Scottish Environment Protection Agency
Buidheann Dìon Àrainneachd na h-Alba

WAT-PS-10 Assigning groundwater assessment criteria for pollutant inputs consultation

November 2020

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Contents

1 Overview

The Scottish Government is consulting on a framework for protecting Scotland's groundwater from pollution. One key element of the consultation proposes revised environmental standards for substances that can adversely affect groundwater.

To align with the proposed revised standards SEPA has revised the guidance, WAT-PS-10, on Assigning Groundwater Assessment Criteria for Pollutant Inputs which is set out below.

It is recommended that you read the Scottish Government consultation prior to reading this guidance. This will allow you to understand the changes being proposed by the Scottish Government before reading SEPA's more detailed guidance on using the standards.

2 Why is SEPA consulting?

The key concepts and associated questions with regard to groundwater standards and how they should be used are set out in the Scottish Government consultation document. To help industry and other interested stakeholders further understand the detail of the proposed approach SEPA has updated the guidance, WAT-PS-10, on assigning groundwater assessment criteria for pollutant inputs. SEPA is seeking your views on this position statement and have set out a number of questions throughout the document to do this.

How to respond

You can respond to this consultation online. As our offices are currently closed, please do not mail your response. You can email your responses on the proposal to groundwater@sepa.org.uk

Responses should be submitted to us by 12 February 2021.

Q1. What is your name? (optional)

Q2. What is your email address? (optional)

Q3. What is your interest in our consultation? (optional)

3. Introduction

SEPA's statutory purpose[1] is to protect and improve the environment (environmental success) in ways that, as far as possible, create:

- health and well-being benefits (social success);
- sustainable economic growth (economic success).

Groundwater is important for Scotland, providing drinking water as well as supporting ecosystems and sustainable economic activity in a range of sectors.

Past and current activities can cause pollutants to enter groundwater, for example historical industrial activity or the disposal of waste or wastewater to ground. Once contaminated, groundwater is often very difficult and very expensive to clean up. Even after the source of the contamination has been removed, groundwater can remain contaminated for several generations.

Thus, effective protection of Scotland's groundwater is vital to achieving SEPA's statutory purpose.

This position statement sets out:

1. SEPA's objectives for protecting and improving groundwater quality
2. Criteria for how we will assess if these objectives are met
3. SEPA's recommended approach to demonstrating compliance with the objectives
4. The circumstances in which the groundwater objectives do not need to be met.

[1] Regulatory Reform (Scotland) Act 2014

This position statement applies to:

- All activities, both old and new
- All pollutants that impact on groundwater, including radioactive substances and heat.

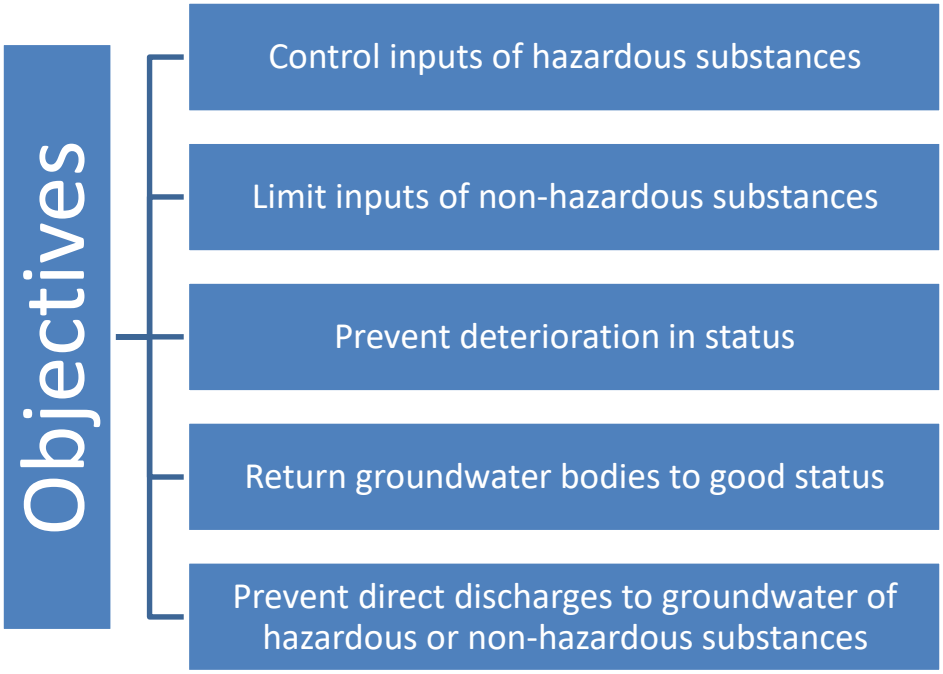
This position statement does not apply to unauthorised inputs to groundwater e.g. recent spills or leaks. This is because there is a prohibition under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR)[2] on the input of pollutants into groundwater without authorisation. Therefore, any evidence of an input, such as a leaking tank or a detection of pollutants in groundwater, which can be attributed to the unauthorised activity, is a breach of CAR.

This position statement has been written primarily to aid SEPA staff in their regulatory duties. SEPA expect the approach outlined in this document to be used to demonstrate compliance with the groundwater objectives. Other parties may also refer to this document, including other regulatory bodies, site owners and operators, consultants and contractors, as well as the general public.

[2] and in Pollution Prevention and Control Regulations (PPC), The Waste Management Licensing Regulations and the Environmental Authorisations (Scotland) Regulations 2018.

4. SEPA objectives for groundwater quality

SEPA's objectives for protecting groundwater quality are set out below.



The groundwater standards (Section 5) will be used to determine whether these objectives are being met. The groundwater standards comprise a concentration, a statistic and a location at which they should be assessed. The background to the standards is set out in Annex 1 and the concentrations for the standards relating to groundwater for a range of common substances are set out in Annex 2.

Q4. Annex 1 sets out the background to the standards. We have not significantly changed the approach set out in section A1.4 "What is an input and a discharge?" from our previous version of this guidance. This is because we think it works well. Do you agree that no changes are required?

Q5. Section A1.5 sets out how compliance and assessments points can differ. This reflects the current guidance. Do you agree that we should continue to set out how assessment and compliance points differ in this way?

Q6. Section A1.7 sets out the basis for the threshold values. The Scottish Government consultation asks if you agree with the approach to assess pollution using threshold values. In this consultation we are asking if you agree with the hierarchy set out to decide which value to use?

The groundwater standards are designed to assess degree of impact to groundwater and to groundwater-dependent receptors. Groundwater-dependent receptors include surface waters, wetlands and existing abstractions. Inputs to groundwater should not cause harm to property, amenities, and other legitimate uses of the water environment. SEPA considers that this will be achieved by protecting groundwater and groundwater-dependent receptors.

Q7. Annex 2 sets out the groundwater standards concentrations. A list of standards for common substances is linked from A2.1. Do you think the layout of this table is clear?

Q8. Do you think there is any information missing from the list of standards for common substances?

Q9. We have not set out a generic temperature standard for groundwater. Instead we propose that the temperature in groundwater must not be high or low enough to cause adverse direct or indirect impacts in groundwater-dependent receptors including surface waters, wetlands or abstractions. Do you agree with this approach?

The groundwater standards are not necessarily authorisation limits or remedial targets, although they may form the basis from which these can be derived once site-specific considerations are taken into account.

The approach SEPA expects to be taken to demonstrate compliance with the groundwater standards is outlined in Section 6 with supporting detail provided in Annex 3. Both the source and associated downgradient plume must be considered.

SEPA will apply these objectives when authorising activities, when consulted on potentially polluting activities that are going through the planning process and when is involved in the process related to land contamination.

In certain circumstances the groundwater objectives do not need to be met. This is set out in Section 7.

5 Groundwater standards to assess objectives

Table 1 below summarises the standards SEPA will use to assess if the objectives presented in Section 2 have been met. The background to the groundwater standards is presented in Annex 1. The assessment concentrations are presented in Annex 2. Further detail on the assessment process, including defining assessment points, is presented in Annex 3.

