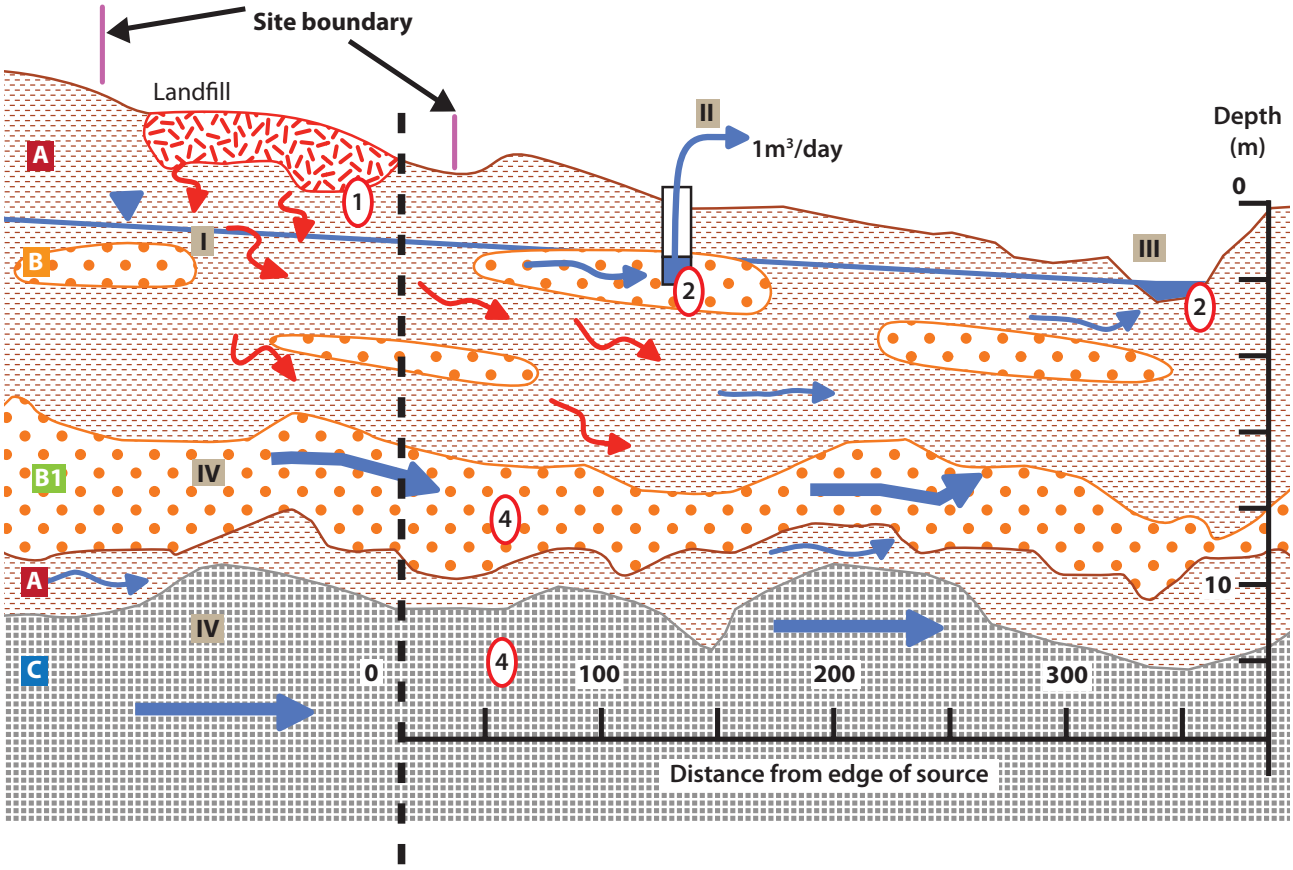


Figure	Pollutant	Receptor	Assessment point	Default assessment limit	Comment
3	Hazardous	Groundwater (I)	Base of unsaturated zone	Minimum reporting value (1)	The silts (A) and gravel lenses (B) have been demonstrated not to be capable of supplying 10m³/day or investigations undertaken to demonstrate this. Unit C is a bedrock aquifer and is consequently capable of supplying 10m³/day. Geological units B1 and C therefore have potential future resource value and must be regarded as receptors. When assessing the impact on the groundwater resource, the resource protection value is increased to take account of upgradient groundwater concentrations.
	Non-hazardous	Domestic groundwater abstraction (II)	Raw water	Resource protection value (2)	
		Surface water (III)	In surface water after dilution	Environmental quality standard (3)	
		Groundwater resource (IV)	In strata B1 and C 50m from source boundary	Resource protection value increased to take account of upgradient concentrations (4)	

Figure 4

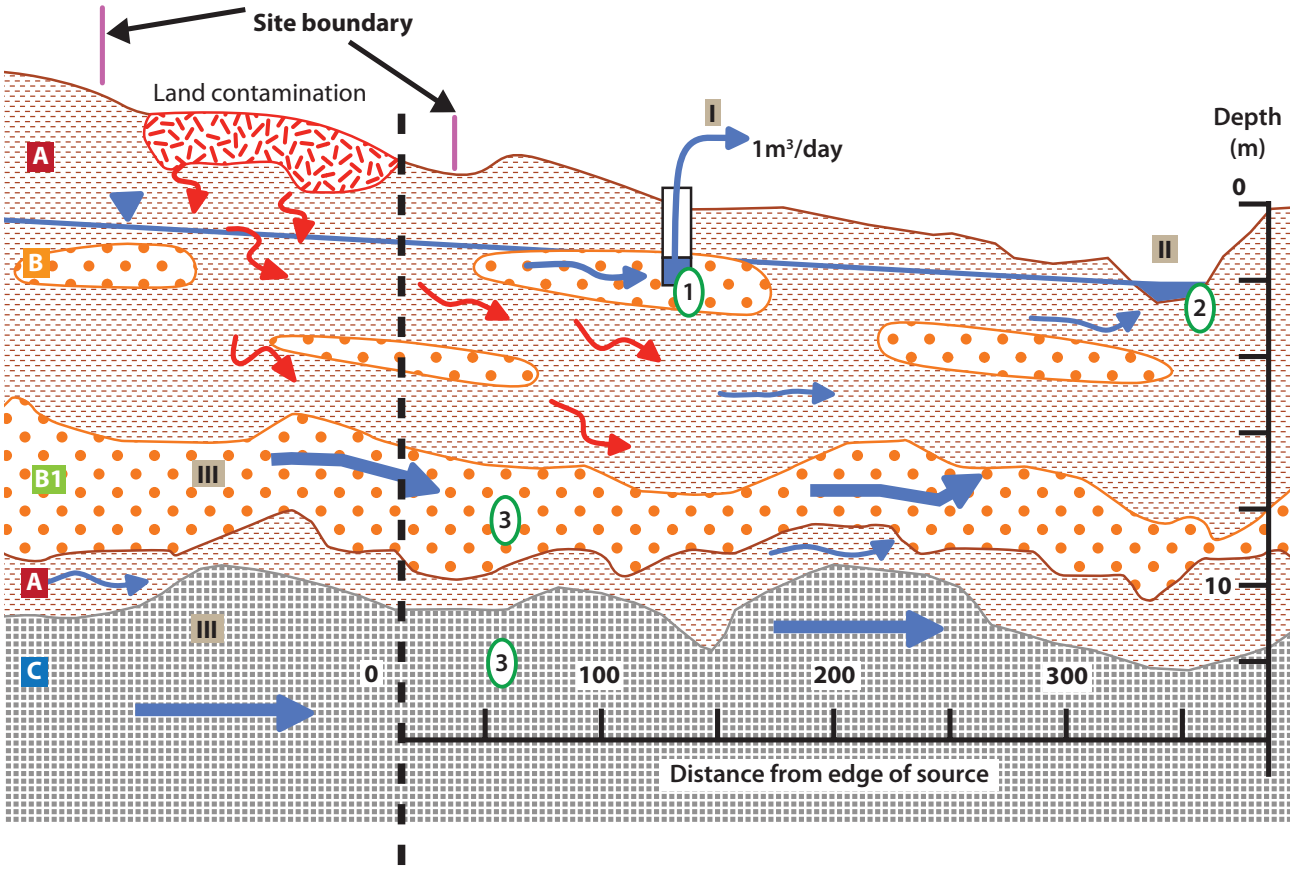


Figure	Pollutant	Receptor	Assessment point	Default assessment limit	Comment
4	Hazardous and non-hazardous	Current abstaction (I)	Raw water	Resource protection value (1)	The geology and resource potential of the geological units are the same as in the previous example.
		Surface water (II)	In surface water after dilution	Envrionmental quality standard (2)	The source is land contamination from a historic activity. Assessment is therefore for significant pollution.
		Groundwater resource (III)	In strata B1 and C 50m from source boundary	Resource protection value increased to take account of upgradient concentrations (3)	When assessing the impact on the groundwater resource, the resource protection value is increased to take account of upgradient groundwater concentrations.

Figure 5

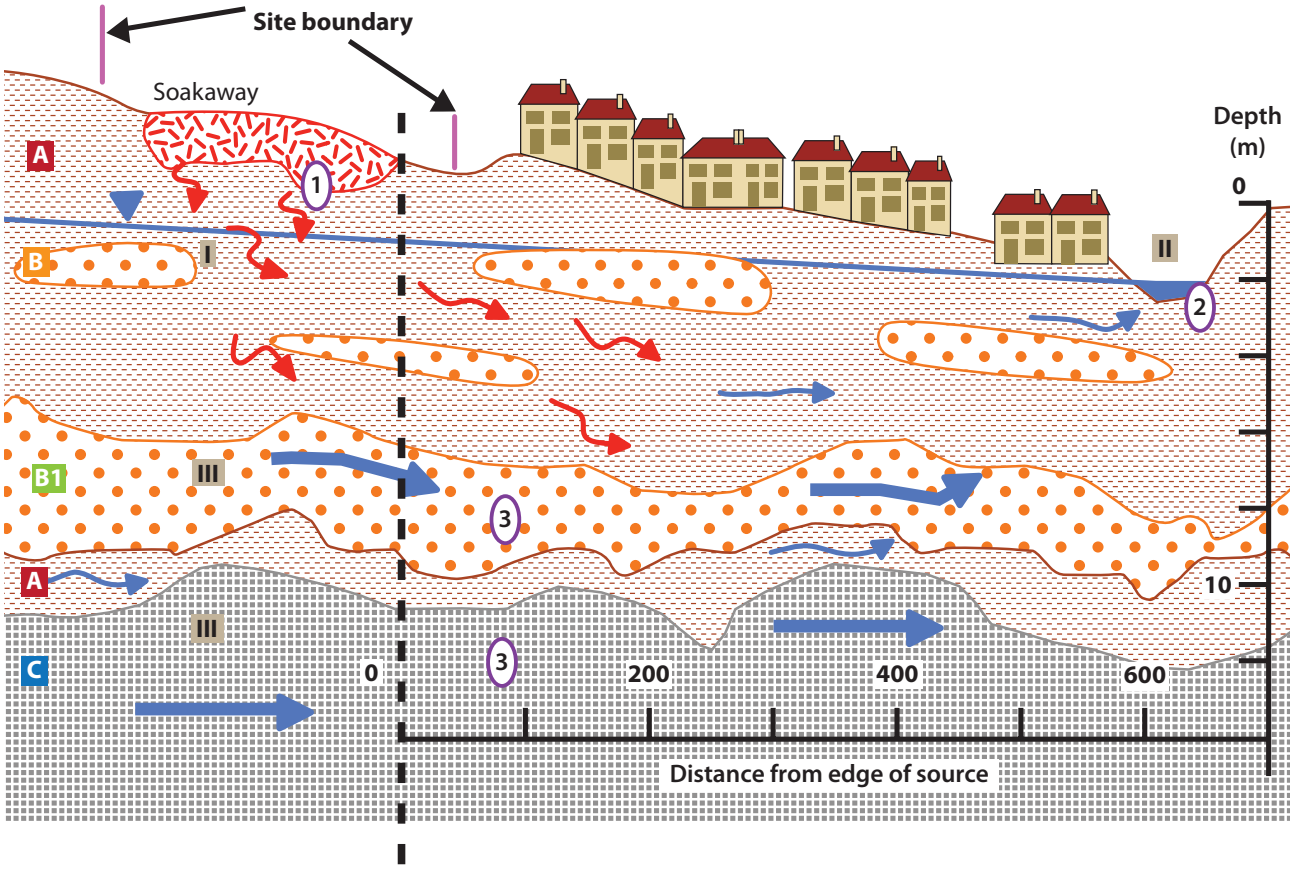


Figure	Pollutant	Receptor	Assessment point	Default assessment limit	Comment
5	Hazardous	Groundwater (I)	Base of unsaturated zone	Minimum reporting value (1)	The geology and resource potential of the geological units are the same as in the previous example. The source is a new activity regulated by SEPA, eg a soakaway discharge of sewage effluent for more than 100 people equivalent (PE). In this case, present land use (housing development) limits the exploitation of the resource for the foreseeable future and the assessment point plan can be up to 250m from the source (note the change in horizontal scale). When assessing the impact on the groundwater resource the resource protection value is increased to take account of upgradient concentrations.
	Non-hazardous	Surface water (III)	In surface water after dilution	Environmental quality standard (2)	
		Groundwater resource (III)	In strata of B1 and C at a maximum distance of 250m from source boundary	Resource protection value increased to take account of upgradient concentration (3)	

2 Introduction

SEPA is the responsible body for most regulatory regimes dealing with inputs of pollutants to groundwater. Where pollutant linkages to the water environment are identified, SEPA is also a consultee for the assessment and remediation of contaminated land through the Development Control and Part IIA regimes, for which local authorities are the competent authority. In the case of designated Special Sites, regulatory responsibility under Part IIA falls to SEPA.

This position statement describes site specific assessment criteria and the way in which SEPA will assign them to high risk groundwater pollutant inputs in a consistent and logical way. The interpretation described here also ensures that, for those regulatory regimes where groundwater quality is, or may be, affected by inputs of polluting substances from point sources, the objectives of relevant European directives are achieved, in particular the requirement of the Water Framework Directive (WFD[4]) to prevent or limit the input of pollutants into groundwater. An explanation of the requirements of the relevant directives and the way that Scots Law interacts with them is given in Annex 1.

[4]Directive 2000/60/EC, establishing a framework for community action in the field of water policy.

3 Purpose and scope

3.1 Purpose

The purpose of this document is to provide guidance on how to allocate, in a consistent and transparent manner, assessment points and appropriate assessment limits when considering **point source** inputs of pollutants into groundwater.

This position statement provides advice on how SEPA will decide the acceptability or otherwise of point source inputs of potentially polluting substances into groundwater regulated by:

- The Pollution Prevention and Control (Scotland) Regulations 2000 (as amended) (PPC);
- The Landfill (Scotland) Regulations 2003;
- The Radioactive Substances Act 1993 (as amended) (RSA);
- The Contaminated Land (Scotland) Regulations 2000 (as amended) (CLR);
- The Waste Management Licensing Regulations 1994 (as amended) (WML);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (as amended) (CAR);
- Planning and Development Control Regime as regulated by the Town and Country Planning Act 1990 (as amended), where SEPA is controlling or influencing at the risk assessment stage.

This position statement is primarily aimed at SEPA's regulatory and science staff involved in reviewing groundwater quality risk assessments or setting rules and conditions for authorisations. However, it is expected that the guidance will also be used by local authorities and other environmental professionals when preparing or reviewing such assessments.

3.2 Scope

SEPA regulates point source inputs to groundwater on the basis of potential impact. The principles described in this position statement apply particularly to those sites where the risk of impact is high.

We will expect a detailed quantitative groundwater quality risk assessment to be undertaken based upon the principles of input assessment described in this document for point source inputs requiring:

- A licence under CAR, or;
- A permit under PPC, or;
- A licence under WML, or;
- An authorisation under RSA.

We will review current, and bring forward further, guidance explaining how lower risk activities, such as small sewage discharges, should be assessed to meet the requirement of the WFD to prevent or limit the input of pollutants to groundwater, using the principles described in this document.

Local authorities are the competent authority for land contamination, where the standard of remediation is determined by statutory guidance[5]. The limit principles described in this position statement may be used by local authorities to determine if 'significant pollution' is occurring.

When dealing with existing sources, we may seek to prevent or limit inputs over an appropriate and reasonable timetable, taking into account the risks posed by the inputs and the costs and technical challenges of preventing or limiting them when prioritising action.

We may also seek alternative means of preventing inputs than by the exercise of our powers where:

- we consider there to be a more cost-effective means of achieving the objective;
- exercising our powers would impose significant burdens; and
- the burdens would be significantly greater than those resulting from the alternative means.

This may be the case where a product control could be introduced to remove an existing source of inputs.

[5] *Environment Protection Act 1990: Part IIA Contaminated Land Statutory Guidance: Edition 2*, Scottish Government, 2006.

4 Background

4.1 European directives

The WFD sets out a framework for protecting and, where necessary, improving the status of the water environment. In order to prevent pollution, the directive requires Member States to introduce measures that prevent the entry of hazardous substances and limit the input of non-hazardous substances to groundwater. The WFD also prohibits the direct discharge of all pollutants, with certain limited exceptions. Article 6 of the Groundwater 'Daughter' Directive (Directive 2006/118/EC) provides details of how the 'prevent' and 'limit' provisions of the WFD should be implemented.

The Groundwater Directive (Directive 80/68/EEC – or 'GWD') also requires Member States to prevent or limit the entry of certain substances into groundwater. The directive's annex contains two lists: the direct or indirect discharge to groundwater of substances in List I must be prevented (except under very limited and well defined circumstances), and the discharge of List II substances into groundwater must not cause pollution. The Groundwater Directive will be revoked in 2013.

Reconciliation of the 'prevent' or 'limit' objectives of both directives is described in Annex 1. These directives have been transposed into Scots Law through the Water Environment and Water Services (Scotland) Act 2003 (WEWS) and the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) – as amended by the Groundwater and Priority Substances(Scotland) Regulations 2009.

4.2 Inputs and discharges

4.2.1 Inputs

Inputs of pollutants are defined by the Groundwater 'Daughter' Directive ('GWDD) as the direct or indirect introduction of pollutants into groundwater as a result of human activity. The term applies to diffuse sources and point sources. In this document only point source inputs are considered.

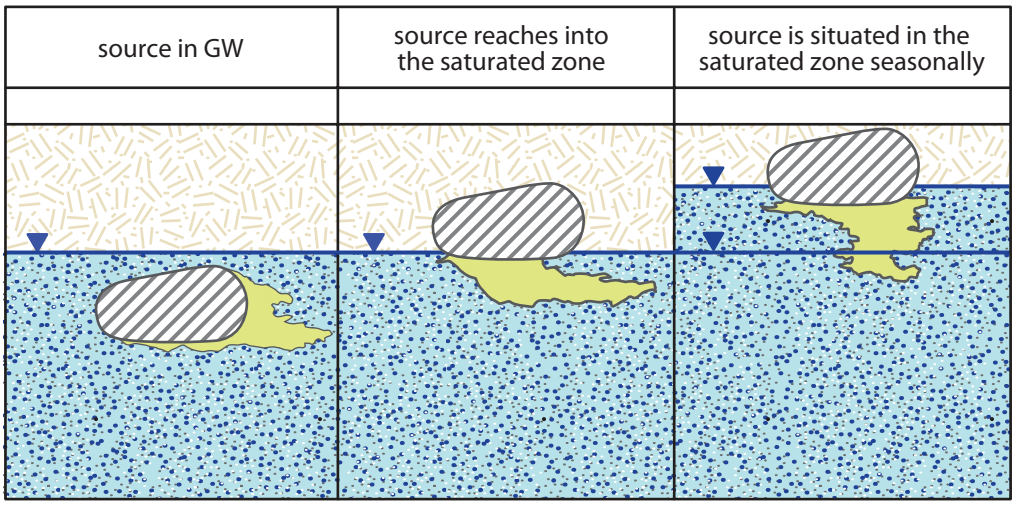
Inputs may also be conveniently divided into three categories:

- **Active inputs** are those resulting from an ongoing activity, even where the activity is a series of separated events, for example inputs arising from septic tank drainage fields, or disposal of waste sheep dip to land.
- **Passive inputs** are those resulting from some previous activity that has now ceased, for example an input from land contamination or from a landfill site no longer under regulatory control.
- **Accidental inputs** are those arising as a result of an unintended activity that initially gives rise to an active input, but which eventually produces a passive input.

A direct input is one that has one or more of the following properties:

- It bypasses the unsaturated zone, or;
- It has its source in the saturated zone, or;
- It has its source in the unsaturated zone but seasonal fluctuations in the water table mean that the source will be in direct contact with groundwater from time to time (see Figure 6).

Figure 6: Direct inputs

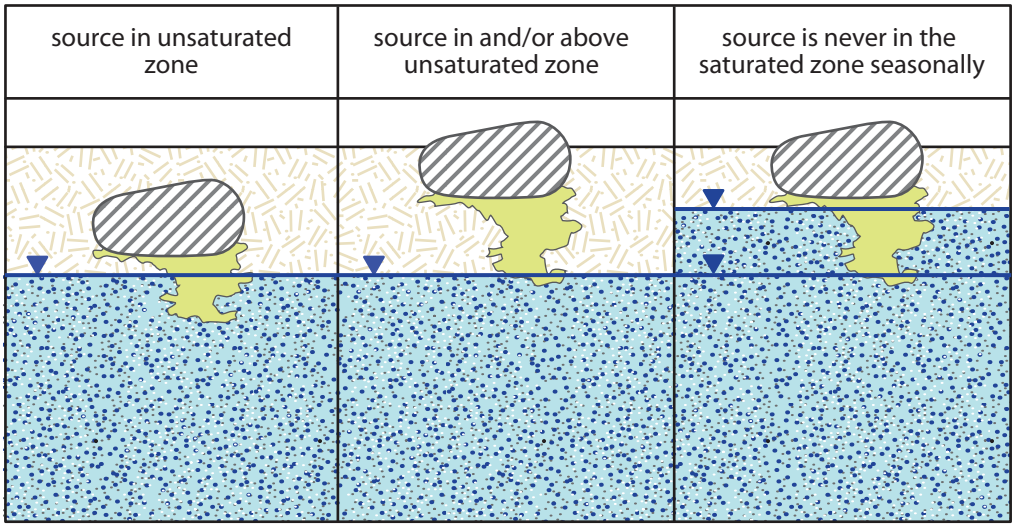


Taken from CIS Guidance Document 17

An indirect input is one that:

- percolates through the unsaturated zone, or;
- has its source wholly in the unsaturated zone, even during seasonal fluctuations in the water table (see Figure 7).

Figure 7: Indirect inputs



Taken from CIS Guidance Document 17

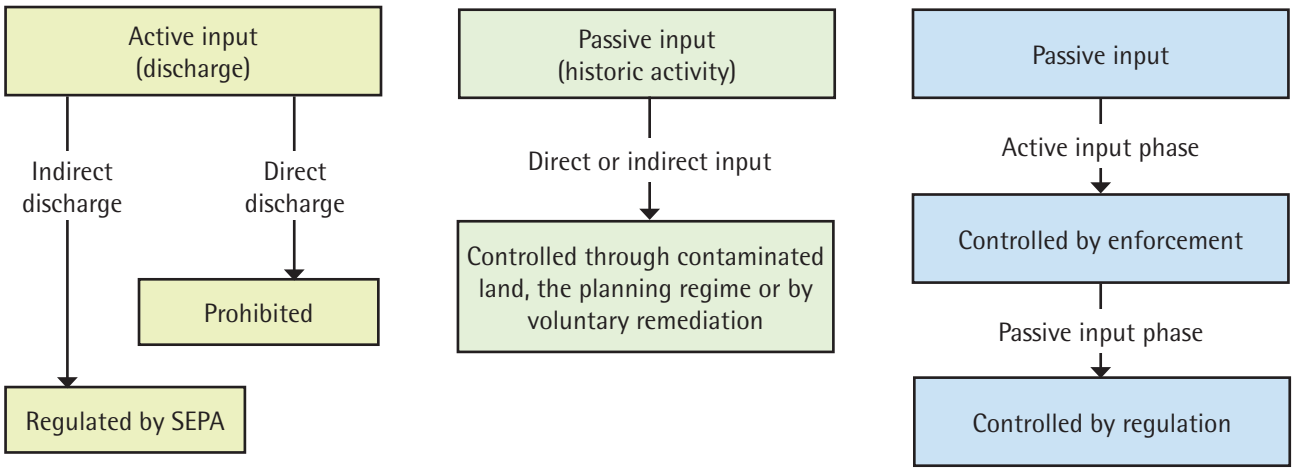
4.2.2 Discharges

For regulatory purposes SEPA considers discharges as representing active inputs arising from point sources. Thus, inputs from septic tank drainage fields or from landfill sites under regulatory control are discharges, whereas inputs arising from the use of agricultural pesticides are inputs but not discharges.

Article 11 (3) (j) of the WFD is a specific ban on all direct discharges of pollutants into groundwater; that is, direct discharges of both hazardous and non-hazardous substances are prohibited. The exemptions contained in the subsequent paragraphs of the article allow authorisation in certain circumstances. As described in Annex 1 A.1.3, these circumstances are generally self evident, but a direct discharge authorised in this way must not compromise the environmental objectives established for that body of groundwater.

Figure 8 may aid understanding of how we distinguish between different types of input.

Figure 8: Active, passive and accidental inputs



4.3 Prevent or limit

The Groundwater Directive (GWD) requires discharges of List I substances to be prevented, and discharges of List II substances to be limited to prevent pollution.

Article 6 of the Groundwater 'Daughter' Directive (GWDD) requires that inputs of hazardous substances are prevented, and that inputs of non-hazardous substances are limited to prevent pollution.

The concept of dividing substances into separate groups depending on their properties is based on the consideration that some substances are so hazardous that all practical and reasonable measures must be taken to prevent them entering the water environment.

4.3.1 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 giving rise to an equivalent level of concern'.

List I substances of the GWD have a high risk of toxicity, persistence, or bio-accumulation.

On this basis, the UK TAG[6] Groundwater Task Team and SEPA consider that List I substances and hazardous substances are equivalent. This document will generally use the term 'hazardous substances', but the same rules apply to point source inputs of List I substances.

The Joint Agency Groundwater Directive Advisory Group (JAGDAG) has produced a list of substances that have been assessed as meeting the criteria for List I substances. SEPA will take the JAGDAG list as the starting point for the identification of hazardous substances. A link to the GWD and to the list of hazardous substances may be found in Annex 3.

SEPA has adopted a position that, if the concentration of a hazardous substance in a discharge is less than the MRV[7], the input is regarded as automatically meeting the Article 2 (b) 'de-minimus' requirement of the GWD and exemption 6 (3) (b) of the GWDD.

The WFD also requires that specific measures are adopted against the pollution of surface water by individual pollutants or groups of pollutants. To this end the Priority Substances Directive (PSD)[8] identifies 33 priority substances for which measures must be taken by Member States to reduce pollution. Environmental Quality Standards for different surface waters have been produced for these substances. These should be applied to surface water receptors.

[6]United Kingdom Technical Advisory Group, a partnership of UK and Ireland environment and conservation agencies set up to interpret and support the implementation of the WFD.
[7]Minimum Reporting Value, as defined by the Environment Agency in Appendix 7 of *Hydrogeological Risk Assessments for Landfills*, LFTGN01, 2003.
[8]Directive 2008/105/EC on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council.

In addition the PSD identifies 20 of these priority substances or groups of substances for which Member States should cease or phase out discharges, emissions, and losses (priority hazardous substances). SEPA has developed a policy position regarding a progressive reduction in surface water inputs of these substances. This should be taken into consideration when assessing inputs to groundwater where surface water is a receptor.

4.3.2 Non-hazardous substances

The GWD requires that entry of List II substances must be limited to avoid pollution.

The GWDD requires that inputs of non-hazardous substances be limited to avoid deterioration. UK TAG guidance equates deterioration with pollution. Non-hazardous substances are all substances not classified as hazardous. The GWDD requirement is the one adopted by SEPA as, applying to more substances, it is more stringent than that of the GWD.

Non-hazardous substances include those families and groups of substances presented in List II of the annex to the GWD and all other non-listed substances, including those which have been classified outside Lists I and II by JAGDAG.

SEPA will use the families and groups of substances identified in points 7 – 12 of Annex VIII of the WFD and those substances classified outside List I by JAGDAG as the starting point for identification of non-hazardous substances.

Annex 3 contains a list of hazardous and non-hazardous substances most commonly found to be entering groundwater or causing pollution.

4.4 Exemptions

The broadening of controls on pollutant inputs by the GWDD is balanced by a set of exemptions in Article 6 (3). These are not exemptions from the requirement to prevent or limit, but rather exemptions from all measures required to achieve prevent or limit; that is, instances when all measures need not be applied. Annex 1 Section A1.4.0 contains SEPA's interpretation of these exemptions.

SEPA considers that application of the GWDD exemptions in conjunction with the application of the approach adopted in this document will provide a fair and balanced outcome for operators and the water environment.

Article 4 of the WFD also contains exemptions which may, in certain circumstances, complement or extend those of Article 6.

4.5 Land contamination

Land contamination is currently regulated by local authorities through the application of Part IIA of the Environment Protection Act (1990), and the procedure for determination and remediation is explained in the statutory guidance[9]. In certain circumstances the responsibility for regulating a site (Special Sites) may be passed to SEPA.

Local authorities also use the principles of Part IIA and the statutory guidance to ensure that contamination dealt with through the planning regime is remediated to a standard that will ensure that the site will not be determined as contaminated land under Part IIA at some future time.

The statutory guidance describes how the effects of land contamination on human health and the environment should be assessed to determine the risk (or significant possibility of risk) of significant harm or of significant pollution.

Application of the principles described in Sections 5 and 7 of this position statement will allow consistent assessments of significant pollution (or a significant possibility of significant pollution) to be made.

[9] *Environment Protection Act 1990: Part IIA Contaminated Land Statutory Guidance: Edition 2,* Scottish Government, 2006.

5 General principles

5.1 The assessment process

The generally accepted procedure for assessing risks from potentially polluting inputs is to use the concept of source-pathway-receptor, where a source and a receptor are linked by a pathway of some kind.

The movement of a substance in the subsurface varies according to the physical and chemical characteristics of the substance and of the geological strata.

The development of a conceptual model[10] will inform the decision of the existence of, and linkage between, these components and the factors that might affect the fate and transport of the input. Factors that must be considered include:

- properties of the source;
- unsaturated and, if required, saturated zone migration and attenuation;
- receptors that could be affected;
- where the potential impact will be assessed;
- what assessment limit to use.

Several documents describe how modelling and data collection processes interact and can be developed. These include:

- WAT-RM-28, *Modelling methods for groundwater abstractions*, SEPA 2006. Whilst developed for the groundwater abstraction regime, this methodology can also be used for groundwater quality models.
- *Hydrogeological Risk Assessments for Landfills and the Derivation of Control and Trigger Levels*, SEPA 2004 (under review). Developed for the landfill regime, Section 4 of this document contains useful information.
- *Guide to Good Practice for the Development of Conceptual Models and Application of Mathematical Models of Contaminant Transport Processes in the Subsurface*, EA, 2001. This document concentrates on the development of the conceptual model in preparation for contaminant fate and transport mathematical modelling and describes the various types of mathematical model available.

5.2 Groundwater and groundwater bodies

The WFD and GWD define groundwater as 'all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil'. This definition has no size limit, so even small volumes of water in the subsurface are considered as groundwater if the ground or subsoil are saturated.

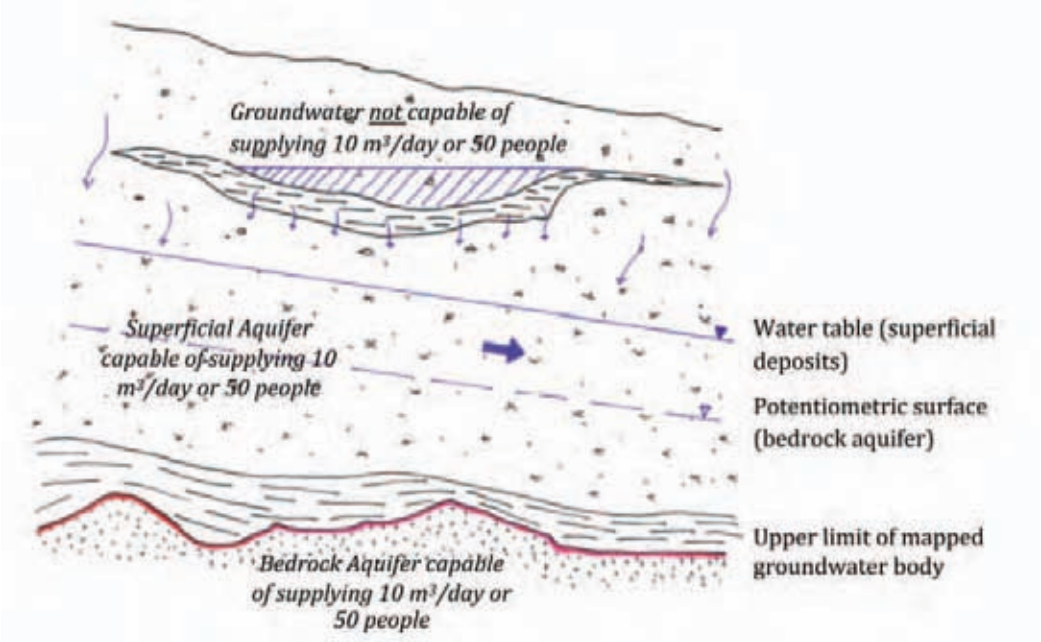
The WFD uses the term 'body of groundwater' and sets a number of objectives for it, including the requirement to protect the present and future resource potential.

UK TAG has determined that, to qualify as a body of groundwater, an aquifer must be capable of supplying 10 m^3/day or 50 people (on a continuous basis) and that such aquifers have future resource value which must be protected.

These two definitions (groundwater and body of groundwater) mean that groundwater can therefore occur **within** an aquifer fulfilling the UK TAG criteria and in other less productive geological strata, for example small volumes of groundwater within deposits such as silty sand overlying a recognised aquifer (see Figure 9).

[10]In this context, a conceptual model, in general terms, is the identification of the process and/or processes which cause groundwater movement together with the major limits and boundaries on these processes.