Table 1 - Summary of groundwater standards used to assess if the objectives have been met

Objective	Groundwater Standard	Receptor	Spatial Assessment Rules	Assessment Concentration and statistic	Assessment Statistic
Control inputs of hazardous substances so that there is no risk of deterioration in the quality of groundwater	Hazardous substance input standard[3]	Groundwater less than 400 m depth below ground level and which is located inland of the mean high water springs tidal limit and groundwater below 400m below ground level or below mean high water springs if there is a pathway for contaminants to reach surface ecosystems.	Assessed at the base of unsaturated zone[4] (more than 50 m from surface water body)[3]	Hazardous substance input value (>50m)	Annual average
		Surface waters	Assessed at the base of unsaturated zone (within 50 m of surface water body)[3]	Hazardous substance input value (<50m)	Annual average
Limit inputs of non-hazardous[5] substances so that they do not cause deterioration of groundwater	Pollution standard	Future groundwater resource	Standard exceeded over 1 hectare[6]	Threshold value[7]	Annual average
		Current abstractions	Assessed in abstraction prior to treatment	Use-based standard[8]	Maximum
		Surface waters	Assessed in surface water following mixing	Environmental quality standard or other SEPA agreed standard[9]	Annual average

[3] The risks posed by radioactive substances will be assessed differently using the procedures set out in the relevant radioactive substances guidance.

[4] Dilution in groundwater must not be taken into account. Sources below the water table should be assessed at the point of entry to groundwater.

[5] The groundwater pollution and status standards will also apply to hazardous substances with respect to historical land contamination but only where the contaminant has already entered groundwater; they do not apply to new or ongoing hazardous substance inputs, which should comply with the hazardous substance input standard.

[6] In scenarios where surface recharge is not the dominant control on the groundwater flow regime (e.g. groundwater at >30m depth in hard rock terranes), an alternative site-specific assessment area capable of supporting a flow of 10m^3/d may be proposed for consideration by SEPA.

[7] See Annex 2.1

[8] If abstracted water is used for multiple uses, then the most stringent use-based standard will apply.

[9] See WAT-SG-53 Environmental Standards for Surface Waters

Objective	Groundwater Standard	Receptor	Spatial Assessment Rules	Assessment Concentration and statistic	Assessment Statistic
		Groundwater dependent wetlands	Assessed in the wetland	Wetland standard or other SEPA agreed standard	Annual average
Prevent deterioration in the status of the groundwater body AND Return groundwater bodies at poor status to good status	Status standard	Future groundwater resource	Hazardous substances exceed standard over 20 hectares[10] Non-hazardous substances exceed standard when averaged across groundwater body	Threshold value	Annual average
		Current abstractions for human consumption	Assessed in abstraction prior to treatment	Drinking Water Standard plus upward trend in concentrations[11]	Maximum
		Surface water bodies subject to classification	Assessed in surface water following mixing taking into account spatial rules[12]	Environmental quality standard or other SEPA agreed standard	Annual average
		Groundwater dependent wetlands designated as Natura 2000 or SSSI sites	Assessed in the wetland	Wetland standard or other SEPA agreed standard	Annual average
Prevent direct discharges to groundwater of hazardous or non-hazardous substances	Direct discharge to groundwater	Groundwater less than 400 m depth below ground level and which is located inland of the mean high water springs tidal limit and groundwater below 400m below ground level or below mean high water springs if there is a pathway for contaminants to reach surface ecosystems.	Point of entry to groundwater	Hazardous substances = Hazardous Substance Input Values Non-hazardous substances = Threshold values	Annual average

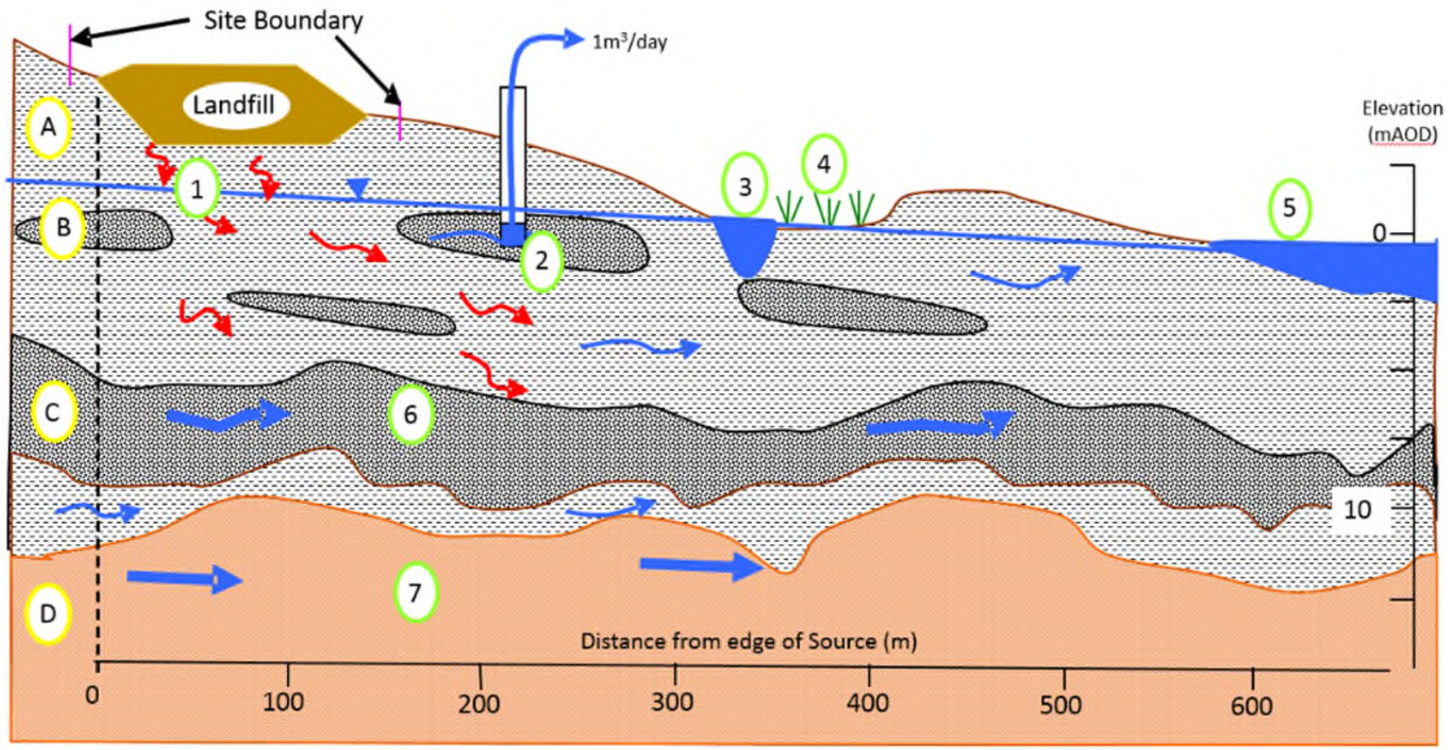
Q10. The Scottish Government consultation asks if you agree with the proposed changes to the standards. Does Table 1 set out the standards clearly?

[10] In scenarios where surface recharge is not the dominant control on the groundwater flow regime (e.g. groundwater at >30m depth in hard rock terranes), an alternative site-specific assessment area capable of supporting a flow of 200m^3/d may be proposed for consideration by SEPA.

[11] As per UKTAG Paper 11b(i).

[12] As set out in Schedule 4 of The Scotland River Basin District (Standards) Directions 2014. See also Annex A3.3.4.