Figure 9: Groundwater and groundwater bodies



For WFD characterisation purposes, SEPA has mapped all bedrock aquifers and some extensive sand and gravel aquifers as groundwater bodies. These by definition are capable of providing 10m^3/day or supplying 50 people. These groundwater bodies underlie the whole mainland of Scotland and many islands. Other more localised aquifers have not been mapped as groundwater bodies due to their inherent variability and a lack of information. The presence of these more localised aquifers can only be determined using site specific data.

When making regulatory decisions, it is important to distinguish whether or not the groundwater occurs within an aquifer meeting the UK TAG criteria as it has direct relevance for:

- **the need to protect the future resource potential of the groundwater and,**
- **the setting of assessment points and associated assessment limits (see Section 6 and 7).**

There is a requirement to prevent the entry of hazardous substances into **all** groundwater, regardless of whether or not it has future resource value. Whether or not groundwater forms part of an aquifer meeting the UK TAG criteria is only relevant for inputs of non-hazardous substances, so when assessing inputs of these substances:

- groundwater meeting the 'groundwater body' criteria requires protection as a long term resource for human use and will have an assessment point; and
- groundwater not meeting the 'groundwater body' criteria requires protection only as a pathway to other dependent receptors and will not have an assessment point.

This groundwater body concept should also be used to determine if inputs from contaminated land are causing significant pollution. Annex 2 includes details of how to determine which group groundwater, encountered during a site investigation, belongs.

5.3 Receptors

The Water Framework Directive (WFD) identifies a number of receptors that may be impacted by inputs to groundwater. They are:

- surface waters;
- transitional waters;
- coastal waters;
- present and future human uses of groundwater (eg abstractions);
- groundwater dependent terrestrial ecosystems (wetlands).

SEPA considers that groundwater pollution will be prevented if these receptors are protected; that is, groundwater quality does not exceed a relevant assessment limit at an assessment point.

In addition, the WFD requires that inputs should not cause harm to material property, amenities, and other legitimate uses of the water environment. SEPA considers that these objectives will be met by protecting the receptors identified above.

5.4 Assessment limits

Assessment limits protect groundwater from inputs of hazardous and non-hazardous substances. They represent the maximum concentration of a substance that should be present at the assessment point, unless an exemption to prevent or limit has been applied. They are derived from a combination of a relevant water quality standard and the quality of the receiving water and, hence, the groundwater's capacity to accept the substance.

For hazardous substances, assessment is made at the entry point into groundwater but before dilution. The default assessment limit applied at the assessment point will be the Minimum Reporting Value (MRV)[11] of the substance or, where an MRV is not available, will be an agreed Limit of Detection (LoD) for the substance in question. Annex 5 contains an agreed list of LoDs.

In order to protect key receptor types from harm, all non-hazardous substances are assessed at a point some distance from the source (the 'assessment point'). The assessment limit applied at the assessment point is determined by selecting the most appropriate water quality standard for the substance and the receptor and considering the prevailing up-gradient concentration (see Section 5.6).

The non-hazardous substance approach can also be used to determine if inputs from land contamination are causing significant pollution.

Only water quality standards relevant to the receptor should be used. Standards that may be applicable include:

- Environmental Quality Standards (EQS) for the protection of aquatic life;
- water quality standards for saline waters required to support fish or shellfish;
- water quality standards for fresh and saline waters used for bathing or contact water sports;
- EC water quality standards;
- World Health Organisation (WHO) *Guidelines for Drinking Water Quality*, 1984;
- European Council Directive 98/83/EC on the quality of water intended for human consumption;
- standards taken from the Water Supply (Water Quality) (Scotland) Regulations 2001, or the Private Water Supplies (Scotland) Regulations 2006;
- the US EPA National Primary Drinking Water Regulations.

This list is for general guidance only and care should be used when applying any of these for specific purposes. It may be necessary to refer back to the original source of the data for qualifying/clarifying purposes. Care should be taken that any standard used is fit for purpose, for example a standard developed to protect ecosystems should not be used to protect human uses or vice versa.

Standards are not simply numbers; they are invariably associated with temporal, spatial and concentration criteria. They are sometimes expressed as an absolute value, for example, the maximum acceptable concentration (MAC), or an average, for example, the annual average concentration (AA), and sometimes both. In some cases the standard will not be a concentration, for example, conductivity, or may be specified as a minimum or minimum and maximum, for example pH.

[11]MRVs are based on a set of values published by the Environment Agency (EA) and are the concentration above which contaminant loading should not occur. SEPA has listed these MRVs in Annex 4.

5.5 Capacity

Capacity defines the capability of a water body to assimilate pollutants. In general it represents the difference between the actual quality of the receiving water and the relevant water quality standard. If capacity is not exceeded the groundwater should not become polluted and there should be no significant and sustained increasing trends or deterioration of status.

Except for particular circumstances (see Section 5.6), if there is no remaining capacity a point source input must prevent any increase in concentration of the substance in the receiving water. For point source inputs into groundwater, capacity applies only to non-hazardous substances, as inputs of hazardous substances must be prevented.

5.6 Upgradient concentrations

In some cases the presence of poor upgradient groundwater quality will raise issues. This may result in further examination at an area, regional or groundwater body scale to assess the nature, scale, and source(s) of groundwater contamination present. This is, however, a separate issue to the site specific regulatory process.

Where upgradient sources causing non-compliant concentrations of substances are identified, SEPA will, where possible, seek to limit them by introducing control measures for SEPA-regulated activities, or by influencing regulatory bodies capable of introducing control measures on activities not regulated by SEPA, for example land contamination.

SEPA has adopted the following approach to assessing inputs where upgradient concentrations are elevated:

Where the receptor is the groundwater resource:

Where groundwater concentrations are elevated upgradient of a site, SEPA will set an assessment limit of the resource protection value (RPV)[12] increased by the up-gradient groundwater concentration (allowing for any attenuation there may be between the upgradient and assessment points). This allows a site to contribute a loading equivalent to the RPV at the assessment point on top of any high concentrations that are present upgradient.

The calculation of this limit recognises the presence of pollutants upgradient of a site and theoretical, or actual, contaminant loadings from the site in line with the system capacity for attenuation between the contaminant source and the assessment point.

SEPA is adopting this approach because it would be unreasonable to restrict new inputs or insist on remediation of land contamination resulting from activities which are not the responsibility of the operator/owner, for example high upgradient groundwater concentrations caused by an adjacent site, diffuse pollution, or poor natural groundwater quality.

Note: There is a UK TAG project underway to examine cumulative impacts. The approach described above may be modified in the future as a result of the findings of this project.

Where the receptor is a current abstraction:

Where groundwater concentrations are elevated upgradient of a site and there is an abstraction currently in use which could be impacted, the assessment limit should prevent an increase in the level of treatment of the abstraction.

This means that the concentration of a substance in the abstracted raw water depends on the quality of water required by the user. For example, if an abstraction is for drinking water purposes and the current groundwater quality is such that the only treatment applied is filtration and disinfection, the input must be controlled so that, in combination with upgradient concentrations, treatment will not be required to provide drinking water (that is, the RPV will be applied irrespective of the upgradient concentration). Similarly, if an abstraction is for drinking water purposes and current groundwater quality is such that treatment is needed to provide water of drinking water quality, the input must be controlled so that the treatment applied will not be increased. This will mean that no further deterioration in quality will be possible, that is, the groundwater has no further dilution capacity.

[12]The RPV that SEPA will use for many of the common non-hazardous groundwater contaminants is listed in Annex 6. This list is based on risk assessments of substances identified as presenting a risk to human health. For assessments of significant pollution only additional RPVs may be found in Annex 7

Where the receptor is surface water:
In setting an assessment limit for surface water, the overall objective is to ensure that the surface water meets the environmental quality standard (EQS) of the substance or substances in question. In order to achieve this, consideration must be given to any dilution capacity that might be available in the groundwater and the surface water. Further details of this process are given in Section 7.2.

Where site-specific evidence can be provided that the surface water EQS is below natural groundwater background concentrations in the vicinity of the site, then the assessment limit should be set on the basis of natural background; that is, there should be no further deterioration in quality of the surface water.

Where the receptor is a wetland:
There are currently no EQS to protect wetlands. Assessment limits will therefore be derived on a site-specific basis in co-operation with other relevant organisations, such as Scottish Natural Heritage (SNH).

5.7 Assessment and compliance

An 'assessment point' may be defined as 'the point at which an appropriate assessment limit should be met'. It may be **real** or **virtual**; that is, it may represent a real borehole from which groundwater samples can be obtained, or a virtual borehole at a real location where the concentration of the polluting substance may be deduced from information on the fate and transport process. **The distance to the assessment point is measured from the downgradient boundary of the source.**

A 'compliance point' is defined as a real sampling point used to demonstrate that the compliance regime is likely to be met, and the input is acceptable. A compliance point may be at the same location as the assessment point or elsewhere along the downgradient flowpath between the source and the receptor as necessary, in order to provide timely protection to a receptor and/or for the convenience of the operator. More than one compliance point may be required to protect all receptors.

The position of the compliance point may vary **laterally and vertically** depending upon:

- the depth of the groundwater resource (or other localised aquifer) below the site;
- the type of ecosystem or abstraction receptor;
- the groundwater flow regime;
- the depth and dimensions of the contaminant plume

A compliance point must be capable of providing groundwater samples representative of the highest concentration of the substance under investigation at that particular distance from the source. (In some cases it may be possible to make allowances for offset from this point when calculating compliance concentrations, although this is not recommended unless no better location is available.)

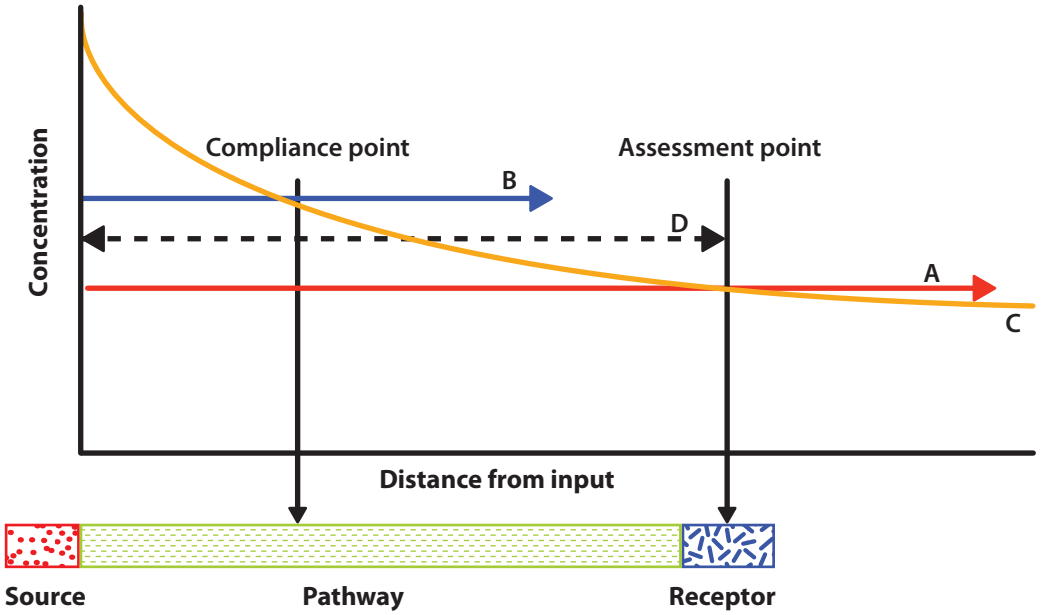
Compliance concentrations required to prevent pollution at the receptor can be derived by back-calculation using:

- the prevailing hydrogeological conditions;
- the distance of the compliance point from the assessment point; and
- the assessment limit derived from the standard appropriate for the receptor and the up-gradient concentration (where appropriate).

Assessment of regulatory compliance will usually consist of comparison of a statistic (such as a mean, 95%ile, or an absolute limit and a time period over which compliance is assessed) against the appropriate compliance concentration. Given the potentially transient nature of both upgradient groundwater conditions and the contaminant loading imposed by a site, SEPA places considerable emphasis on trend assessment studies. The latter are required to develop time-based relationships that both inform the need to readjust compliance concentrations and identify/track issues with site management/controls which, unless rectified, could result in pollution occurring.

The relationship between assessment limits, assessment points, and compliance points is illustrated in Figure 10.

Figure 10: Assessment and compliance points



A = Concentration of **assessment limit**
B = **Compliance concentration**, set to ensure the assessment limit is met at the assessment point
C = Concentration of input
D = Possible range of compliance points according to specific site conditions - could be at the assessment point, or some other point along the pathway

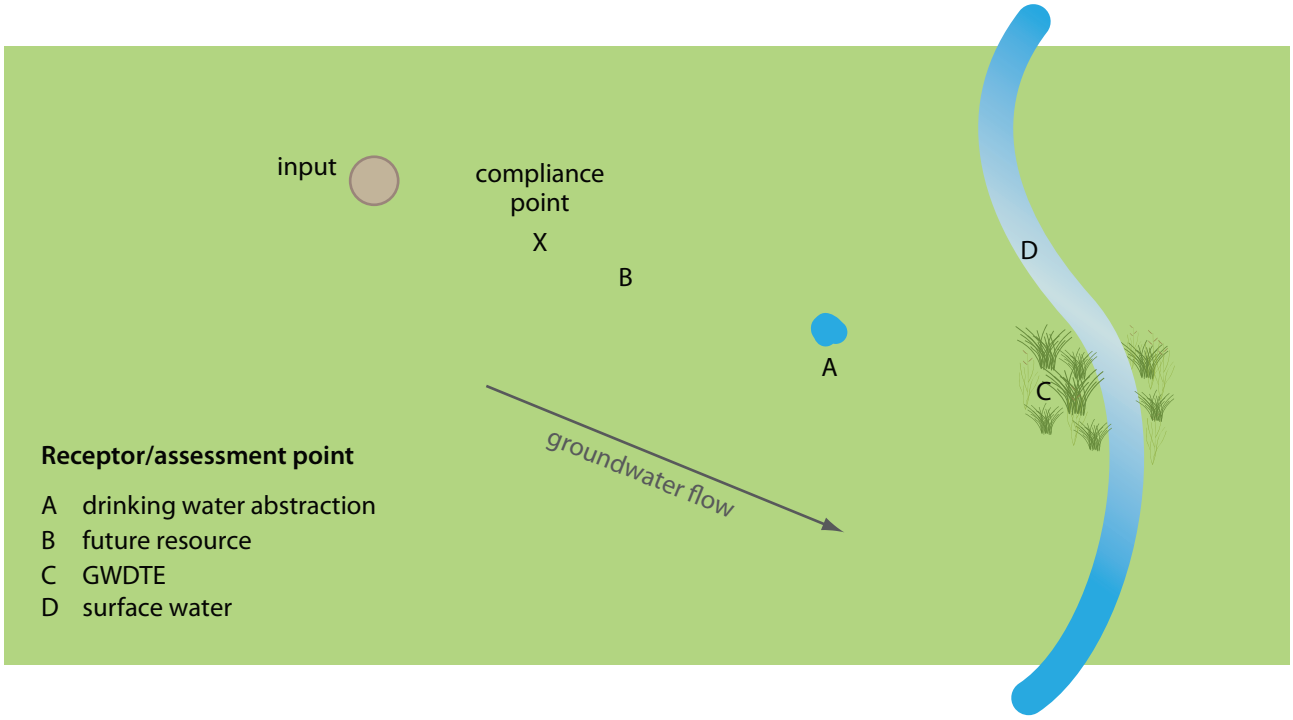
Note: the above one dimensional source-pathway-receptor relationship could translate into any number of possible 3D linkages

Adapted from UK TAG paper 11 (b) iii

5.8 Compliance and multiple receptors

When assessing inputs where multiple receptors are present, the appropriate assessment limit should be chosen for each potential receptor. The concentration of each substance at the compliance point for each receptor can then be derived by back calculation. The lowest calculated concentration of each substance represents the compliance concentration for that substance at the compliance point. In some cases a common compliance point might exist. The relationship between the source, receptors, and compliance point is illustrated in Figure 11. In this example, point X has been chosen as an appropriate location to compare assessment limits applicable to the abstraction at A, the future resource at B, the wetland at C and the surface water at D.

Figure 11: Receptors, assessment and compliance points



5.9 Control measures

Where the compliance regime is exceeded, it may be possible to introduce control measures to return to compliance. Control measures may include such instruments as concentration limit values on a discharge licence, remediation targets for contaminated land, or leachate levels for a landfill permit.

Control measures for contaminated land regulated under Part IIA may be modified by considering what would be reasonable using the guidelines described in *Contaminated Land Statutory Guidance*.

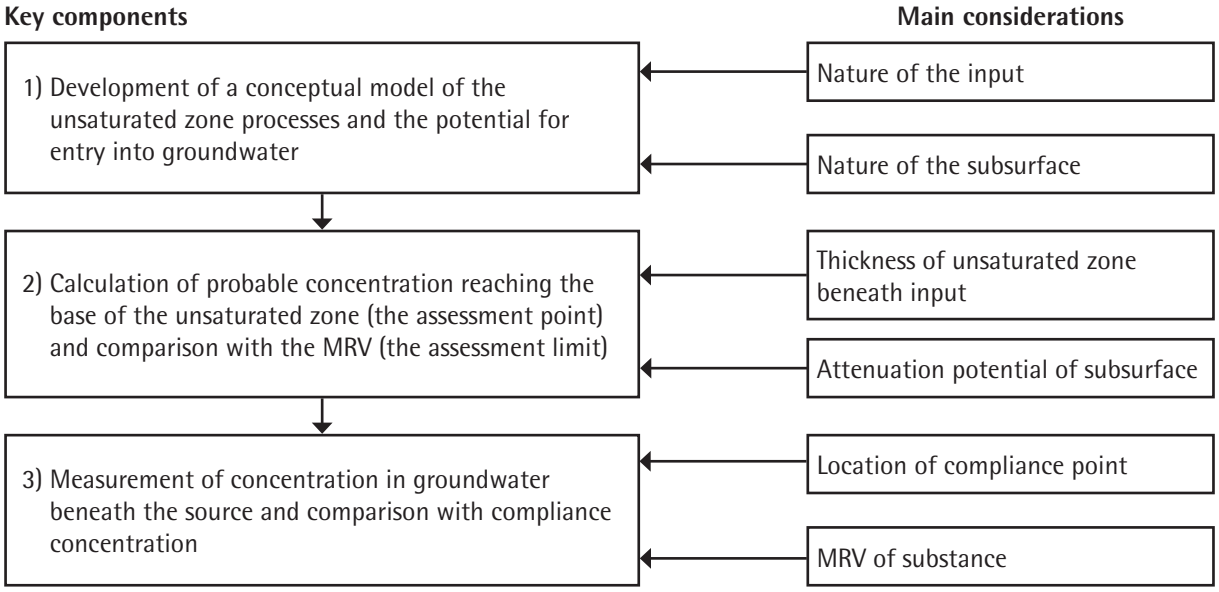
6 Inputs of Hazardous Substances

6.1 Assessment points and assessment limits for inputs of hazardous substances

One objective of the GWDD and the GWD is to prevent the entry into groundwater of hazardous substances. The key components for assessing inputs of hazardous substances are identified in Figure 12. Except for radioactive substances, this section does not apply to assessments of significant pollution under the Contaminated Land Regime.

Figure 12: Key components – hazardous substances

The following are considered to be the minimum that need to be considered in an assessment of the acceptability or otherwise of an input of hazardous substance where the prevent requirement applies:



Direct discharges

Unless authorised though an Article 11 (3) (j) exemption, direct discharges are prohibited. As described in Section 4.2 above, discharges are active inputs, that is, those resulting from an ongoing activity.

Assessment limit

For inputs of hazardous substances regulated by SEPA (other than inputs containing radioactive substances) the default assessment limit will be the minimum reporting value (MRV). A list of MRVs is given in Annex 4. Where no MRV exists for the substance, the default assessment limit will be an agreed limit of detection (LoD). A selection of appropriate LoDs is given in Annex 5. Where the input fulfils one or more of the exemptions of Article 6 (3), the assessment limit will be agreed on a site-specific basis using sector specific guidance, for example landfill guidance.

Receptors

Except for point source inputs containing radioactive substances, the receptor for hazardous substances is the groundwater first encountered beneath the source.

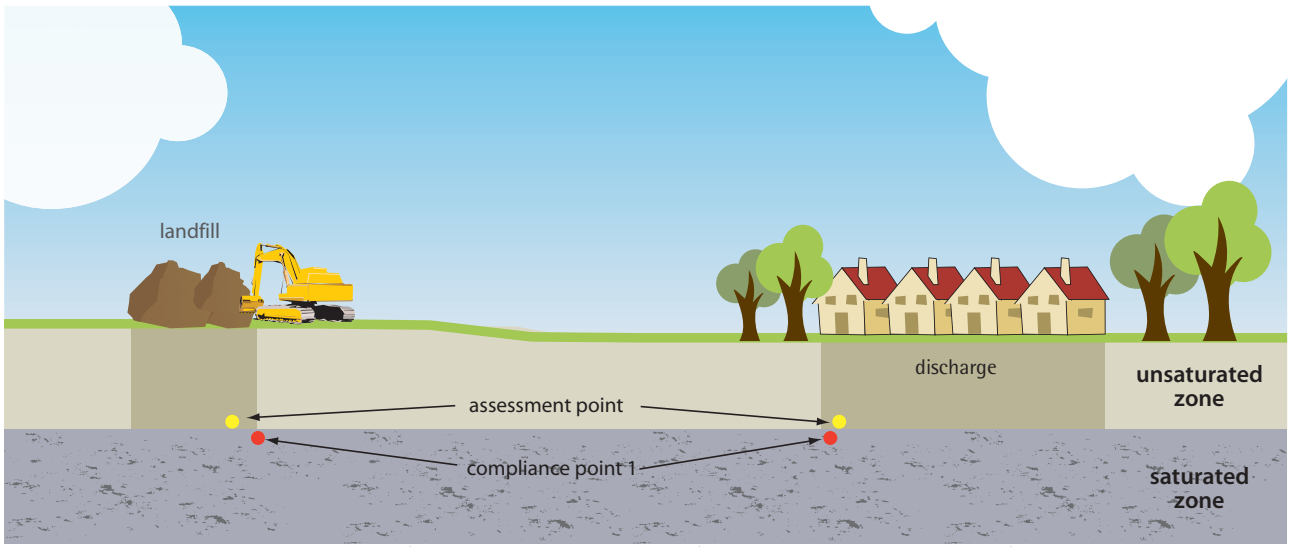
Assessment

Except for point source inputs containing radioactive substances, assessment will consist of calculation of the concentration that will be present in the unsaturated zone immediately before entry into groundwater (see Figure 13).

Compliance

Except for point source inputs containing radioactive substances, the input will be unacceptable if the measured concentration of the substance exceeds its MRV but, where the substance is present in groundwater up-gradient of the site, allowance should be made for the present and future concentration in any compliance regime. Measurement must take place as near to the point of entry as is practically possible (see Figure 13). Where an exemption under Article 6 (3) of the GWDD has been applied, the compliance concentration will be derived on a site-specific basis using sector-specific guidance.

Figure 13: Assessment and compliance points for hazardous substances



6.2 Assessing inputs of radioactive substances

For the purposes of regulating under the Radioactive Substances Act 1993 (as amended), the following approach should be adopted.

Regulating disposals of radioactive substances

When radioactive substances are to be disposed of to the environment they are termed radioactive waste. Any premises wishing to dispose of radioactive waste must be authorised by SEPA under the Radioactive Substances Act 1993 (as amended) (RSA), unless an Exemption Order, made under RSA, applies.

A RSA authorisation for disposals of radioactive waste which results in inputs of radioactive substances to groundwater must meet the requirements of Controlled Activities Regulations (CAR). The impact of any non-radioactive hazardous and non-hazardous properties of the radioactive waste will be assessed in the manner described in the other relevant sections of this document.

The approach to assessing inputs of radioactive substances to groundwater differs from that taken for other hazardous substances for two reasons:

1. The analytical limits of detection for radionuclides (radioactive elements of a particular atomic number and mass) can be extremely low, down to 1,000s or even 100s of atoms, making the application of minimum reporting values both impracticable and disproportionate.
2. Directive 96/29/EURATOM requires SEPA to assess public exposures to radiation by calculating the total dose delivered by all of the radionuclides in a given source, rather than on the basis of the concentrations of individual radionuclides. A similar approach has been adopted by SEPA for calculating radiation doses to other organisms in the environment.

When determining any application for authorisation to dispose of radioactive waste that may result in inputs of radioactive substances to groundwater, SEPA must be satisfied that the exposures to people and the environment are consistent with applicable dose and/or risk criteria. The applicant must also demonstrate that other relevant regulatory requirements will be met.

The following section describes SEPA's approach to authorising inputs of radioactive substances to groundwater.

Direct discharges to groundwater

SEPA does not authorise direct discharges containing radioactive substances into groundwater.

Disposals to near-surface facilities that rely mainly on engineered controls and barriers to limit inputs to groundwater

Solid radioactive waste may be disposed of to near-surface disposal facilities which rely mainly on engineered barriers and controls in order to limit inputs of radioactive substances into groundwater. Examples of barriers and controls include the use of landfill liners or techniques to chemically or physically immobilise radionuclides. Provided that appropriate assessments demonstrate that inputs from disposals are consistent with applicable regulatory dose and risk criteria, SEPA considers that such inputs fall within the scope of exemption 6(3)(b) of the GWDD. If SEPA's other regulatory requirements can be met, such disposals may be authorised under RSA.

Disposals to near-surface facilities that make use of host geology to reduce risks to human health and the environment as a whole

Near-surface facilities for solid radioactive waste may be designed and constructed to make use of their host geology in order to reduce risks to human health and the environment as a whole. Examples of this might include construction of facilities in underground caverns. Provided that the developer of such a facility demonstrates that inputs from disposals are consistent with the applicable regulatory dose and risk criteria, and that, for technical reasons, feasible alternatives to such a disposal pose a higher risk to people and the quality of the environment as whole, SEPA considers that the resulting inputs fall within the scope of exemption 6 (3) (e) (i) of the GWDD. If SEPA's other regulatory requirements can be met, such disposals may be authorised under RSA.

Detailed guidance on SEPA's regulatory criteria and requirements applicable to the disposal scenarios described above may be found in our Low Level Waste Guidance and our Guidance on Requirements for Authorisation for Near Surface Disposal of Solid Radioactive Waste.

Regulating radioactively contaminated land

Inputs of radioactive substances from radioactively contaminated land are regulated under the Radioactive Contaminated Land (Scotland) Regulations 2007 (as amended) and supporting statutory guidance. These regulations are made under the Environmental Protection Act 1990, rather than under RSA. The approach to assessment and regulation taken is analogous to that for conventional contaminated land except that, as described above, assessments are performed in terms of doses, rather than concentrations, which are then compared against appropriate dose criteria.

7 Inputs of non-hazardous substances

7.1 Key components

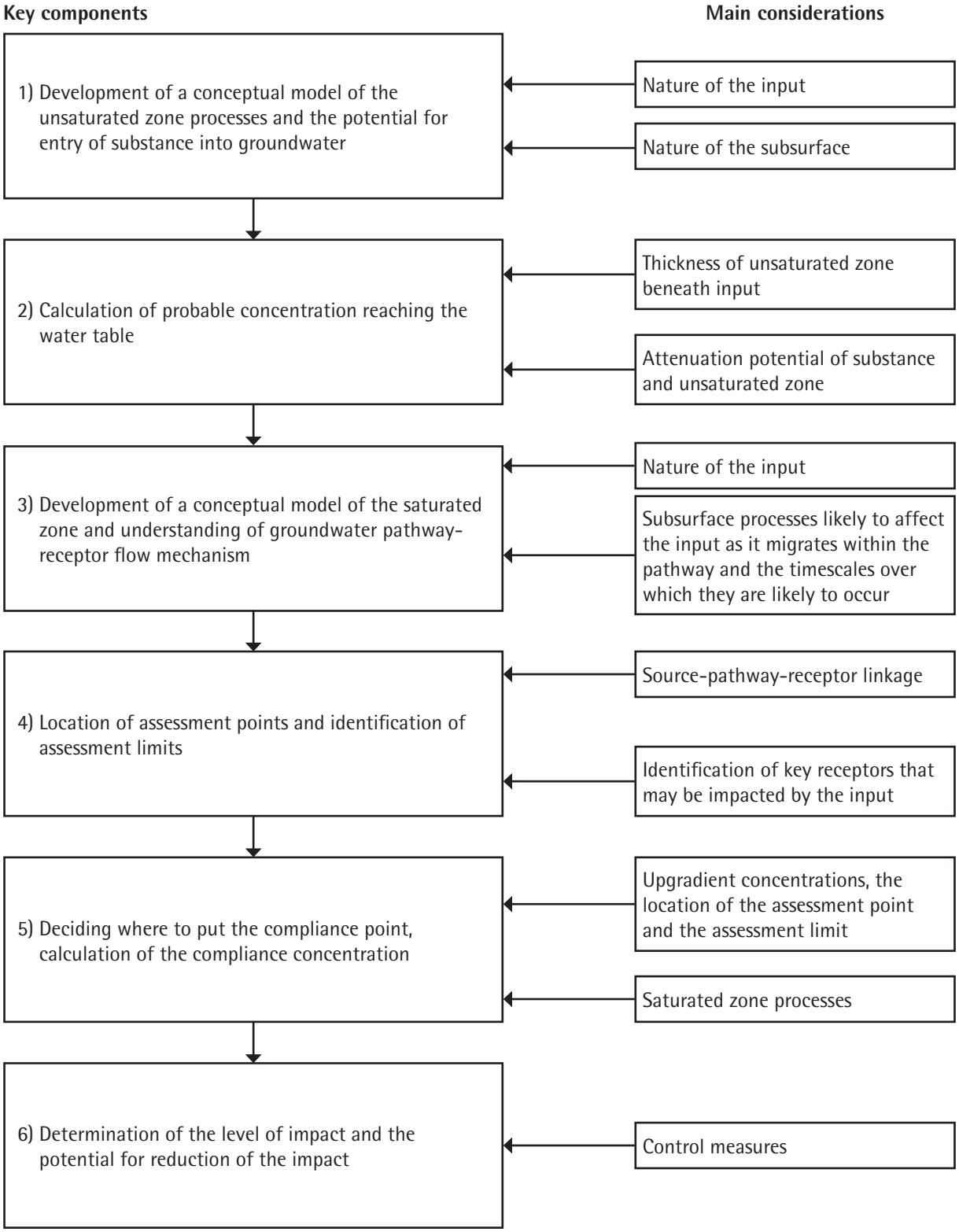
An objective of the GWD is to limit inputs of non-hazardous substances so that they do not cause deterioration or significant and sustained upward trends in pollutant concentrations; that is, they should not cause pollution. This section describes the assessment process that should be undertaken to achieve this objective.

The capacity of groundwater to accept an input of a non-hazardous substance depends upon the nature of the contaminant, the fate and transport process in the unsaturated and saturated zones, the distance to any receptor, and the assessment limit applied to that receptor. These factors are incorporated in the assessment process. Key components of the process are presented in Figure 14.

SEPA considers that groundwater pollution will occur when an input of a non-hazardous substance causes a breach of an assessment limit at an appropriate assessment point for a receptor.

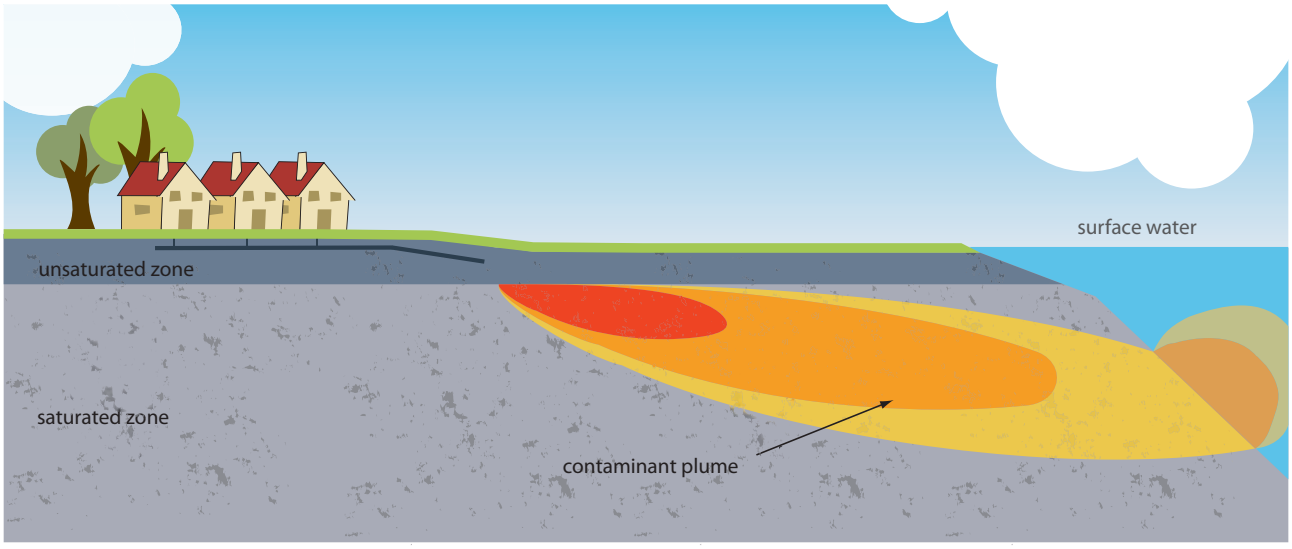
Figure 14: Key components – non-hazardous substances

The following are considered to be the minimum that need to be included in any assessment of groundwater pollution by non-hazardous substances:



7.2 Assessment points and assessment limits for surface, transitional, and coastal water receptors

Figure 15: Assigning assessment points and limits to surface water receptors



Assessment point

Surface waters are defined by the WFD as all inland waters, except groundwater; transitional water, and coastal waters. For these receptors the assessment point is located in the surface water following dilution. The actual point chosen will depend upon the type of surface water. For example, the modelling package for rivers assumes instantaneous mixing; for estuarine and coastal waters that makes use of a mixing zone. Section 6.4 of SEPA Regulatory Method WAT-RM-05: Regulating Trade Effluent Discharges to Surface Waters offers a summary of these procedures.