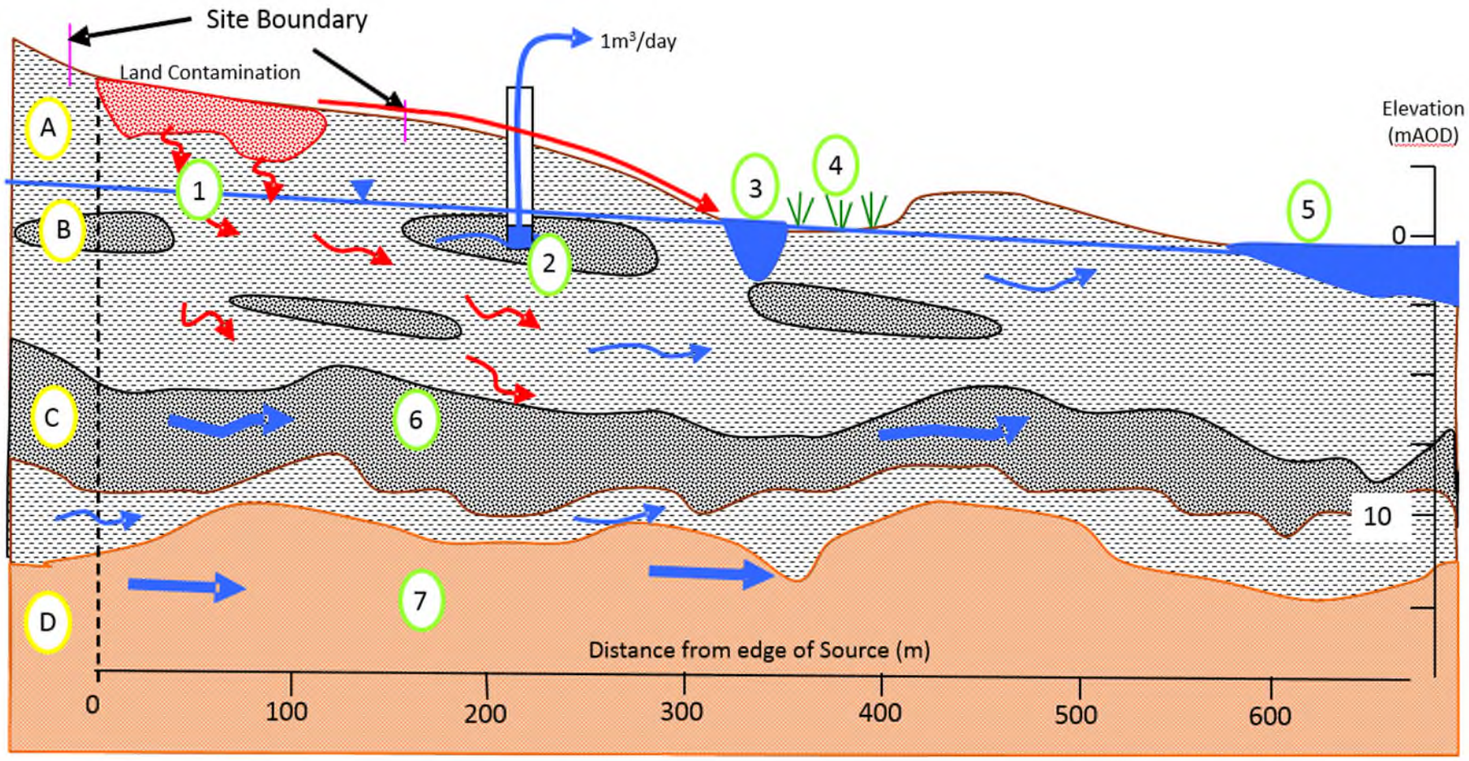
Figure 1 - Example of relevant assessment points for an operational activity



Type of Substance	Receptor	Groundwater Standards	Spatial Assessment Point		Comment
Hazardous	Groundwater	Hazardous Substances Input Standard	1	Base of unsaturated zone	Irrespective of aquifer size or productivity
Non-Hazardous	Existing abstraction	Pollution Standard Status Standard	2	In supply prior to treatment	Status standard only applies abstraction is for human consumption and if there is an upward trend in concentrations
	Surface water	Pollution Standard	3	In surface water after dilution	Note status standard assessment point may be downstream if closest water feature is a tributary of water body

		Status Standard	5		
	GWDTE	Pollution Standard Status Standard	4	In groundwater at upgradient boundary of the GWDTE	Only applies if hydraulic connection between contaminated groundwater and GWDTE Note status standard only applies if GWTDE is a designated site
	Future groundwater resource	Pollution Standard	6 7	Within hydrogeological unit with future groundwater resource potential located at a distance “x” measured from upgradient source boundary in the direction of groundwater flow. See section A3.3.3	A – Low productivity superficial deposits. Not future groundwater resource but pathway to other receptors. B – High productivity superficial deposits of limited spatial extent. Not future groundwater resource but pathway to other receptors. C - High productivity superficial aquifer capable of supplying 10 m^3/d. Future groundwater resource. C – Bedrock aquifer. Future groundwater resource.

Figure 2 - Example of relevant assessment points for historical land contamination



Type of Substance	Receptor	Groundwater Standards	Spatial Assessment Point		Comment
Hazardous	Groundwater	Hazardous Substances Input Standard	1	Base of unsaturated zone	Irrespective of aquifer size or productivity
Non-Hazardous	Existing abstraction	Pollution Standard Status Standard	2	In supply prior to treatment	Status standard only applies abstraction is for human consumption and if there is an upward trend in concentrations
Hazardous, but only if substance has already	Surface water	Pollution Standard Status Standard	3 5	In surface water after dilution	Note status standard assessment point may be downstream if closest water feature is a tributary of water body

entered groundwater	GWDTE	Pollution Standard Status Standard	4	In groundwater at upgradient boundary of the GWDTE	Only applies if hydraulic connection between contaminated groundwater and GWDTE Note status standard only applies if GWDTE is a designated site
	Future groundwater resource	Pollution Standard Status Standard (hazardous substances only)	6 7	Within hydrogeological unit with future groundwater resource potential located at a distance “x” measured from upgradient source boundary in the direction of groundwater flow. See section A3.3.	Note status standard only applies to hazardous substances that have already entered groundwater. A – Low productivity superficial deposits. Not future groundwater resource but pathway to other receptors. B – High productivity superficial deposits of limited spatial extent. Not future groundwater resource but pathway to other receptors. C - High productivity superficial aquifer capable of supplying 10 m^3/d. Future groundwater resource. C – Bedrock aquifer. Future groundwater resource.

6 Demonstrating compliance with objectives

This section sets out what SEPA expect with respect to determining whether the groundwater objectives have been achieved.

6.1 Low hazard activities

SEPA consider certain activities to pose a comparatively low hazard. The standards presented in this document will be used by SEPA to determine what activities are considered low hazard. To regulate these low hazard activities, SEPA will define generic criteria. If these criteria and rules are met, SEPA will assume the activity can proceed without breaching the objectives.

SEPA considers activities regulated by SEPA using registrations or general binding rules to be comparatively low hazard. Examples of activities that SEPA consider to be relatively low risk include (but are not limited to) small septic tank discharges (<15 PE), grouting of former mine workings, small cemeteries and most site investigation and drilling activities. Where appropriate, SEPA will also recommend generic criteria for specific low hazard development activities in our standard planning guidance for local authorities.

Examples of types of generic criteria include:

- soil thickness
- soil type
- depth to groundwater
- proximity to abstractions or surface waters

If the generic criteria and standard rules cannot be met, the approach outlined for higher hazard activities should be adopted (see Section 6.2 below).

6.2 Higher hazard activities

For higher hazard activities, SEPA will expect a site-specific risk assessment to be undertaken. This should be based on a site-specific conceptual site model (CSM), supported by appropriate desk study and ground investigation. The CSM should be used to identify relevant pollutant linkages using a Source-Pathway-Receptor approach.

Where relevant pollutant linkages exist, a phased approach to the detailed quantitative risk assessment is recommended:

Tier 1 Compare source concentrations with relevant standards

Tier 2 Compare predicted concentrations at the relevant assessment point with the relevant standards taking into account dilution only

Tier 3 Compare predicted concentrations at the relevant assessment point with the relevant standards taking into account natural attenuation

Q11. Do you agree with our tier-based system to assessing impact?

Further details regarding SEPA's recommended approach to site-specific hydrogeological risk assessment are presented in Annex 3.

Q12. Section A.3.1.5.sets out guidance on calculating annual average concentrations. Do you agree with our approach to dealing with limits of detection?

Q13. Section A.3.1.5.sets out guidance on calculating annual average concentrations. We have not specified a minimum number of data points. Do you agree with this approach?

Q14. Section A3.3.1 sets out how to calculate input loading. Do you agree with our approach to assessing source input loading rates where the source is below the water table?

Q15. Section A3.3.3 sets out guidance on assessing the impact on the future groundwater resource. We have set out equivalent assessment point distances for the future groundwater resource. Do you think these tables are useful?

Q16. Section A3.3.3 sets out guidance on assessing the impact on the future groundwater resource. We have set out equivalent assessment point distances for the future groundwater resource. Do you agree with our upper limits to equivalent assessment point distances?

Q17. A3.3.4, A3.3.5 and A3.3.6 set out how to assess the impact on surface waters, GWDTE and abstractions. This approach has not significantly changed to that set out in current guidance. Do you agree that no changes are required?

7. Next steps if objectives may not be achieved

SEPA is aware that, in certain circumstances, it may not always be feasible to meet the groundwater standards. Similarly, in some circumstances, meeting the groundwater standards may not represent the best overall option for the environment as a whole.

This section sets out scenarios where SEPA will consider whether an exemption from meeting the groundwater objectives applies. This is set out in Table 2.

For new activities, SEPA expect best practice to be followed. For existing authorised activities, SEPA expect best practice to be adopted as far as practicable. However, consideration will be given as to the necessity of adopting any additional measures, in particular whether the measures would increase the risks to human health or the quality of the environment as a whole.

For historical land contamination, consideration may be given as to whether remedial measures are disproportionately costly or would increase the risks to human health or the quality of the environment as a whole. For further details regarding historical land contamination, refer to SEPA Guidance Land Contamination and Impacts on the Water Environment, commonly known as the ‘Brown Booklet’

Table 2 - Scenarios where SEPA will consider accepting breaching groundwater objectives

Objective	How can you tell if the objective has been met	Scenarios where SEPA will consider exemption from meeting groundwater objectives	
		Inputs from historical land contamination	Inputs from current and new activities
1. Control inputs of hazardous substances so there is no risk of deterioration in the quality of groundwater	Inputs of hazardous substances meet the hazardous substances input standards at the base of the unsaturated zone.	If measures to achieve the objective are disproportionately costly or would increase the risks to human health or the quality of the environment as a whole. Action beyond remediation of the sources[13] of hazardous substances as far as practicable is considered to be disproportionately costly and may not need to be undertaken.	If measures to achieve the objective would increase the risks to human health or the quality of the environment as a whole. SEPA consider it likely that exemption from meeting this objective will normally only be acceptable where there is a disposal of radioactive waste to ground. Detailed justification will be required to show that there is no better environmental option for the disposal. Activities must apply best practice and comply with sector-specific guidance and seek to minimise the input of radioactive substances into groundwater.
2. Limit inputs of non-hazardous[14] substances so they do not cause deterioration of groundwater.	Inputs of non-hazardous substances meet the pollution standards (see table 1). Where groundwater is already polluted further inputs should not cause any further significant deterioration or prevent improvement of groundwater quality.	If measures to achieve the objective are disproportionately costly or would increase the risks to human health or the quality of the environment as a whole. Source management to break the pollutant linkage is not normally considered to be disproportionately costly. Any proposals to undertake less action than this must be supported by a detailed cost-benefit assessment.	If measures to achieve the objective would increase the risks to human health or the quality of the environment as a whole. SEPA consider it likely that exemption from meeting this objective will normally only be acceptable[15] for landfill sites, cemeteries and where there is a disposal of radioactive waste. New activities must apply BAT and comply with sector-specific guidance. Existing activities must apply BAT and comply with sector-specific guidance as far as practicable, provided any additional measures

[13] In this context, sources are considered to include tanks and associated pipework or other underground infrastructure or services containing hazardous substances, free product non-aqueous phase liquids, and soil containing leachable concentrations that could result in groundwater pollution.

[14] As stated in Chapter 3, the pollution and status standards may also be applied to hazardous substances with respect to historical land contamination where the contaminants have already entered groundwater; they do not apply to new or ongoing inputs, which should comply with the hazardous substance input standard.

[15] SEPA recognise that it is not always feasible for the footprint of these activities to be less than 1 ha.

Objective	How can you tell if the objective has been met	Scenarios where SEPA will consider exemption from meeting groundwater objectives	
		Inputs from historical land contamination	**Inputs from current and new activities**
			will not increase the risks to human health or the quality of the environment as a whole.
3. Prevent deterioration in the status of the groundwater body	The groundwater status standard is not breached. The pollution standard may or may not be exceeded locally.	This objective cannot be breached. Action should be taken to avoid a breach of the groundwater status standard by controlling inputs and/or by remedying the impact on groundwater and/or groundwater-dependent receptors. This should include undertaking remedial measures where a plume is expanding or there is an upward trend in concentration such that groundwater body is likely to be at poor status in future.	
4. Return groundwater bodies at poor status to good status.	Groundwater status standards are met.	If measures to achieve the objective would be infeasible or disproportionately expensive. Action beyond that listed below is considered to meet this criteria and does not need to be undertaken. • Where the contamination has impacted on an abstraction for human consumption or caused a surface ecosystem to be at poor status, then action must be taken to remedy the impact on the receptor. • Where the long term resource is at poor status then action must be undertaken to prevent further expansion of the plume or an upward trend in concentration at the source. • Action should also be undertaken to achieve good status in the groundwater resource in future. Any proposals to undertake less action than that specified above must be supported by a detailed cost-benefit assessment.	Activities will be authorised unless they will prevent a groundwater body already at poor status from being restored.
5. Prevent Direct Discharges	No materials that leach above the standard should be placed below the water	Not applicable as historical land contamination sources are considered to be inputs but not discharges (see Annex 1.4).	As detailed in Regulation 13(j) The Water Environment (River Basin Management Planning: Further Provision) (Scotland) Regulations 2013.

Objective	How can you tell if the objective has been met	Scenarios where SEPA will consider exemption from meeting groundwater objectives	
		Inputs from historical land contamination	Inputs from current and new activities
	table without an appropriately engineered barrier and/or there is no discharge of effluent containing substances in concentrations above the standards set out for this objective in table 1.		Activities involving direct discharges will be authorised only where they comply with CAR. Refer to CAR Practical Guide for details regarding relevant GBRs.

Q18. We have tried to outline the circumstances when exemptions from meeting the objectives apply in table 2. Do you agree with our guidance?

Q19. Reading the document and annexes as a whole, do you find it clear and is there sufficient information for you to make an assessment?

Annex 1 Background to the standards

A1.1 What is groundwater?

Groundwater is defined by legislation as '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 or depth limit so even small volumes of water in the subsurface or at depth are considered as groundwater if the ground or subsoil[16] are saturated. Groundwater is present in all parts of Scotland and to considerable depth.

Legally controlled activities taking place in groundwater within the landward limits of coastal waters (up to 3 miles from limit of the highest tide) are subject to control under CAR or equivalent legislation.

However, groundwater at significant depth and under coastal and transitional waters is typically saline, naturally unsuitable for use and its flow is not significant for associated surface water or wetland ecosystems. Such groundwater does not require protecting as a receptor provided it can be demonstrated that there is no significant pathway for contaminants to reach surface ecosystems.

A1.2 What is future groundwater resource potential?

SEPA consider that future groundwater resource potential is groundwater within all aquifers capable of supplying 10 m^3/day or 50 people (on a continuous basis), that are less than 400 m below ground level, and located inland of the mean high water springs tidal limit. This is in line with the UK TAG criteria for defining groundwater bodies[17]. Note that aquifers that are not currently used for potable supply may still have future groundwater resource potential.

SEPA considers that the following groundwater have future resource potential:

[16] Subsoil is considered here to include both natural soils and anthropogenic soils ('made ground').
[17] UKTAG, 2012, *Defining & Reporting on Groundwater Bodies*

- Groundwater within all bedrock aquifers[18] to a depth of 400 m below ground level in mainland Scotland plus those islands mapped by SEPA as groundwater bodies[19].
- Groundwater in sand and gravel aquifers mapped by SEPA as groundwater bodies. Selected extensive sand and gravel aquifers are mapped as groundwater bodies[20].
- Groundwater in superficial deposits that are not mapped as groundwater bodies unless it has been demonstrated using the methodology in Annex 4 that the groundwater does not have resource potential.

Where groundwater is not classed as having future resource potential, it still requires consideration as a pathway to other receptors, such as other groundwater that does have future resource potential, surface waters, abstractions or wetlands.

A1.3 What is a hazardous substance?

Hazardous substances are "*substances or groups of substances that are toxic, persistent and liable to bioaccumulate, and other substances or groups of substances which give rise to an equivalent level of concern*[21]".