Assessment limit

Where the water is a transitional water, river, stream, or loch, the default assessment limit will be the environmental quality standard (EQS) defining the good/moderate status boundary. Where the surface water is coastal water the standard should be:

- bathing water quality standards for discharges to bathing water protected areas, or;
- an EQS relevant to coastal waters.

Where site-specific evidence shows that the assessment limit is below natural background levels for groundwater in the vicinity of the site, then the assessment limit should be set on the basis of natural background; that is, the presumption should be no deterioration from the status quo.

Assessment

Ideally, active and passive point source inputs will be controlled to ensure that surface water status does not deteriorate, or where surface water status is less than good, improvement to good status can be achieved. In some cases this aim will not be met, for example where a WFD or GWDD exemption is applied. In such circumstances it will be a **minimum requirement** for existing inputs that the action will result in a decreasing trend in pollutant concentrations.

Fundamentally, the degree of input control will be dependent upon the capacity of the groundwater and surface water to assimilate the loading from the site. This may be expressed as the groundwater and surface water capacity.

For surface water receptors, groundwater capacity may be defined as the difference between the relevant water quality standard of the substance and the concentration of that substance in groundwater at the point of entry into the surface water **if the site in question were absent**. To summarise:

- For **new** inputs, groundwater capacity = water quality standard – current concentration in groundwater prior to entry.
- For **existing** inputs, groundwater capacity = water quality standard – current concentration in groundwater prior to entry – the contribution from the site in question.

Surface water capacity may be defined as the difference between the relevant water quality standard and the concentration in the surface water adjacent to, but unaffected by, the input contribution. To summarise:

- Surface water capacity = water quality standard – concentration in surface water.

Different types of input and whether or not there is capacity in groundwater and surface water leads to a number of possible outcomes. These are outlined in Figure 16.

Calculations are effectively conducted in reverse so that the surface water dilution calculation is followed by groundwater dilution calculation.

For surface water dilution the input from groundwater should be considered as arising from a pipe discharge. Surface water calculation methods depend upon the type of water body:

- calculations for rivers are described in SEPA's supporting guidance document WAT-SG-02;
- calculations for lochs are described in SEPA's supporting guidance document WAT-SG-10;
- calculations for coastal and transitional waters are described in SEPA's supporting guidance document WAT-SG-11.

These calculations are aimed at identifying the acceptable load from the groundwater discharge. Once this is established, it is necessary to calculate compliance concentrations in groundwater prior to entry into the surface water (assume no attenuation in hyporheic zone). These calculations should take account of:

- the local concentration of that substance in groundwater at the point of entry into the surface water **if the site in question were absent**;
- the average annual groundwater flow and the average annual concentration at the point of entry into the surface water **during site operations**.

Figure 16: Groundwater and surface water capacity

		Groundwater capacity[1] **Yes**	Groundwater capacity **No**
New active inputs	Surface water capacity[2] **Yes**	Dilution in surface water allowed up to EQS (Specific regulatory regimes may be more stringent)	
	Surface water capacity **No**	Meet relevant water quality standard in groundwater as it discharges to surface water[3] (no dilution in surface water is possible)	Meet relevant water quality standard at entry to groundwater[3] (no dilution in groundwater or surface water is possible)
Existing active inputs and passive inputs	Surface water capacity **Yes**	Dilution in surface water allowed up to relevant water quality standard (Specific regulatory regimes may be more stringent).	
	Surface water capacity **No**	Meet relevant water quality standard in groundwater as it discharges to surface water[4] (no dilution in surface water allowed). Ignore upgradient groundwater concentrations (assume background is zero)	

Notes

[1]The groundwater capacity is determined at the point of entry into the surface water by calculation of the difference between the concentration of a substance in groundwater (without contribution from the input in question) and the relevant surface water quality standard.

[2]The surface water capacity is determined by measurement of the difference between the concentration of the substance in surface water unaffected by the input, and the relevant surface water quality standard. Inputs should be controlled such that they do not cause local pollution

[3]Control measures to be derived by calculation

[4]Remedial targets to be derived by calculation

Surface water dilution calculations will not be necessary when:

- concentrations in groundwater will not/do not exceed the relevant surface water quality standard prior to entry into the surface water;

- the concentration required to protect another receptor leads to a concentration in groundwater prior to entry into surface water less than the relevant surface water quality standard.

Please note: diffusion of poor quality groundwater through the hyporheic zone may cause harm to some sensitive species living in or on sediments (for example fish eggs, freshwater mussels). SEPA considers that significant harm is more likely from larger sources. In order to minimise the risk to these sensitive species, we will automatically consult SNH where discharges occur in or to Special Areas of Conservation (SACs) or Special Protection Areas (SPAs), and will also consult SNH on selected point source discharges authorised by a licence or permit.

Where SNH indicates the presence of a sensitive species and where an alternative EQS is defined by SNH, this will be applied at an assessment point located in groundwater immediately before entry into the surface water; that is, dilution will not be considered.

These parameters can be measured, modelled, or estimated as appropriate to the level of risk posed by the site.

Compliance

The compliance point should be located in groundwater between the site and the surface water on the basis of being precautionary.

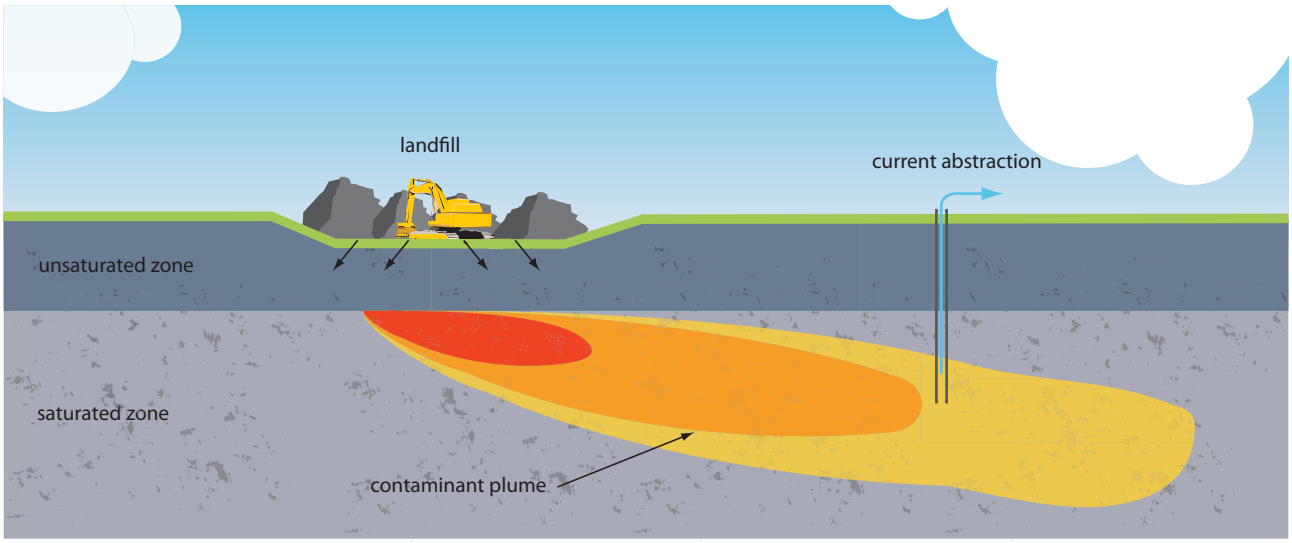
7.3 Assessment points and limits for the groundwater resource (current and future abstractions)

One of the aims of the WFD is to protect the quality of water for human use both now and in the future. In effect this means that groundwater resources should be protected so as to allow future exploitation, even where no current abstraction exists.

The identification of groundwater resource receptors in the shape of current abstractions or the future resource potential is therefore an integral part of the investigation and assessment process.

In accordance with UKTAG guidance, SEPA considers that groundwater bodies or other more localised aquifers capable of supplying 10 m^3/day or 50 people should be regarded as having future resource potential.

Figure 17: Assigning assessment points and assessment limits to current and future abstractions



Assessment point

The assessment point for the groundwater resource is located in groundwater meeting the UKTAG criteria for a groundwater body. Site investigations should aim to establish which groundwater impacted by the input should be considered to have resource potential; that is, the first groundwater encountered beneath the site or that at greater depth. Annex 2 provides details of how this may be undertaken.

Assessment points for the groundwater resource need not be identified where no hydraulic pathway exists between the source and the groundwater resource, for example where a geological boundary is present.

Please note: No geological formation is completely impermeable. For this reason the presence of low permeability deposits beneath a site does not permit an assumption that a groundwater body will not be impacted in the future, although significant attenuation may have occurred before this happens. Risk assessments should incorporate the most appropriate value of permeability and be conducted over a sufficient time period for impacts and attenuation to be assessed.

The assessment point for protecting the resource potential should be identified within the groundwater body or localised aquifer at a distance from a source beyond which future developers could **reasonably** expect to abstract groundwater taking into account the following guidance.

SEPA defines 'reasonably' in this context using a default distance based on established principles used in codes of good agricultural practice and current Scottish building standards, with consideration of current and potential future land-use in the proximity of the site. The distance between the boundary of the pollutant source and the assessment point should be set within the groundwater body at a 'default' distance of **50m** from the downgradient boundary of the source. The distance can be **more than 50m** in the following circumstances:

- Where present or planned future land-use limits the exploitation of the groundwater resource for the foreseeable future. The most likely example is the presence of sewered urban areas, forestry, or major infrastructure development. In this instance, the assessment point should be located at the downgradient extent of the limiting land use, subject to a maximum distance of 250m[13]. Note that the existing concentrations of pollutants or current ownership of the site should not influence this decision.
- Where topography is so steep or inaccessible that it limits development of land for activities that will require groundwater supply. In this instance, the assessment point should be set at the downgradient extent of the limiting topography up to a maximum distance of 250m.
- Where concentrations of the relevant substances are **naturally** in excess of appropriate quality standards, such that requirements for treatment render future development of groundwater economically less viable. The assessment point should be set at 250m.

Where a major groundwater discharge zone occurs closer to the source than the point selected for resource protection, resource potential considerations are not appropriate and assessment points will be derived from factors only related to protection of ecosystems and existing abstractions.

Major groundwater discharge zones are surface water features beyond which groundwater is not expected to flow. Large estuaries and the sea clearly constitute major discharge zones, while canals and perched streams clearly do not.

The determination of a surface water as a major discharge zone depends on a number of factors including:

- relative water levels in the aquifer and the surface water;
- connectivity between the groundwater and the surface water;
- the groundwater flow paths within the aquifer.

In general larger surface waters are more likely to be major discharge zones, but smaller rivers and streams can be significant discharge zones in low productivity aquifers.

Assessments must be made on a site-specific basis, but the burden of proof should be higher in the more productive aquifers. Arguments presented in favour of a surface water being a major discharge zone will need to present geological hydrogeological and hydrological evidence and a suitably annotated cross section in support.

In all cases, the **depth** of the assessment point will be a key consideration alongside distance. When protecting the future groundwater resource, the appropriate depth will be determined by the location of the groundwater resource below the site (see Annex 2 and Section 5.2).

The assessment point for current abstractions is located in the raw water prior to any treatment this might receive.

Risks to an abstraction are related to the size of the abstraction and its distance from the pollutant source. Large abstractions may be impacted even where these are a considerable distance (more than 1 km) from the source, as groundwater flow patterns can be disrupted by the cone of depression.

[13]SEPA considers that a distance of 250 metres represents a reasonable balance between the need to allow sustainable development and need to protect the potential future human use of groundwater.

Where a current abstraction exists within 50 m of the pollutant source, the assessment point will be raw water within the abstraction prior to treatment. Further assessment of the groundwater resource at 50 m will not be necessary.

All abstractions that might be impacted should be identified, regardless of whether they draw from groundwater with resource potential or another aquifer.

Assessment limit

Because there will often be more than one assessment point identified for the groundwater resource (one or more current abstractions plus the future potential use), it may be necessary to establish more than one assessment limit. The most stringent assessment limit must be achieved to ensure protection of the most sensitive receptor.

Groundwater resource

Where no abstractions are present within the appropriate distance from the source, and only the resource potential needs to be considered, the assessment limit should be the resource protection value applied at the assessment point and increased to take account of upgradient concentrations (see Section 5.6). In such circumstances it will be a **minimum requirement** for existing inputs that the action will result in a decreasing trend in pollutant concentrations. A list of RPVs for non-hazardous substances is given in Annex 6. Additional RPVs are given in Annex 7 for assessment of significant pollution only.

Current abstractions

Where the assessment point is an existing drinking water abstraction, the assessment limit should prevent an increase in the level of purification treatment applied. This means that, for a drinking water abstraction where treatment is not currently applied for the substance in question, the assessment limit should ensure that future treatment will not be necessary; that is, resource protection values should be used for the assessment limit. Where treatment is currently applied to an abstraction for drinking water supply the assessment limit should ensure that the level of treatment does not increase.

Where an abstraction is for other than drinking water supply, the assessment limit should be determined using the same principle; that is, if an abstractor is currently not treating water or is treating water to achieve a certain level, then the input should not result in treatment, or an increase in treatment being necessary. In all cases upgradient concentrations must be considered.

This approach recognises:

- the presence of pollutants upgradient of a site;
- theoretical, or actual, contaminant loadings from the site;
- the system capacity for attenuation between the contaminant source and the assessment point;
- the WFD requirement to reduce the level of treatment required for drinking water abstractions.

The above approach mirrors the manner in which sites have previously been regulated by SEPA and is largely based on the need to:

- 'separate' contaminant loadings imposed by the site from existing upgradient contamination arising from other sources;
- 'quantify' loadings from the site to facilitate effective site monitoring, engineered controls and operational compliance.

This approach is also consistent with the 'Polluter Pays' principle.

Notwithstanding the above, protection of a current abstraction for drinking water supply overrides any other consideration.

Asswessment

Where no abstraction exists between the input and the assessment point for the groundwater resource, assessment consists of calculating the concentration in groundwater at the assessment point and comparing this concentration with the appropriate assessment limit.

Where an abstraction exists at or within the distance of the groundwater resource assessment point, in addition to calculating the concentration at the groundwater resource assessment point, the concentration at the abstraction assessment point must also be calculated, prior to any treatment the abstracted water might receive. The assessment limit adopted should be such as to protect both receptors.

Compliance

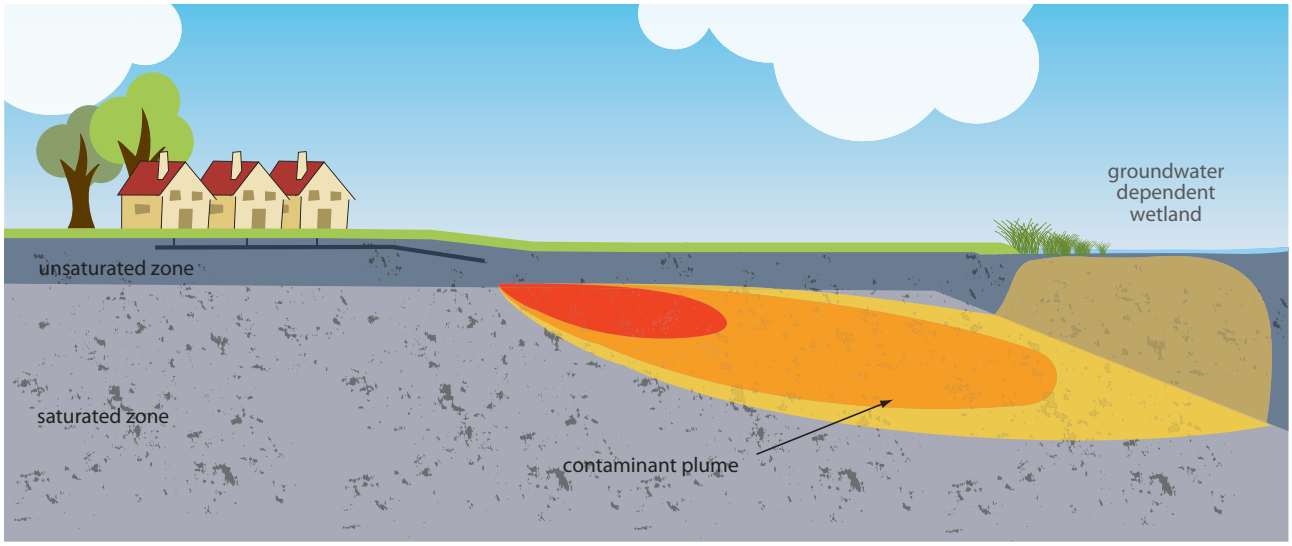
Compliance will be assessed by comparing the concentration of the substance in groundwater at the assessment point or at a suitable compliance point, with the compliance concentration back-calculated as described in Section 5.7.

Where an abstraction exists at or between the input and the groundwater resource assessment point, compliance will be measured in the abstracted groundwater (raw water) prior to any treatment this might receive.

The point for measuring compliance for protecting the groundwater resource must be located at the appropriate depth along the pathway to the receptor, in the groundwater body hydraulically linked to the groundwater first impacted. This is to intercept the highest concentration within the plume.