The Water Environment (Controlled Activities) (Scotland) Regulations 2011 require SEPA to publish a list of the Groundwater Hazardous Substances that are applicable in Scotland on the basis of their intrinsic properties. This list is based on the recommendations of the Joint Agency Groundwater Directive Advisory Group (JAGDAG).

[18] Including weathered bedrock

[19] Note that a groundwater body is a management unit for Scotland's groundwater. All of mainland Scotland and the majority of inhabited islands are split into groundwater bodies. Each groundwater body includes the bedrock and/or overlying superficial deposits

[20] Ó Dochartaigh et al, 2015, *Scotland's aquifers and groundwater bodies*

[21] As defined in GWD – note that other regulatory regimes may use alternative definitions for 'Hazardous'.

Radioactive material and radioactive waste[22] are considered hazardous pollutants in groundwater.

Any substances that are not designated as hazardous by SEPA are considered to be non-hazardous. Non-hazardous substances also include pathogens and heat.

A1.4 What is an input and a discharge?

An input of a pollutant is direct or indirect introduction of pollutants into groundwater as a result of human activity.

Inputs to groundwater may be divided into three categories:

- Active inputs - 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 - those resulting from some previous activity that has now ceased, for example, an input from land contamination.
- Accidental inputs - 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 discharge is an active input directly into groundwater i.e. it bypasses the unsaturated zone during at least part of the year. Direct discharges of pollutants to groundwater[23] are prohibited except in certain exceptional circumstances – see Section 5.

The deliberate placement of materials, where leaching exceeds the standard, below the water table without an appropriately engineered barrier will be considered to be a

[22] As defined in The Environmental Authorisations (Scotland) Regulations 2018 and associated guidance.

[23] Direct discharges of pollutants to groundwater can be permitted to groundwater below 400m below ground level or below mean high water springs if there is no pathway for contaminants to reach surface ecosystems.

direct discharge. Discharge of effluents below the water table containing substances in concentrations above the standard will be considered to be a direct discharge.

An indirect discharge is an active input into groundwater via the unsaturated zone. The source is located wholly within the unsaturated zone, even during seasonal fluctuations of the water table.

Historical land contamination sources, including those that are in contact with or extend below the water table, are considered by SEPA to be inputs but not discharges.

Diffuse inputs, such as use of fertilisers in agriculture, are considered by SEPA to be inputs but not discharges.

In summary, all discharges are inputs but not all inputs are discharges.

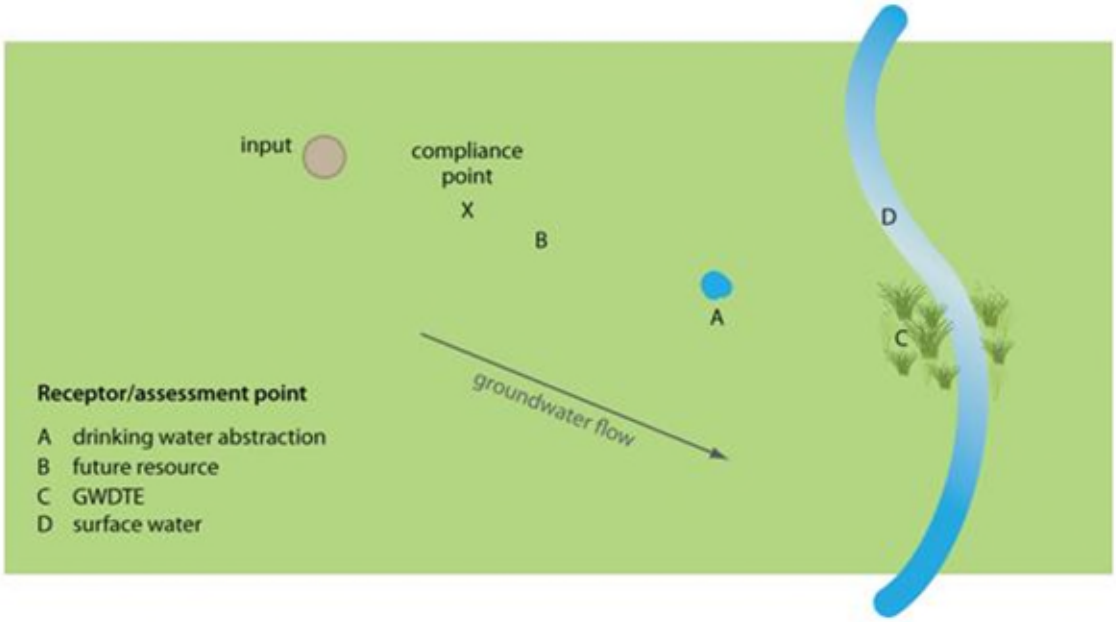
A1.5 What is an assessment point and how does it differ from compliance?

An “assessment point” may be defined as ‘the point at which the standard should be met’ i.e the point used to assess if there has been or will be an impact. It may be real or theoretical; 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. It can be derived from the spatial assessment rules.

A “compliance point” is defined as a physical sampling point used to demonstrate that the activity is likely to have achieved the agreed objectives and the input is acceptable. It need not be in the same location as the assessment point because:

- It may not be practical to install monitoring points at the assessment point e.g. the base of the unsaturated zone or due to land use or access constraints.
- A compliance point may be required to provide an early warning to receptors e.g. by being located between the source and a water supply.

It is important that the compliance point is located within the plume or potential pathway of the plume, including monitoring at an appropriate depth and in appropriate strata.



More than one assessment point may be required to protect all receptors as is shown in Figure 3.

The compliance concentration measured at the compliance point may also differ from the concentration at the assessment point because:

- it may need to be adjusted to take account of attenuation and dilution between the assessment point and compliance point - see Figure 4.
- the agreed action e.g. a remedial target, may not be to achieve the assessment criteria

Figure 3 - Receptors, assessment and compliance points

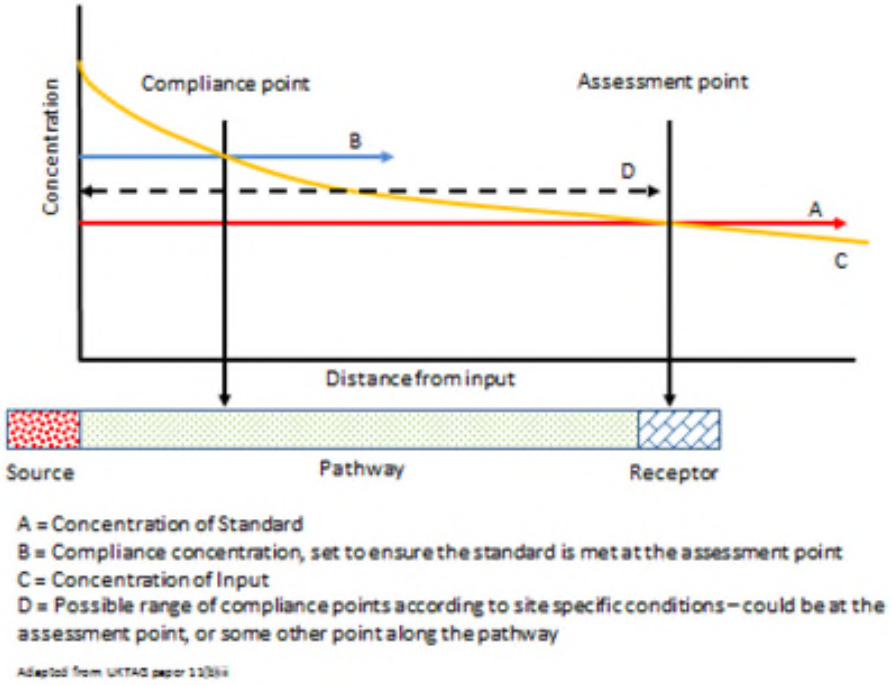


Figure 4 - Assessment and compliance points

A1.6 What is the basis for the hazardous substance input standard?

Entry of hazardous substances into groundwater must be controlled to ensure there is no risk of deterioration. In order to achieve this SEPA applies a Hazardous Substance Input Standard.