7.4 Assessment points and limits for groundwater dependent terrestrial ecosystems

Figure 18: Groundwater Dependent Terrestrial Ecosystems



Impacts upon GWDTEs will be measured by determining the 'significance' of any damage that is caused. The way in which this will be assessed is in the process of development and no assessment point or water quality standards have yet been defined. Until such time, a wetland ecologist and SNH should be consulted where there may be an impact.

Concentrations of pollutants upgradient of the site should be taken into account when assessing pollution, and controlling inputs.

8 Glossary

Assessment limit
The concentration of a substance which should not be exceeded. For hazardous substances this is the minimum reporting value (MRV) or, where one is undefined, an agreed limit of detection (LoD) may be used. For non-hazardous substances this depends on the relevant water quality standard and the background concentration. Assessment Limits may be modified by the application of exemptions.

Assessment point
A point associated with a receptor where an assessment limit should be met.

For hazardous substances it is usually a point at the base of the unsaturated zone beneath a source. For non-hazardous substances it is usually a point at some distance downgradient from the source.

Background water quality
The concentrations of chemical, physical, biological, or radiological constituents, or other characteristics in or of groundwater at a particular point in time and upgradient of an activity that have not been affected by that activity.

Capacity
The ability of the water environment to assimilate a pollutant, related to the background water quality and the relevant water quality standard.

Compliance point
The point where the compliance concentration is measured and therefore where this concentration must be achieved. For hazardous substances the compliance point is located in groundwater as close to the point of entry as practicably possible. For non-hazardous substances the compliance point is located between the source and the assessment point, and may or may not coincide with the assessment point.

Compliance concentration
The concentration of a substance at a compliance point back-calculated using:

- the appropriate assessment limit;
- the fate and transport process influencing the concentration of the substance between the assessment point and the compliance point.

Control measures
A regime designed to ensure that a concentration on a discharge licence, a remedial target for contaminated land or a control level on a landfill permit, is met.

Direct discharge
The introduction of substances into groundwater without percolation through the ground or subsoil.

Environmental quality standards (EQS)
Standards adopted by the Scottish Government and used by SEPA to protect aquatic plants and animals and define surface water body classification for status purposes. These are published in:

- The Scotland River Basin District (Surface Water Typology, Environmental Standards, Condition Limits and Groundwater Threshold Values) Directions 2009;
- The Solway Tweed River Basin District (Surface Water Typology, Environmental Standards, Condition Limits and Groundwater Threshold Values) (Scotland) Directions 2009.

Groundwater
Water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.

Hazardous substance
Substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances which give rise to an equivalent level of concern.

Indirect discharge
The introduction of substances into groundwater after percolation through the ground or subsoil.

Inland water
Inland water means all standing or flowing water on the surface of the land and all groundwater on the landward side of the baseline from which the breadth of territorial waters is measured.

Input
The introduction of pollutants into groundwater as a result of past or present human activity, from a point or diffuse source.

Pollutant linkage
A connection existing between an input and a receptor via a pathway.

Minimum reporting value (MRV)
A list of substances and concentrations produced by the Environment Agency in its document *Hydrogeological Risk Assessments for Landfills*, LFTGN01, Environment Agency, 2003.

Natural groundwater quality
Groundwater quality that that has not been affected by anthropogenic influences.

Receptor
The water use or part of the water environment that could be impacted by an input. Receptors include:

- surface waters;
- dependent terrestrial ecosystems;
- the groundwater resource (including current and potential future groundwater abstractions).

Resource protection value
Standards based upon risk to human health and used to maintain a minimum level of groundwater quality. They are based upon values given in:

- European Commission Directive 98/83/EC on the quality of water intended for human consumption.
- The Water Supply (Water Quality) (Scotland) Regulations 2001.
- World Health Organisation: *'Guidelines for Drinking Water Quality, Third Edition'.* Only those values derived using human health risk assessments should be used.
- United States Environment Protection Agency National Primary Drinking Water Regulations.

Saturation zone
The part of the ground below the water table in which all accessible voids (spaces and fissures) are filled with water.

Surface water
Surface water means inland waters (other than groundwater), transitional waters, and coastal waters. In this context SEPA regards springs as surface waters.

UK TAG
The United Kingdom Technical Advisory Group, a partnership of UK and Ireland environment and conservation agencies set up to interpret and support the implementation of the Water Framework Directive (WFD).

Annex 1 Legislative background

A1.1.1 The WFD, GWDD and GWD

There are three EC Directives affecting groundwater: the Groundwater Directive (Directive 80/68/EEC), the Water Framework Directive (Directive 2000/60/EC), and the Groundwater Daughter Directive (Directive 2000/118/EC). These are known as the 'GWD', the 'WFD', and the 'GWDD' respectively. The GWD will be withdrawn in 2013, but until then all three apply.

The key objectives for groundwater quality in the WFD are to achieve good chemical status for groundwater bodies and to prevent the deterioration of such status. There are two additional quality objectives that apply to groundwater:

- to reverse any significant and sustained upward trend in pollutant concentrations;
- to prevent or limit the inputs of pollutants.

The WFD also prohibits the direct discharge of all pollutants into groundwater, subject to certain exemptions.

Article 6 of GWDD describes measures to be introduced to prevent or limit inputs of pollutants into groundwater; that is, it expands upon the 'prevent or limit' objective detailed in the WFD.

The 'prevent and limit' and 'direct discharge' objectives will be achieved through regulating controlled activities using the Controlled Activities Regulations (or 'CAR' –see below) and the implementation of programmes of measures under the river basin management process.

The main objectives of the GWD may be summarised as follows:

- To prevent the direct or indirect introduction of List I substances to groundwater.
- To limit the direct and indirect introduction into groundwater of substances in List II so as to avoid pollution.

These objectives are realised by the authorisation of disposal or tipping for the purpose of disposal. In addition, the discharge of listed substances from non-disposal activities can be controlled by taking appropriate measures such as issuing notices to control or prevent activities as required. GWD requirements are achieved via CAR.

A1.1.2 Controlled Activities Regulations (CAR)

Discharges previously controlled by the Control of Pollution Act 1974 now fall within the scope of the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR), which was introduced to help achieve the objectives of the WFD.

Some discharging activities controlled by other legislation are deemed to be authorised by CAR. Relevant legislation includes:

- Part I of the EPA 1990 (as amended);
- Radioactive Substances Act 1993 (as amended);
- Pollution Prevention and Control (Scotland) Regulations 2000 (as amended);
- Waste Management Licensing Regulations 1994 (as amended).

CAR contains a requirement to achieve compliance with the GWD, GWDD and other European legislation. All activities authorised or deemed to be authorised by CAR are therefore WFD, GWD and GWDD compliant.

A1.1.3 Land contamination

Land contamination is regulated through Part II A of the EPA by the Contaminated Land (Scotland) Regulations 2000 (as amended). These regulations are in turn interpreted through the *Contaminated Land Statutory Guidance Edition 2*, 2006.

Part IIA uses the concept of 'source – pathway – receptor', where the EPA 1990 defines a receptor as either:

(a) a living organism, a group of living organisms, an ecological system or a piece of property which:

(i) is in a category listed in Table A in Chapter A as a type of receptor;

(ii) is being, or could be, harmed, by a contaminant; or

(b) the water environment which is being, or could be, polluted by a contaminant (Paragraph A1.14).

The term receptor as used in this document, refers only to (b) above, that is the water environment, and only as this is meant in the WFD.

Remediation of contaminated land causing an input to groundwater relies on the concept of 'significant pollution'. SEPA considers that the term significant pollution is equivalent to pollution as used in this document. The principles described are therefore directly applicable to the contaminated land regime.

A1.1.4 Development control

One of the aims of the Town and Country Planning Act 1990 (as amended) is to control development activities that would not otherwise be regulated, in order to meet requirements of European, UK and Scottish legislation e.g. achieve the requirements of the GWD and WFD by preventing pollution.

Development Control Planning Advice Note 33 requires that remediation of land contamination, undertaken as part of a development, should achieve a standard that would preclude the possibility of the site being identified as contaminated land under the Contaminated Land Regulations at any time in the future. This ensures a common standard of treatment between the planning and contaminated land regimes. The principles described in this document are therefore also applicable to development activities involving land contamination.

A1.2.0 Reconciliation of the WFD, GWD and GWDD

In relation to groundwater, the WFD sets out in Article 4 (9) that "steps must be taken to ensure that the application of the new provisions... guarantees at least the same level of protection as the existing community legislation". In addition, European Court judgement and set academic text on European community directives agree that, where one directive is silent or ambiguous on a matter, then clearly another directive which makes a specific statement carries more weight. This suggests that when considering the GWD and WFD together, in areas where the WFD is not specific and the GWD is, the Groundwater Directive applies. In areas where the WFD is specific and the GWD is not, the Water Framework Directive applies.

The GWDD was introduced under Article 17 of the WFD and provides further details and explanation of measures required under the WFD. Reconciliation between the WFD and GWDD is therefore not required.

Reconciliation of the WFD, GWD and GWDD is explained in the following sections.

A1.3.0 GWD exclusions

The GWD excludes three types of activity from the scope of the directive:

- septic tank discharges from isolated dwellings;
- discharges which are considered by SEPA to contain substances in Lists I or II in a quantity and concentration so small as to present no risk to the receiving groundwater (de minimis principle);
- discharges of matter containing radioactive substances.

There are no such exclusions in the WFD or GWDD. However, Article 11 (3) (j) of the WFD provides exemptions from the prohibition on direct discharges and Article (6) (3) of the GWDD provides for exemptions from measures needed to achieve the 'prevent and limit' requirement for inputs of hazardous and non-hazardous substances. These exclusions/ exemptions are not equivalent and must be reconciled. The GWD exemptions, reconciled with the WFD and GWDD, apply until 2013. After the GWD is withdrawn in 2013, only the exemptions arising from the WFD and GWDD will apply. SEPA's interpretation of the reconciliation of the GWD exclusions with the requirements of the WFD/GWDD is as follows:

A1.3.1 Isolated dwellings

There is no exclusion of isolated dwellings from the prevent or limit requirements of the WFD or the GWDD. The WFD and GWDD are therefore more stringent than the GWD in this matter and this exclusion can no longer apply.

A1.3.2 No danger of causing deterioration

The GWD and the GWDD contain a similar exemption: an input 'of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving water' is exempt from the measures needed to achieve 'prevent or limit'. Such a quantity and concentration can arise in several ways:

- as a result of an input containing very small amounts of a hazardous or non-hazardous substance which it is obvious, from simple examination, that the amount that would enter is not environmentally significant (This is the meaning of the 'de-minimis' ruling of the European Court, case C-131/88.);
- as a result of an input containing slightly larger amounts of a hazardous substance but that prior investigation shows that passage through the unsaturated zone will provide sufficient attenuation that the amount is no longer environmentally significant (this is equivalent to the prior investigation requirement of Article 4 of the GWD);
- as a result of an input containing even larger amounts of a hazardous substance where prior investigation demonstrates that passage through the unsaturated zone would not provide sufficient attenuation but measures have been applied to reduce the amount to one which is no longer environmentally significant.

It is SEPA's position that any input which contains concentrations of the substances described below automatically meets the European Court 'de minimis' requirement:

- hazardous/List I substances which are at or below Minimum Reporting Value levels; and/or
- non-hazardous/List II substances which are at or less than those given in the Water Supply (Water Quality) (Scotland) Regulations 2001 or any other recognised human health risk assessment standard.

A1.3.3 Matter containing radioactive substances

The GWD excludes discharges of matter containing radioactive substances from the requirements of the directive. The WFD and GWDD contain no such exclusion and are therefore more restrictive. Radioactive substances should be considered in any impact assessment. This document provides details of how point source inputs containing radioactive substances are assessed. Further explanation of the direct discharge of radioactive substances is provided in Section A1.5.1.

A1.4.0 GWDD Exemptions

Article 6 of the GWDD also includes a number of exemptions from the 'prevent or limit' requirement. The provisions of Article 6 are more stringent than those of the GWD, as the directive applies to a greater range of substances and a greater range of inputs. In principle, therefore, these exemptions can take precedence over some of the requirements of the GWD. The exemptions do not however mean that the 'prevent and limit' requirements can be ignored, only that they can be relaxed under the given circumstances. The objective should always be to achieve the smallest entry or least pollution possible. The following table lists the Article 6 exemptions, gives SEPA's interpretation, and suggests examples of where each exemption might apply.

Table 1: Article 6 exemptions

SEPA will always seek to prevent inputs of hazardous substances into groundwater and will always seek to limit inputs of non-hazardous substances to prevent pollution. In some cases, preventing or limiting inputs is not appropriate for one or more of the reasons presented below. These reasons are associated with exemptions allowed under Article 6 (3) of the Groundwater 'Daughter' Directive.

When applying one or other of these reasons, SEPA will first confirm that all practicable measures have been taken to prevent or limit inputs.

GWDD Article 6 exemption	Additional measures to prevent or limit may be inappropriate	Examples to which the exemption may apply
(3) (a) The result of direct discharges authorised in accordance with Article 11(3)(j) of Directive 2000/60/EC.	Self explanatory (further information is provided in A1.5 below).	Self explanatory.
(3) (b) Considered to 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.	For inputs where: (i) The concentration of a hazardous substance in the discharge is less than the MRV or the concentration of a non-hazardous is less than the RPV, or; (ii) the amounts of the hazardous substances are so small that the concentration cannot be quantified in groundwater, or; (iii) the hazardous pollutant is of low persistence and its breakdown products non-hazardous and these will not cause pollution (see note B below), and the amounts of hazardous substances involved are so small (in relation to the receiving water) that concentrations contributed by the inputs are barely discernible (or cause only a short-lived spike) in the groundwater and are environmentally insignificant, or; (iv) the hazardous pollutant is persistent but its fate in groundwater and the wider environment is understood (see note B below), and the amounts of hazardous substances involved are so small (in relation to the receiving water) that concentrations contributed by the inputs are barely discernible (or cause only a short-lived spike) in the groundwater and are environmentally insignificant, or; (v) the concentrations of the non-hazardous substances are so small that they could not cause pollution.	Discharges of hazardous substances in sewage effluent from single dwellings via a septic tank. Inputs from disposal of radioactive waste where such disposal has been assessed to be radiologically insignificant to people and the environment.

(3) (c) The consequence of accidents or exceptional circumstances of natural cause that could not reasonably have been foreseen, avoided or mitigated.	Where the inputs result from road, rail, industrial etc accidents, or exceptional natural phenomena such as flooding, and where these could not reasonably have been foreseen, avoided or mitigated.	Inputs resulting from road, rail, industrial etc accidents and exceptional natural causes.
(3) (d) The result of artificial recharge or augmentation of bodies of groundwater authorised in accordance with Article 11(3)(f) of Directive 2000/60/EC.	Self explanatory.	Self explanatory.
(3) (e) (i) Incapable for technical reasons from being prevented or limited without using measures that would increase the risk to human health or the quality of the environment as a whole.	For inputs where: (i) attempts to remove or treat the source would re-mobilise pollutants and lead to increased health risks or environmental impacts, or; (ii) other feasible ways of managing the pollutants would pose greater risks to human health or environmental quality (see note A below), or; (iii) additional measures to prevent or limit would increase the risk to human health or environmental quality.	Contaminated land sites, old unlined landfill sites, or; pesticides used in past agricultural activities where the pollutants are in the ground or subsoil, or; inputs from SUDs, and; inputs from disposal of radioactive waste where the alternatives to such disposal pose a demonstrably higher risk to people and the wider environment.
(3) (e) (ii) Incapable for technical reasons from being prevented or limited without using disproportionately costly measures to remove quantities of pollutants from or otherwise control their percolation in, contaminated ground or subsoil.	For inputs where the hazardous or non-hazardous pollutants are in the ground or subsoil and: (i) a range of treatment options have been considered, and the option chosen provides best net environmental benefit (see note A below), or; (ii) where remedial actions have already been taken to affect a long term improvement, and further action would be unreasonable (see note A below).	Contaminated land sites, or old unlined landfill sites, or pesticides used in past agricultural activities. Where monitoring has determined that measures already taken are halting and reversing the concentration of pollutants in groundwater.

(3) (f) The result of interventions in surface waters for the purposes, amongst others, of mitigating the effects of floods and droughts, and for the management of waters and waterways, including at international level. Such activities, including cutting, dredging, relocation and deposition of sediments in surface water, shall be conducted in accordance with general binding rules, and, where applicable, with permits and authorisations issued on the basis of such rules, developed by the Member States for that purpose provided that such inputs do not compromise the achievement of the environmental objectives established for the water bodies concerned in accordance with Article 4(1)(b)(ii) of Directive 2000/60/EC.	The activities described in this exemption may be authorised, provided they do not directly give rise to inputs that would cause deterioration in status for any water body.	Self explanatory.

Notes
A) Judgements will be made using sector-specific guidance (for example contaminated land or radioactive substances).
B) Arguments concerning the standing of particular hazardous substances can only be accepted on the basis of UK (through JAGDAG) or EU-wide agreements.

A1.5 Direct discharges

Both the GWD and the WFD aim to restrict direct discharges to groundwater. However, there is a clear difference between requirements of the WFD and GWD. The WFD prohibits the direct discharge of **all** pollutants, except in certain circumstances, identified in Article 11 (3) (j), where they may be authorised. The GWD prohibits only the direct discharge of List I substances, except in certain circumstances where they may be authorised. An exception must be subject to an investigation prior to authorisation. SEPA considers that a collective prior investigation has been undertaken for those activities controlled by general binding rule.