For locations more than 50 m from surface waters, the Hazardous Substance Input Standard is set at 50% of the relevant potable standard[24] assessed as an annual mean concentration. This ensures that, even if there were no dilution in groundwater and irrespective of the size of the source, the Threshold Value (as referred to in A1.8) should not be breached.

In close proximity (<50 m) to surface water features, the Hazardous Substance Input Value is either 0.5 x potable standard OR 2 x Environmental Quality Standard

[24] See Annex 2 for further details.

(whichever value is lower). The latter is based on an assumption of dilution within the surface water feature; the 95th percentile baseflow index for Scottish rivers is <0.5. While baseflow does vary both spatially and temporally, SEPA have chosen to assume a single baseflow index value to aid consistency in decision making.

In reality, there is likely to be dilution on entry to groundwater in most scenarios. Thus, SEPA consider that there is no risk of deterioration if compliance with the Hazardous Substance Input Standard is achieved.

A1.7 What is the basis for the threshold value?

Threshold values are values set at 75% of the relevant potable standard and assessed as an annual mean concentration. This is approach has been adopted to help ensure that the potable standard (assessed as a maximum concentration) is unlikely to be breached whilst allowing for a small margin of error to address minor temporal fluctuations in water quality. This approach is consistent with the approach recommended by UK TAG[25] for general chemical assessment during groundwater body classification.

The decision on which potable value to use has been based on the following hierarchy: Groundwater Directive pesticide standard (if applicable) > UK drinking water standard > World Health Organisation (WHO) drinking water guideline value> other international drinking water value (that has been derived in a reliable and relevant way and that has undergone peer review). For cases where such values are not available, a valid and reliable Health Criteria Value (HCV) for the substance has been used to derive a value following WHO guidance. Taste and odour thresholds are used where these are lower than (eco)toxicologically based values. This is because having a bad taste or odour would affect the future use of the water resource. Only where none of these values are available has a value been based on laboratory detection limits.

[25] UK TAG Paper 11b(i) 'Groundwater Chemical Classification for the Purposes of the Water Framework Directive and the Groundwater Directive', 2019.

A1.8 What is the basis for the groundwater pollution standards?

Pollution in relation to the water environment means the direct or indirect introduction, as a result of human activity, of substances or heat into the water environment, or any part of it, which may give rise to any harm.

The groundwater pollution standard considers both existing groundwater uses, by humans, surface water ecosystems or groundwater-dependent terrestrial ecosystems (GWDTE), and potential future groundwater use. The groundwater pollution standard applies to all future groundwater resource as well as groundwater supporting surface waters, GWDTEs or abstractors.

The groundwater pollution standard for future groundwater resources is set at >1 ha of groundwater exceeding the Threshold Value assessed as an annual mean. The 1 ha area is equivalent to the area required to support 10 m^3/day of groundwater supply assuming a typical Scottish recharge rate of 1 mm/day. Whilst recharge does vary both spatially and temporally, SEPA have chosen to assume a single recharge value to aid consistency in decision making. The flow threshold of 10 m^3/day is aligned with the determination of whether a hydrogeological unit has future resource potential (see A1.2).

For hazardous substances, the groundwater pollution standards only apply to contaminants that have already entered groundwater. New or ongoing entry above the Hazardous Substance Input Value is not permitted (see Sections 5 and 7).

A1.9 What is the basis for the groundwater status standards?

Status standards in relation to the water environment reflect a serious impact on nationally or regionally important receptors.

The groundwater status standards consider both existing groundwater uses, by humans, surface water ecosystems or GWDTEs, and potential future groundwater use. Note that here groundwater status is used in relation to chemical status, as opposed to quantitative status.

The groundwater status standard in relation to surface water receptors is based on the actual or potential impact on the status of the relevant surface water body, taking into account the spatial rules used to determine surface water body status.

The groundwater status standard for GWDTEs is based on the potential impact on designated sites (i.e. sites that have been designated as Natura 2000 sites or as Sites of Special Scientific Interest (SSSI)). SEPA consider that impact or potential impact on a designated GWDTE is sufficient to also impact or potentially impact on groundwater body status.

The groundwater status standard for existing abstractions is based on potential anthropogenic impact on abstractions supplying water for human consumption. The standard also includes assessment of whether there is an upward trend in concentrations.

The groundwater status standard for future groundwater resources is set at >20 ha of groundwater exceeding the Threshold Value assessed as an annual mean. The 20 ha area is equivalent to the area required to support 200 m^3/day of groundwater supply assuming a typical Scottish recharge rate of 1 mm/day. The 20 ha area is based on an area that is 20% of the area of the smallest potential groundwater body, which is assumed to be 1 km^2. This is aligned with current guidance[26], which provides that an acceptable extent of exceedance for each substance would not exceed 20% of the total groundwater body. Whilst groundwater bodies vary in size, a single areal value for point source status assessment is used to aid consistency in decision making and to account for scenarios where a source and/or plume may straddle groundwater body boundaries. Hazardous substances are prioritised when assessing status in relation to future groundwater resources.

For hazardous substances, the groundwater status standards only apply to contaminants that have already entered groundwater. New or ongoing entry above the Hazardous Substance Input Value is not permitted (see Sections 5 and 7).

[26] Common Implementation Strategy for the Water Framework Directive – Guidance Document No. 18 – Guidance on Groundwater Status and Trend Assessment.

A1.10 What is significant pollution?

Part IIA of the Environment Protection Act 1990[27] uses the concept of significant pollution of the water environment, or significant possibility of significant pollution.

SEPA consider the following to represent significant pollution of groundwater:

- Breach of the groundwater pollution standard for existing abstractions, for surface waters and for GWDTEs
- Breach of the groundwater status standard for future groundwater resources.
- What can constitute significant pollution is discussed further in SEPA Guidance, Land Contamination and Impacts on the Water Environment, the so-called Brown Booklet.

[27] This regime is also subject to The Contaminated Land (Scotland) Regulations 2000 (SSI 2000 No. 178) as amended and the Scottish Government's Statutory Guidance: Edition 2.

Annex 2 Groundwater Standard concentrations

A2.1 Standards for common substances

A list of standards for common substances is available here.

For radioactive substances, the standards are dose based and assessed by the risk to members of the public and non-human organisms and their habitats[28]. The risk will be assessed using the procedures set out in the relevant radioactive substances guidance; SEPA staff are recommended to consult the Radioactive Substances Unit for specialist advice.

For heat, no generic temperature standard has been set for groundwater. The temperature in groundwater must not be high or low enough to cause adverse direct or indirect impacts in groundwater-dependent receptors including surface waters, wetlands or abstractions.

A2.2 Methodology for deriving standards

Where no standards are available, standards may be derived using the methodology set out in Scottish Government directions.

When assessing risks to surface waters posed by metals in groundwater, bioavailability may be taken into account as set out in WAT-SG-53 provided the relevant supporting surface water quality data is available for the receiving waterbody.

A2.3 Methodology for modifying standards to account for naturally elevated background concentrations

Where appropriate site-specific assessment shows that natural background concentrations exceed the Hazardous Substance Input Value or Threshold Value, a

[28] This standard is achieve the principles and standards set out in COUNCIL DIRECTIVE 2013/59/EURATOM)

site-specific value equal to the annual average natural background concentration may be used instead.

It is not permissible to modify the standards due to background concentrations that are elevated due to anthropogenic influences.

A2.3 Approach to managing limits of detection

SEPA recognise that, particularly for contaminated water samples, it may be difficult to achieve limits of detection and quantification that are below some Hazardous Substance Input Values or Threshold Values.

It is not permissible to modify the standards due to issues relating to limits of quantification or detection.

When undertaking numerical modelling or calculations during quantitative risk assessment, the standard should be used.

When undertaking site investigation or water monitoring, for example during site characterisation or for compliance assessment, efforts should be made to achieve limits of detection and quantification that are below the relevant standard. If this is not feasible, SEPA recommend the following approach:

- Use the minimum achievable limit of detection as an initial screening value;
- Adopt a lines of evidence approach to determine the potential significance of the consequent uncertainty;
- Take the significance of the uncertainty into account during regulatory decision making.

In particular, SEPA expect a precautionary approach to be adopted in relation to abstractions used for potable water supply and in relation to ecosystems and habitats that are designated sites (e.g. SSSI).

Annex 3 Recommended assessment approach

For activities that SEPA consider pose a high hazard, a site-specific risk assessment is required to determine if the objectives have been met. This annex sets out SEPA's recommended approach for undertaking such an assessment.

The Standards that will require assessment will depend on the nature of the substance and whether the assessment relates to current / new activities or to historical land contamination.

Table 3 sets out which groundwater standards apply when undertaking assessment of impacts on the water environment. Note that other criteria may also be taken into account when setting compliance limits or deriving remedial targets (see Section 7).

Table 3 - Overview of applicable groundwater standards for impact assessment

Type of Substances	Hazardous Substance Input Standard	Groundwater Pollution Standard	Groundwater Status Standard
Hazardous Substances	Always	Only for historical land contamination where Hazardous Substance has already entered groundwater	Only for historical land contamination where Hazardous Substance has already entered groundwater
Non-Hazardous Substances	Not applicable	Always	Only for surface waters, abstractions and GWDTEs

A3.1 General approach

The recommended assessment methodology is based on a source-pathway-receptor approach, adopting a phased approach using the following tiers:

Tier 1 Compare source concentrations with relevant standards

Tier 2 Compare predicted concentrations at the relevant assessment point with the relevant standards taking into account dilution only

Tier 3 Compare predicted concentrations at the relevant assessment point with the relevant standards taking into account natural attenuation

Dilution (Tier 2) does not apply to the Hazardous Substance Input Standard since this standard applies at the base of the unsaturated zones, immediately prior to entry into groundwater.

Table 4 - Overview of applicable assessment tiers for groundwater standards

Assessment Tier		Hazardous Substances Input Standard	Groundwater Pollution Standard	Groundwater Status Standard
1	Screening	Yes	Yes	Yes
2	Dilution	No	Yes	Yes
3	Natural attenuation	Yes	Yes	Yes

The level of detail required for the assessment should be proportional to the risk posed by the source and the sensitivity of the receptors. If site-specific data is not available, conservative assumptions based on literature values should be adopted. All relevant assumptions must be stated and justified.

SEPA recommends that site-specific risk assessments are undertaken by groundwater professionals with appropriate qualifications and experience.

A3.1.1 Pollutant linkages

The generally accepted procedure for assessing risks to water quality is to use the concept of source-pathway-receptor linkages.

The movement of a substance in the subsurface varies according to the physical and chemical characteristics of the substance and the local hydrogeological regime. Characterising the fate and transport of an input requires development of a site-specific conceptual model. In this context, a conceptual model is the identification and characterisation of the process and/or processes which cause migration of the substance(s) between source and receptor(s), together with the major limits and boundaries on these processes.

Factors that must be considered include:

- properties and geometry 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.

A3.1.2 Source characterisation

The source(s) must be characterised as part of the conceptual model. Both the geometry and the composition of the source must be considered.

For proposed new inputs (i.e. not yet built), the source area should be characterised based on the system design and specification.

For existing inputs, the source area should be characterised based on the available evidence, which might include:

- Details of the system design and construction (if known) for active discharges (e.g. soakaways) or for engineered systems (e.g. PPC landfills)

- Desk study and / or ground investigation in accordance with BS5930:2015 +A1:2020 and BS10175:2011+A1:2013 for historical passive inputs (e.g. land contamination).

A3.1.3 Pathway characterisation

The pathway(s) between the point of entry to groundwater and the relevant receptors must be characterised as part of the conceptual model.

Constraints on contaminant migration may be taken into account provided they are appropriately justified. There may be physical constraints on contaminant migration, such as hydraulic barriers to groundwater flow or major discharge zones such as the sea or a river. Consideration should also be given to the potential for preferential pathways (natural or man-made) to exist that may influence contaminant migration.

Attenuation processes in the unsaturated and saturated zone between the source and the receptor may be taken into account provided they are appropriately justified (see A3.4 for further details). Degradation should only be assumed to occur where hydrogeological conditions indicate that it is likely to occur. Both the original contaminant and its daughter products should be taken into account in the assessment.

A3.1.4 Receptor characterisation

The key receptors requiring consideration include:

- Groundwater (for hazardous substances only)
- Potential future groundwater resources (for both hazardous and non-hazardous substances)
- Surface waters
    - Rivers and streams
    - Lochs
    - Coastal and transitional waters
- Existing abstractions
- Groundwater dependent terrestrial ecosystems.

A3.1.5 Calculation of average annual concentrations

The following guidelines are recommended to be adopted when calculating annual average concentrations for comparison with the groundwater standards.

a) Annual averages in source concentrations and loadings may be calculated on both a temporal and spatial basis.
b) Annual averages in concentrations in groundwater at the assessment point should be calculated on a temporal basis only. Spatial averaging within the plume is not recommended.
c) The minimum number of data points required will vary on a site-specific basis, taking into account the variability of the dataset and the level of risk to the water environment. Any potential seasonal or other temporal variations in the dataset should be taken into account.
d) Parameters varying by more than two orders of magnitude are usually recommended to be calculated using a geometric mean, rather than an arithmetic mean.
e) Values that are less than the limit of detection should be assumed to be equal to the limit of detection.
f) Potential outliers should only be excluded from the dataset if there is supporting evidence available to justify their omission, such as a documented problem with the sampling /analysis or results of more detailed statistical analysis. Caution in the treatment of outliers is particularly required when assessing small datasets.
g) When undertaking probabilistic predictive modelling, the 50%ile value is not necessarily equivalent to the annual average. SEPA recommend the 95%ile value is usually appropriate for comparison with the relevant standard.

Alternative statistical approaches may be acceptable provided they are appropriately justified.

A3.2 Tier 1 Screening

Tier 1 assessments involves comparison of concentrations within the source with the relevant groundwater standards.

If the source concentration does not exceed any of the relevant groundwater standards then no further assessment is required.

If the source concentration does exceed the relevant standards, the assessment should proceed to Tier 2.

A3.3 Tier 2 QRA (dilution only)

Tier 2 assessment requires a quantitative risk assessment (QRA) to determine whether dilution is sufficient to prevent the standards being exceeded.

This requires comparison of input loading rates with the hydrogeological regime to assess potential dilution.

The methodology for the assessment of dilution varies depending on the receptor being assessed. This section sets out the recommended approach for each type of receptor.

If the Tier 2 assessment indicates that there is potential for the relevant standard to be exceeded, either currently or in the future, even once dilution is taken into account, then the assessment should progress to Tier 3.

A3.3.1 Input loading

The load of contamination being added to groundwater per day from the source should be calculated. This requires consideration of the nature and geometry of the source and the rate at which substances will enter groundwater.

The geometry of the source area should be based on the spatial extent of:

- Active discharge to ground; or
- Leachable substances in soils or wastes; or
- Non-aqueous phase liquid (NAPL).

The nature of the source will influence how the loading rate to groundwater (concentration x flow rate) should be estimated – see Table 5. Both concentration and flow rate should be considered as annual averages, except for abstractions for human consumption where maximum values should be used.

The use of site-specific infiltration and recharge rates is preferred. Literature vales will require adequate justification.

Source composition and concentrations may change over time. Temporal trends in source concentrations may be taken into account in predictive modelling of future impacts provided this can be appropriately justified.

Table 5 - Estimation of source input loading rates

Source Type	Concentration	Flow Rates
Active discharge to ground	Effluent concentration (measured or calculated)	Discharge rate
Leachable soils or wastes	Leachable concentration (measured[29] or calculated)	Recharge rates multiplied by source area for sources located above water table Groundwater flux passing through source for sources located below water table
NAPL	Solubility limit[30]	Recharge rates multiplied by source area for NAPL located above water table Groundwater flux passing NAPL located at or below water table

A3.3.2 Accounting for upgradient groundwater quality

A3.3.2.1 Naturally elevated background concentrations

Where the background groundwater upgradient of the site being assessed contains naturally elevated concentrations, then site-specific values may be adopted in accordance with Annex 2.4 instead of applying the Hazardous Substance Input Value and Threshold Value set out in Annex 2.1.

[29] In accordance with BS EN 18772:2014 for soils or BS EN 12457:2002 for wastes.

[30] Where mixtures of substances are present within a NAPL, the solubility of the individual substances may be adjusted in accordance with Raoult's Law.