A1.5.1 Direct discharges of List I/hazardous substances

Direct discharges of List I substances are prohibited by the GWD with very few exceptions. Similarly, direct inputs of hazardous substances are prohibited under the WFD, but there are a greater number of exemptions. Reconciliation of these exemptions allows the following statements to be made:

1. Although radioactive substances are exempt from the GWD, the requirements of Article 11(3) (j) of the WFD apply to the direct discharge of all pollutants. SEPA can therefore only authorise direct discharges to groundwater of radioactive substances if the activity is exempt under Article 11(3) (j), and the discharges 'do not compromise the achievement of the environmental objectives established for that body of groundwater'.
2. SEPA will only authorise the direct discharge of a List I/hazardous substance where:

a) The groundwater is, **for natural reasons**, permanently unsuitable for use and the discharge is due to:

- injection of water containing substances resulting from the operation for exploration and extraction of hydrocarbons or mining activities and injection of water for technical reasons. Such injections shall not contain substances other than those resulting from the above operations;
- injection of natural gas or liquefied petroleum gas (LPG) for storage purposes into geological formations of natural gas or liquefied petroleum gas (LPG) for storage purposes into geological formations;
- injection of carbon dioxide streams for storage purposes into geological formations.

SEPA considers that, as presently understood, there is no readily exploitable groundwater in Scotland that is permanently unsuitable for future use for **natural** reasons. This will restrict these discharges to deep saline aquifers.

b) The discharge is due to the re-injection of water containing substances resulting from the exploration and extraction of hydrocarbons or mining activities, and injection of water for technical reasons, into geological formations from which hydrocarbons or other substances have been extracted

c) The discharge is due to the re-injection into the same aquifer of water used for geothermal purposes. Schedule 3 (17) of CAR describes the general binding rule by which this activity may be authorised.

d) The discharge is re-injection of water pumped out of mines and quarries, water pumped out for construction, civil engineering and building works, other similar activities.

A **mine** is generally taken to refer to an excavation in the Earth's crust for minerals. Often, but by no means invariably, there is a connotation that the excavation is underground, for example a coal mine may be underground or opencast

A **quarry** is usually defined as an open excavation in the Earth's crust from which stone is obtained for construction purposes.

The definition of civil engineering and building works and other similar activities is interpreted to encompass:

- most construction sites, including buildings, earthworks etc;
- construction of roads, railways, pipelines etc;
- construction of boreholes, wells etc.;
- construction of drainage systems;
- the preliminary works associated with the construction of landfills, quarries, mines etc. before these are brought into their final use;
- groundwater remediation schemes where some engineering works are involved, for example pump and treat.

In order to prevent pollution of the groundwater the re-injection (discharge) of water pumped out should not be in a location where it could pollute previously unpolluted groundwater. Conditions will need to be attached to the authorisation to prevent pollution, or in the extreme case, the authorisation may not be granted on these grounds.

e) The discharge will not compromise the achievement of the environmental objectives for that body of groundwater.

A1.5.2 Direct discharges of non-hazardous substances

Direct discharges of List II substances are allowed under the GWD, but direct discharges of all pollutants are prohibited under the WFD, subject to limited exemptions. The WFD is more restrictive for direct discharges of non-hazardous substances.

SEPA will only authorise direct discharges of a non-hazardous substance where:

a) The discharge is of water containing substances resulting from operations for exploration and extraction of hydrocarbons or mining activities, and injection of water for technical reasons, into geological formations from which hydrocarbons or other substances have been extracted or into geological formations which for natural reasons are permanently unsuitable for other purposes. Such injections shall not contain substances other than those resulting from the above operations.

b) Injection of carbon dioxide streams for storage purposes into geological formations which for natural reasons are unsuitable for other purposes.

c) The discharge is due to the re-injection into the same aquifer of water used for geothermal purposes. Such discharges should not contain pollutants at concentrations greater than that in the water that was abstracted or the receiving water.

d) The discharge results from construction, civil engineering, and building works and similar activities on, or in the ground which come into contact with groundwater. For these purposes, Member States may determine that such activities are to be treated as having been authorised, provided that they are conducted according to general binding rules developed by the Member State in respect of such activities. Schedule 3 (16) of CAR describes the General Binding Rule authorising this activity.

e) The discharge is re-injection of water pumped out of mines and quarries, water pumped out for construction, civil engineering and building works, other similar activities.

   A **mine** is generally taken to refer to an excavation in the Earth's crust for minerals. Often, but by no means invariably, there is a connotation that the excavation is underground, eg a coal mine may be underground or opencast.

   A **quarry** is usually defined as an open excavation in the Earth's crust from which stone is obtained for construction purposes. **Civil engineering and building works and other similar activities** are interpreted to encompass:

   - most construction sites, including buildings, earthworks etc;
   - construction of roads, railways, pipelines etc;
   - construction of boreholes, wells etc.;
   - construction of drainage systems;
   - the preliminary works associated with the construction of landfills, quarries, mines etc before these are brought into their final use;
   - groundwater remediation schemes where some engineering works are involved (eg pump and treat schemes where there are boreholes, permeable reactive barriers or specially constructed soakaways).

   In order to prevent pollution of the groundwater the re-injection (discharge) of water pumped out should not be in a location where it could pollute previously unpolluted groundwater. Conditions will need to be attached to the authorisation to prevent pollution, or in the extreme case, the authorisation may not be granted on these grounds.

f) The discharge is of small quantities of substances for scientific purposes for characterisation, protection or remediation of water bodies limited to the amount strictly necessary for the purposes concerned.

g) The discharge will not compromise the achievement of the environmental objectives for that body of groundwater.

A1.6 Indirect discharges

Under the GWD the discharge of List II substances to groundwater is an activity liable to cause pollution. The WFD requires that measures be introduced to regulate point source discharges liable to cause pollution. The two directives have the same objective, however the WFD is more restrictive in that it applies to all pollutants rather than just those of List II of the GWD. Therefore, when authorising indirect point source discharges, SEPA must consider all potential non-hazardous pollutants and apply the exemptions from the prevent and limit requirement described in Sections 1.4.1 to 1.4.6.

Annex 2 Determination of groundwater resource potential

A2.1 Background

This Annex sets-out broad guidelines on the type of investigations that SEPA will consider acceptable for determining that the groundwater first encountered fulfils the criteria for a groundwater body, and therefore has resource value which must be protected.

Groundwater bodies form the basis of ongoing groundwater classification and will be the main focus of large scale groundwater management requirements such as river basin planning.

In accordance with WFD and on the basis of UK TAG criteria described in Section 5.2, SEPA has mapped all bedrock aquifers and selected extensive sand and gravel aquifers as groundwater bodies, and these underlie the whole mainland of Scotland and many islands. Other more localised sand and gravel aquifers have not been mapped as groundwater bodies due to their inherent variability and a lack of information. The presence of these more localised aquifers can only be determined using site specific data.

Subsurface materials not included within the designated boundaries of groundwater bodies and where groundwater is not expected to meet the UK TAG criteria include peat, silt, and clay deposits. These materials will usually be strata overlying, or adjacent to, groundwater bodies.

Groundwater fulfilling the UK TAG criteria for a groundwater body is considered by SEPA to have future resource value. Other groundwater requires protection only as a pathway to other receptors. Assessing the supply capacity of groundwater beneath the site will enable correct location of the assessment and compliance points to protect the future resource.

A2.2 Recommended approach

The methodology described below consists of three tiers of increasing complexity and cost aimed at assessing whether the superficial deposits above bedrock will fulfil the UK TAG criteria for a groundwater body. Those wishing to use this approach may start at Tier 1 as appropriate and continue to the next tier(s) as necessary. Those taking this route should be aware that SEPA will use the 'weight of evidence' from the investigation to decide the resource potential of the deposit.

- **Tier 1: Prior to site investigation**
  Assume that all saturated materials below the site form part of the groundwater body. In some situations it may be more cost effective to accept this assumption. However examination of the implications of acceptance might reveal that it may be an advantage to test this assumption by progressing to Tier 2; that is, the cost of the investigation could be offset by savings elsewhere.

- **Tier 2: Drilling/excavation to bedrock**
  The aim is to **infer** if the superficial strata can provide more than $10m^3$/day using information from site investigation and available geological mapping.

  If the stratum is of significant areal extent[14] and more than 2m thickness of continuous saturated sand or gravel (or coarser material) is found in any one excavation, then either a Tier 3 investigation should be undertaken, or the stratum should be considered to form part of a groundwater body with its limit at the top of the relevant stratum.

  The determination of 'sand or gravel strata' can be made in one of two ways:

  Using field descriptions made by qualified personnel in accordance with British Standards (BS5930: 1999. Codes of Practice for Site investigations). In samples from sand or gravel strata, the 'principal soil type' should be sand or coarser, with the material having no apparent plasticity/cohesion or being dominantly cobbles or boulders.

  Using particle size analysis. The distribution from the relevant strata should be less then 8% fines[15] (silt and clay) in all samples.

[14]Areal extent, average thickness and physical properties combine to produce a deposit with resource potential.
[15]Ó Súilleabháin, C. 2000. *Assessing the boundary between high and moderately permeable subsoils.* Dissertation Submitted To The University Of Dublin In Partial Fulfilment Of The Requirements For The Degree Of Master Of Science In Civil, Structural And Environmental Engineering.

Available geological mapping can be used to provide additional confidence to the conclusions drawn from site investigation, eg areal extent.

Where the superficial geological sequence is complex, or where there is doubt concerning any of the Tier 2 assessments, then a Tier 3 investigation should be undertaken. An example of a complex sequence is the common situation, where numerous thin layers or lenses of permeable strata are interbedded with less permeable deposits.

- **Tier 3: Productivity testing**
  Enhancing the information provided by Tier 2, the aim is to **demonstrate with more confidence** if the relevant stratum identified in Tier 2 can provide more than 10m^3/day.

  The groundwater will be considered to have resource value and the top of the groundwater body set at the top of the relevant stratum unless flow within the strata can be demonstrated to be less than 10 m^3/day. Depending on the degree of uncertainty, this assessment can be undertaken through representative in-situ test pumping or through a combination of in-situ testing and analytical or numerical calculations of flow based upon data representing the relevant strata as a whole. Field test should be undertaken in accordance with British Standards (BS5930: 1999, Code of Practice for Site investigations). SEPA will make a final decision on whether or not the stratum should be considered to have resource value based upon the following properties of the deposit:

  - areal extent;
  - average thickness;
  - physical properties;
  - permeability/productivity.

Annex 3 Polluting substances

A3.1 Polluting substances

There are a number of sources referred to in the text which list polluting substances. These include:

- The Annex to the Groundwater Directive
  - The list produced by JAGDAG that identifies those substances that have been determined as hazardous (this may be found at: Hazardous substances)
  - The list produced by JAGDAG that identified those substances that have been determined as non-hazardous
- Annex VIII of the Water Framework Directive

Of these, the last is perhaps the most useful in that it lists most of the substances or groups of substances which should be regarded as the most important; that is, the most likely to cause pollution because of their usage or toxicity.

Annex VIII has subtly changed the definitions of some of the groups in List I of the Annex to the Groundwater Directive to better reflect their hazardousness; it takes into account the fact that not all substances in some of the List I groups are hazardous. This is also the objective of the JAGDAG list of non-hazardous substances where individual substances, while belonging to a family or group of pollutants in groups 1 – 6 of Annex VIII, have been determined by JAGDAG as non-hazardous on the basis of a low risk of toxicity, persistence, and bioaccumulation.

SEPA considers the following to be the most frequently occurring polluting substances and therefore important to quantify for groundwater pollution assessment purposes:

- hazardous substances;
- metals, particularly:
- Arsenic
  - boron
  - chromium,
  - copper
  - selenium
- nitrates and nitrites;
- phosphates;
- ammonia and ammonium compounds;
- phenols and other substances having a deleterious effect on taste;
- pathogens, eg enterococci.

Other pollutants need not routinely be considered in assessments unless:

- there is evidence to suggest that they are impacting on a surface water, current abstraction, or wetland, or;
- there is evidence to show that large amounts or high concentrations of a substance are present in the source which could impact on the groundwater resource, a surface water, current abstraction or wetland.

Annex 4 Minimum reporting values

Table 2 contains information concerning minimum reporting values (MRV) based upon Environment Agency data[16]. Inputs of these substances into groundwater should be prevented.

Table 2: Minimum reporting values (MRV)

Pollutant	MRV (µg/l)	Notes
1,1,1 Trichloroethane	0.1	
1,1,2 Trichloroethane	0.1	
1,2 Dichloroethane	1.0	
2,4,D Ester	0.1	Methyl, ethyl, isopropyl and butyl each to 0.1
2,4 Dichlorophenol	0.1	
2 Chlorophenol	0.1	
4 chloro-3-methylphenol	0.1	
Aldrin	0.003	
Atrazine	0.03	
Azinphos-ethyl	0.02	
Azinphos-methyl	0.001	
Benzene	1	
Cadmium0.1		
Carbon Tetrachloride	0.1	
Chlorfenvinphos	0.001	
Chloroform	0.1	
Chloronitrotoluenes	1	2,6-CNT; 4,2-CNT; 4,3-CNT; 2,4-CNT; and 2,5-CNT
PCB (individual congeners)	0.001	
DDT (op and pp)	0.002	o = ortho, p = para
DDE (op and pp)	0.002	
TDE (op and pp)	0.002	
Demeton	0.05	Demeton-s-methyl only
Diazinon	0.001	
Dieldrin	0.003	
Dimethoate	0.01	
Endosulfan	0.005	Endosulphan a and Endosulphan b each to 0.005µg/l
Endrin	0.003	
Fenitrothion	0.001	
Fenthion	0.01	
Hexachlorobenzene	0.001	
Hexachlorobutadiene	0.005	
Hexachlorocyclohexanes	0.001	α, γ and δ - HCH each to 0.001µg/l, β – HCH to 0.005µg/l

[16]Data drawn from *Hydrogeological Risk Assessments for Landfills*, LFTGN01, Environment Agency, 2003.

Isodrin	0.003	
Malathion	0.001	
Mecoprop	0.04	
Mercury (inorganic)	0.01	
Mevinphos	0.007	
Parathion	0.01	
Parathion Methyl	0.015	
Pentachlorophenol	0.1	
Permethryn	0.001	cis and trans both to 0.001µg/l
Simazine	0.03	
Tetrachloroethylene	0.10	
Toluene	4.00	
Tributyl Tin	0.001	
Trichlorobenzene	0.01	135 tcb; 124 tcb; and 123 tcb
Trichloroethylene	0.1	
Trifluraline	0.01	
Triphenyl Tin	0.001	
Xylenes (total)	3	Ortho and meta+para each to 3µg/l (may not be possible to separate meta and para)

In some situations, the groundwater sample matrix may not be suitable for analysis by such sensitive analytical methods, eg samples of landfill leachate containing high ionic concentrations. We accept that, in such cases, the MRVs cannot be reasonably achieved by a number of laboratories. The Environment Agency has proposed that alternative values for MRVs may be appropriate in such cases. We will consider applications for the use of the proposed alternatives where operators can provide evidence that they are looking for the most appropriate indicators and that their methods represent best practice. This evidence should not be based solely on cost.

Table 3 contains a list of the proposed MRVs that may be acceptable in these circumstances.

Table 3: Proposed MRVs

Parameter	MRV for 'clean' groundwater samples	Proposed alternative MRVs
Azinphos-ethyl	0.02	<0.05
Azinphos-methyl	0.001	<0.03
Chlorfenvinphos	0.001	<0.01
Diazinon	0.001	<0.05
Dimethoate	0.01	<0.05
Fenitrothion	0.001	<0.01
Fenthion	0.01	<0.01
Malathion	0.001	<0.03
Mevinphos	0.005	<0.07
Parathion	0.01	<0.06
Parathion methyl	0.015	<0.01
Cis-permethryn	0.001	<0.02
Trans-permethryn	0.001	<0.01
Pentachlorophenol	0.1	<1
Cadmium	0.1	<1
Mercury	0.01	<0.1
Mecoprop	0.04	<0.1

Annex 5 Limits of detection

SEPA is currently developing a set of values for limits of detection (LoDs) for a range of hazardous substances not having minimum reporting values (MRVs). Until such time as this list is complete, we recommend that LoDs given in the *WHO Guidelines for Drinking Water Quality*, Third Edition, Volume 1, 2004, as amended, are used as a guide for the most accurate values to derive the most appropriate LoD.

Annex 6 Resource protection values – non-hazardous substances

Table 4 contains information regarding resource protection values (RPVs) based upon human health risk criteria. Inputs of non-hazardous substances should be limited to prevent pollution.

Table 4: Resource protection values – non-hazardous substances

	Pollutant link to information	RPV	Units	Source	EPA factsheet	Potential effects from contaminated water	Common source of contaminant
	Ammonia	0.50	mg/l NH4	a, b		Toxic to freshwater organisms forms nitrate in aerobic groundwater conditions.	Poorly treated sewage effluent.
	Antimony	5.00	µg/l Sb	a, b	Antimony	Gastrointestinal irritation, abdominal cramps, diarrhoea and cardiac toxicity.	Petroleum refineries; fire retardants; ceramics; electronics; solder.
	Arsenic	10.00	µg/l As	a, b	Arsenic	Affects skin and circulatory systems, and increases risk of cancer.	Erosion of natural deposits; runoff from orchards, runoff from glass and electronics production wastes.
	Barium	0.70	mg/l Ba	c	Barium	Increase in blood pressure.	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits.
	Beryllium	4.00	µg/l Be	d	Beryllium	Intestinal lesions.	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defence.
	Boron	1.00	mg/l B	a, b		May affect the central nervous system.	Semiconductors and the nuclear industry. As fire retardant, in washing powders and toothpaste.
	Bromate	10.00	µg/l BrO3	a, b		Suspected carcinogen.	Discharge from chemical plant.
	Carbofuran	7.00	µg/l	c	Carbofuran	Problems with blood, nervous system, or reproductive system.	Leaching of soil fumigant.
	Chlorine	250	mg/l Cl	a, b		Eye/nose irritation, stomach discomfort.	Swimming pool disinfection product.
	Chromium (total)	50.00	µg/l Cr	a, b	Chromium (total)	Allergic dermatitis.	Discharge from steel and pulp mills; erosion.
	Di(2-ethylhexyl) phthalate	6.00	µg/l	d	Di(2-ethylhexyl) phthalate	Reproductive difficulties; liver problems; increased risk of cancer.	Discharge from rubber and chemical factories.
	Dinoseb	7.00	µg/l	d	Dinoseb	Reproductive difficulties.	Runoff from herbicide used on soybeans and vegetables.
	Diquat	0.10	µg/l	a, b	Diquat	Cataracts.	Runoff from herbicide use.
	Fluoride	1.50	mg/l F	a, b	Fluoride	Bone disease. Children may get mottled teeth.	discharge from plastic and fertilizer factories.
	Iron	200.00	mg/l Fe	a, b		Causes staining of sanitary ware and laundry, affects taste.	

	Lead	**(a) 25, from 3/7/06 until 24/12/13**	µg/l Pb	**a, b**	**Lead**	Delays in physical or mental development of children. Kidney problems and high blood pressure of adults .	Corrosion of household plumbing systems; erosion of natural deposits.
	Manganese	**50.00**	µg/l Mn	**a, b**		Discolouration of sanitary ware.	Erosion of natural deposits.
	Nickel	**20.00**	µg/l Ni	**a, b, c**	**Nickel**		
	Nitrate (measured as Nitrogen)	**50.00**	mg/l NO3	**a, b, c**	**Nitrate (measured as Nitrogen)**	Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits.
	Nitrite (measured as Nitrogen)	**0.50**	mg/l NO2	**a, b**	**Nitrite (measured as Nitrogen)**	Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits.
	Oxamyl (Vydate)	**0.10**	µg/l	**a, b**	**Oxamyl (Vydate)**	Slight nervous system effects.	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes.
	Selenium	**10.00**	µg/l Se	**a, b, c**	**Selenium**	Hair or fingernail loss; numbness in fingers or toes; circulatory problems.	Discharge from petroleum refineries; erosion of natural deposits; discharge from mines.
	Thallium	**2.00**	µg/l Tl	**d**	**Thallium**	Hair loss; changes in blood; kidney, intestine, or liver problems.	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories.

Notes		
	SEPA listed non-hazardous substance	
	Substance in Groups 7-9 of Annex VIII of the WFD and having a drinking water standard or guideline value	
	i) RPV - resource protection value	Standard used by SEPA to give general protection to the groundwater resource for human consumption
a	The Water Supply (Water Quality) (Scotland) Regulations 2001	
b	Directive 98/83/EC the Drinking Water Directive	
c	WHO Guidelines for Drinking Water Quality	
d	US EPA National Primary Drinking Water Regulations	

Annex 7 Resource protection values – land contamination significant pollution

In assessing inputs to the water environment arising from land contamination, local authorities must determine if hazardous and non-hazardous substances are causing or are likely to cause significant pollution. They will therefore need to consider a wider range of substances than presented in Annex 6. Table 5 on the following pages is meant to supplement the table of non-hazardous substances in Annex 6 and contains additional values for a range of substances drawn from the following hierarchy: EC and Scottish drinking water standards, the WHO Drinking Water Quality Guidelines and US EPA National Primary Drinking Water Regulations. This list should not be taken as exhaustive.

Table 5: Resource protection values – significant pollution

	Pollutant (links to information)	RPV (i)	Units	Source	EPA factsheet	Potential Effects from Contaminated Water	Common Source of Contaminant
	Cadmium	5.00	µg/l Cd	a, b	Cadmium	Kidney damage.	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints.
	Cyanide (as free cyanide)	50.0	µg/l CN	a, b	Cyanide (as free cyanide)	Nerve damage or thyroid problems.	Discharge from steel/ metal factories.
	Mercury and its compounds (inorganic)	1.00	µg/l Hg	a, b, c	Mercury (inorganic)	Kidney damage.	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands.
	Alachlor	0.10	µg/l	b (ii)	Alachlor	Eye, liver, kidney or spleen problems; anaemia; increased risk of cancer.	Runoff from herbicide used on row crops.
	Aldrin and Dieldrin	0.03	µg/l	a, b		Affect the central nervous system and the liver.	Residue of banned pesticides.
	Atrazine	0.10	µg/l	b (ii)	Atrazine	Cardiovascular system or reproductive problems.	Runoff from herbicide used on row crops.
	Benzene	1.00	µg/l	a, b	Benzene	Anaemia; decrease in blood platelets; increased risk of cancer.	Discharge from factories; leaching from gas storage tanks and landfills.
	Benzo(a)pyrene (PAHs)	0.01	µg/l	a, b	Benzo(a)pyrene (PAHs)	Reproductive difficulties; increased risk of cancer.	Incomplete combustion of organic compounds.
	Carbon tetrachloride	3.00	µg/l	a	Carbon tetrachloride	Liver problems; increased risk of cancer.	Discharge from chemical plants and other industrial activities.
	Chlordane	0.10	µg/l	a, b (ii)	Chlordane	Liver or nervous system problems; increased risk of cancer.	Residue of banned termiticide.

	Chlorfenvinphos	0.10	µg/l	a, b (ii)		Slightly to highly toxic to aquatic organisms. Highly toxic to humans.	Runoff and infiltration from use of this pesticide.
	Chlorobenzene	0.10	mg/l	d	Chlorobenzene	Liver or kidney problems.	Discharge from chemical and agricultural chemical factories.
	2,4-D	0.10	mg/l	a, b (ii)	2,4-D	Kidney, liver, or adrenal gland problems.	Runoff from herbicide treated crops.
	Chlorotoluron	0.03	mg/l	c			Runoff from herbicide treated crops.
	Chlorpyriphos	0.03	mg/l	c			Runoff from insecticide treatment.
	Dalapon	0.10	mg/l	a, b (ii)	Dalapon	Minor kidney changes.	Runoff from herbicide used on rights of way.
	Diazinon	0.10	µg/l	a, b (ii)		Moderately toxic.	Runoff and infiltration from use of this pesticide.
	1,2 -dibromoethane	0.4	µg/l	c		Suspected carcinogen.	Solvent and chemical intermediate.
	1,2-Dibromo-3-chloropropane (DBCP)	1.00	µg/l	c	1,2-Dibromo-3-chloropropane (DBCP)	Reproductive difficulties.	Runoff/leaching from soil.
	1,2-Dichlorobenzene	0.60	mg/l	d	1,2-Dichlorobenzene	Liver, kidney, or circulatory system problems.	Discharge from industrial chemical factories.
	1,4-Dichlorobenzene	0.08	mg/l	d	1,4-Dichlorobenzene	Anaemia; liver, kidney or spleen damage; changes in blood.	Discharge from industrial chemical factories.
	1,2-Dichloroethane	0.03	mg/l	d	1,2-Dichloroethane	Increased risk of cancer.	Discharge from industrial chemical factories.
	1,1-Dichloroethylene	0.007	mg/l	d	1,1-Dichloroethylene	Liver problems.	Discharge from industrial chemical factories.
	cis-1,2-Dichloroethylene	0.07	mg/l	d	cis-1,2-Dichloroethylene	Liver problems.	Discharge from industrial chemical factories.
	1,2-Dichloropropane	5.00	µg/l	d	1,2-Dichloropropane	Increased risk of cancer.	Discharge from industrial chemical factories.
	trans-1,2-Dichloroethylene	0.05	mg/l	c	trans-1,2-Dichloroethylene	Liver problems.	Discharge from industrial chemical factories.
	Dichloromethane	0.005	mg/l	d	Dichloromethane	Liver problems; increased risk of cancer.	Discharge from drug and chemical factories.
	1,2 - Dichloropropane	0.005	mg/l	d	Dichloropropane	Increased cancer risk.	Soil fumigant.
	Dichloropropene	0.02	mg/l	c			

	Dimethoate	**6.00**	µg/l	**c**		Slightly to moderately toxic to aquatic organisms. Highly toxic to humans.	Runoff and infiltration from use of this pesticide.
	Dioxin (2,3,7,8-TCDD)	**0.00003**	µg/l	**d**	**Dioxin (2,3,7,8-TCDD)**	Reproductive difficulties; increased risk of cancer.	Waste incineration and other combustion; discharge from chemical factories.
	Endrin	**0.6**	µg/l	**c, d**	**Endrin**	Possible liver problems.	Runoff from insecticide use.
	Epichlorohydrin	**0.10**	µg/l	**a, b**	**Epichlorohydrin**	Increased cancer risk, and over a long period of time, stomach problems.	Discharge from industrial chemical factories; an impurity of some water treatment chemicals.
	Ethylbenzene	**0.30**	mg/l	**c**	**Ethylbenzene**	Liver or kidneys problems.	Discharge from petroleum refineries.
	Ethylene dibromide	**0.05**	µg/l	**d**	**Ethylene dibromide**	Liver, stomach, reproductive system, or kidneys; increased risk of cancer.	Discharge from petroleum refineries.
	Fenitrothion	**0.10**	µg/l	**a, b (ii)**		Toxic to a range of wildlife and accumulates in aquatic organisms. Toxic to humans.	Runoff and infiltration from use of this pesticide.
	Fenthion	**0.10**	µg/l	**a, b (ii)**		Moderately to very highly toxic and accumulative to a range of aquatic organisms. Moderately toxic to humans.	Runoff and infiltration from use of this pesticide.
	Glyphosate	**0.10**	mg/l	**a, b (ii)**	**Glyphosate**	Kidney problems; reproductive difficulties.	Runoff and infiltration from herbicide use.
	Heptachlor	**0.03**	µg/l	**a, b (ii)**	**Heptachlor**	Liver damage; increased risk of cancer.	Residue of banned termiticide.
	Heptachlor epoxide	**0.03**	µg/l	**a, b (ii)**	**Heptachlor epoxide**	Liver damage; increased risk of cancer.	Breakdown of heptachlor.
	Hexachlorobenzene	**0.10**	µg/l	**a, b (ii)**	**Hexachlorobenzene**	Liver or kidney problems; reproductive difficulties; increased risk of cancer.	Discharge from metal refineries and agricultural chemical factories.
	Hexachlorobutadiene	**0.6**	µg/l	**c**		Kidney problems.	Solvent in chlorine gas production, a pesticide, an intermediate in the manufacture of rubber compounds and a lubricant.

	Lindane	**0.10**	µg/l	**a, b (ii)**	Lindane	Liver or kidney problems.	Runoff/leaching from insecticide used on cattle, lumber, gardens.
	Malathion	**0.10**	µg/l	**a, b (ii)**		Slightly to highly toxic to aquatic organisms. Moderately toxic to humans, may be carcinogenic and suspected endocrine disrupter.	Runoff and infiltration from the use of this pesticide.
	Mecoprop	**0.10**	µg/l	**a, b (ii)**		Slight to moderate toxicity to aquatic organisms. Slight toxicity to humans, possible carcinogen.	Runoff and infiltration from use of this pesticide.
	Methoxychlor	**0.10**	mg/l	**a, b (ii)**	Methoxychlor	Reproductive difficulties.	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock.
	Mevinphos	**0.10**	µg/l	**a, b (ii)**		Moderately to very highly toxic to aquatic organisms. Highly toxic to humans, suspected endocrine disrupter.	Runoff and infiltration from use of this pesticide.
	PAH	**0.10**	µg/l	**a, b (iii)**			
	Parathion	**0.10**	µg/l	**a, b (ii)**		Slightly to very highly toxic to aquatic organisms. Highly toxic to humans, suspected endocrine disrupter.	Runoff and infiltration from the use of this pesticide.
	Parathion Methyl	**0.10**	µg/l	**a, b (ii)**		Slightly to very highly toxic to aquatic organisms. Highly toxic to humans, suspected endocrine disrupter.	Runoff and leaching from the use of this pesticide.
	cis-Permethryn	**0.10**	µg/l	**a, b (ii)**			Runoff and leaching from the use of this pesticide.
	trans-permethryn	**0.10**	µg/l	**a, b (ii)**			Runoff and leaching from the use of this pesticide.
	2, 4, 6 - Trichlorophenol	**0.2**	mg/l	**c**			Degradation of phenoxy herbicides.
	2, 4, 5 – Trichlorophenoxy acetic acid	**0.009**	mg/l	**c**			Use as a herbicide.
	Total pesticides	**0.50**	µg/l	**a, b (ii)**			

	Polychlorinated biphenyls (PCBs)	0.50	µg/l	d	Polychlorinated biphenyls (PCBs)	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer.	Runoff from landfills; discharge of waste chemicals.
	Pentachlorophenol	0.10	µg/l	a, b (ii)	Pentachlorophenol	Liver or kidney problems; increased cancer risk.	Discharge from wood preserving factories.
	Simazine	0.10	µg/l	a, b (ii)	Simazine	Problems with blood.	Herbicide runoff.
	Styrene	0.02	mg/l	c	Styrene	Liver, kidney, or circulatory system problems.	Discharge from rubber and plastic factories; leaching from landfills.
	Tetrachloroethene & Trichloroethene	10.00	µg/l	a, b	Tetrachloroethene Trichloroethene	Liver problems; increased risk of cancer.	Discharge from factories and dry cleaners.
	Toluene	0.70	mg/l	c	Toluene	Nervous system, kidney, or liver problems.	Discharge from petroleum factories.
	1,2,4-Trichlorobenzene	0.07	mg/l	d	1,2,4-Trichlorobenzene	Changes in adrenal glands.	Discharge from textile finishing factories.
	1,1,1-Trichloroethane	0.20	mg/l	d	1,1,1-Trichloroethane	Liver, nervous system, or circulatory problems.	Discharge from metal degreasing sites and other factories.
	1,1,2-Trichloroethane	5.00	µg/l	d	1,1,2-Trichloroethane	Liver, kidney, or immune system problems.	Discharge from industrial chemical factories.
	Vinyl chloride	0.50	µg/l	a, b	Vinyl chloride	Increased risk of cancer.	Leaching from PVC pipes; discharge from plastic factories.
	Xylenes (total)	0.50	mg/l	c	Xylenes (total)	Nervous system damage.	Discharge from petroleum factories; discharge from chemical factories.

Notes	
	JAGDAG Hazardous substance having drinking water quality standard or guideline value
	Substance in Points 1 - 6 of WFD Annex VIII having a drinking water quality standard or guideline value
	i) RPV - Resource protection value
	ii) Pesticides - each individual max 0.1 µg/l, total max 0.5 µg/l
	iii) PAH means Polycyclic Aromatic Hydrocarbons, the specified compounds are: benzo(b)fluoranthene benzo(k)fluoranthene benzo(ghi)perylene indeno(1,2,3-cd)pyrene
	a = The Water Supply (Water Quality) (Scotland) Regulations 2001
	b =Directive 98/83/EC the Drinking Water Directive
	c = *WHO Guidelines for Drinking Water Quality*
	d = US EPA National Primary Drinking Water Regulations

9 References

- WAT-RM-05: *Regulating Trade Effluent Discharges to Surface Waters*
- WAT-SG-02: *Modelling Continuous Discharges to Rivers*
- WAT-SG-10: *Modelling the effects of Phosphorous Inputs to Freshwater lochs*
- WAT-SG-11: *Modelling Discharges to Coastal and Transitional Waters*
- WAT-RM-28: *Modelling methods for groundwater abstractions*
- *Hydrogeological Risk Assessments for Landfills and the Derivation of Control and Trigger Levels*
- *Guide to Good Practice for the Development of Conceptual Models and Application of Mathematical Models of Contaminant Transport Processes in the Subsurface*, EA, 2001
- Environmental Quality Standards (EQS) for the protection of aquatic life
- Water quality standards for saline waters required to support fish or shellfish
- Water quality standards for fresh and saline waters used for bathing or contact water sports
- EC water quality standards
- World Health Organisation (WHO) *Guidelines for Drinking Water Quality*, 1984
- European Council Directive 98/83/EC on the quality of water intended for human consumption
- Standards taken from:
  - Water Supply (Water Quality) (Scotland) Regulations 2001; or
  - The Private Water Supplies (Scotland) Regulations 2006;
- The US EPA 'National Primary Drinking Water Regulations'
- The Annex to the Groundwater Directive
- JAGDAG Hazardous Substances (this may be found at: Hazardous substances)
- JAGDAG non-hazardous substances
- Annex VIII of the Water Framework Directive

0668_MR 08/10