A3.3.2.2 Elevated background concentrations due to anthropogenic contamination

The groundwater standards apply irrespective of any background anthropogenic contamination already present in the groundwater.

Where background groundwater concentrations upgradient of the site being assessed are already impacted by anthropogenic contamination[31], this must be taken into account during the quantitative risk assessment process. SEPA recognises that levels of background contamination are often not within the control of site owners or operators. However, groundwater resources do not have an infinite capacity to accept inputs before the groundwater becomes no longer suitable for future potable use.

If the background contamination does not yet exceed the relevant groundwater pollution or status standard, the input being assessed must not result in the standard being exceeded. The ability of the groundwater to accept additional inputs will be constrained. Upgradient groundwater concentrations should be taken into account when calculating acceptable source concentrations, including consideration of any significant temporal trends. Natural attenuation within both the unsaturated zone and the saturated zone may be taken into account provided this can be adequately justified.

If the background contamination already exceeds the relevant groundwater pollution or status standard, significant additional inputs will not be permitted. The input concentration must not exceed the standard at the point of entry into groundwater. Natural attenuation within the unsaturated zone only may be taken into account provided this can be adequately justified.

The input to groundwater being assessed must not result in the groundwater body becoming poor status or prevent a groundwater body already at poor status from being restored.

[31] This includes impacts to upgradient groundwater quality due to anthropogenic atmospheric emissions.

Additionally the input to groundwater being assessed must not result in any additional adverse impact to surface waters, abstractions or wetlands.

A3.3.3 Assessing impacts on future groundwater resources

When assessing impacts on future groundwater resources, the combined area of both the source and the predicted maximum extent of the associated downgradient plume (see Figure 5) should be compared with the relevant assessment areas (1 ha for pollution or 20 ha for status).

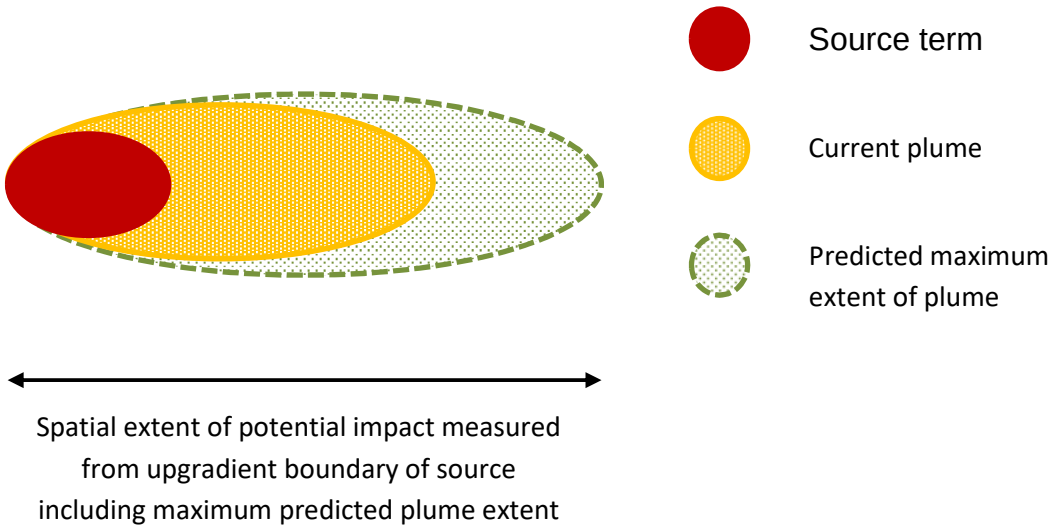


Figure 5 - Assessing spatial extent of potential impacts on future groundwater resources

For the purposes of this assessment, the edge of the plume will be considered to be the point at which the concentration is equal to the Threshold Value[32].

Many commonly used quantitative risk assessment methods involve 2-dimensional equations or models that simulate a vertical cross-section of the source and plume. To aid such calculations, equivalent downgradient assessment points may be assigned, taking into account the source area geometry. The equivalent assessment point distance must be measured from the upgradient boundary of the source in the

[32] Or natural background concentrations when this exceeds the Threshold Value.

direction of groundwater flow. Thus for larger source areas, the equivalent assessment point may be located within the source area.

Equivalent assessment point distances for different source size thresholds are set out in Tables 6 and 7 for pollution and status respectively. The maximum acceptable equivalent assessment point distances are 500m for pollution and 4km for status.

Table 6 - Equivalent assessment point distance for future groundwater resource pollution standard

Source width perpendicular to groundwater flow (m)	Equivalent assessment point for pollution: Distance from upgradient boundary of source (m)
<20	500
20-50	200
50-100	100
>100	50

Table 7 - Equivalent assessment point distance for future groundwater resource status standard

Source width perpendicular to groundwater flow (m)	Equivalent assessment point for status: Distance from upgradient boundary of source (m)
<50	4000
50-100	2000
100-200	1000

200-500	400
>500	200

The depth of the equivalent assessment point should be defined on a site-specific basis, taking into account the local hydrogeological setting, so as to be representative of the vertical centreline of the plume (i.e. the highest concentration in the vertical dimension). The exception to this is where the centreline of the plume is located within superficial deposits that are not classed as having future groundwater resource potential, in which case the equivalent assessment point should be located at the top of the underlying groundwater resource receptor (see Figure 1).

If the equivalent assessment point is located beyond the coast (mean high water springs tidal limit), the future groundwater resources need not be considered as a receptor. The groundwater should be considered as a pathway to the coastal or transitional water body receptor.

If the equivalent assessment point is located on the opposite side of a large river or loch from the source, further assessment is required. If it can be demonstrated that the majority of the downgradient plume enters the surface water body as baseflow, then groundwater may be considered as a pathway rather than as having future groundwater resource potential. However, where the geological and hydrogeological evidence suggests that the majority of the plume may pass beneath the surface water feature, then future groundwater resources should be considered as a receptor. The assessment should be based on site-specific evidence obtained from site investigation and/or groundwater and surface water monitoring. In the absence of plausible site-specific evidence, SEPA recommend adopting a precautionary approach.

A3.3.4 Assessing impacts on surface waters

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 beyond the mixing zone (i.e. taking dilution into

account). The actual assessment point chosen will depend upon the type of surface water feature.

The assessment concentrations to be used for surface waters are set out in WAT-SG-53 Environmental Standards for Surface Waters.

The groundwater pollution standard for surface water impacts is considered to be exceedance of the relevant surface water quality standard in the surface water beyond the mixing zone due to groundwater inputs.

Calculation of dilution in surface waters is only required:

- If the surface water feature is located within the equivalent assessment distance set out in A3.3.3; and
- If the predicted groundwater concentrations at the point of entry to surface waters exceed the surface water assessment concentrations.

The groundwater status standard for surface water impacts comprises two elements:

- Deterioration (actual or predicted) in surface water status
    - Exceedance of the relevant surface water quality standard in the surface water body[33] beyond the mixing zone over a specified spatial extent of the water body as set out in Schedule 4 of The Scotland River Basin District (Standards) Directions 2014.
- Groundwater inputs account for at least 50% of the surface water quality impacts[34].

For surface water dilution calculations the input from groundwater should be considered as arising from a pipe discharge. Instantaneous mixing in the surface water may be assumed for the purposes of undertaking mass balance calculations.

[33] Only water bodies used for classification under WFD will be considered; impacts on tributaries will only cause groundwater status failures if the main water body is or is predicted to be impacted to the point at which deterioration in status below Good could occur.

[34] Takes into account that 95th percentile baseflow index for Scottish water bodies is <0.5.

SEPA uses the digital river network (DRN[35]) for assessing inputs into the surface water environment. Therefore, for small watercourses, the assessment point is the point at which the tributary enters the river on the DRN.

Surface water calculation methods to determine the acceptable load from groundwater depend upon the type of water body:

- **Rivers** - as described in WAT-RM-03 Regulation of Sewage Discharges to Surface Waters and WAT-SG-03 Data Analysis and River Quality Planning Models.
- **Lochs** – for phosphorous as described in WAT-RM-37: Regulation of Phosphorus Discharges to Freshwater Lochs[36].
- **Coastal and transitional waters** - as described in WAT-SG-11: Modelling Coastal and Transitional Discharges or alternatively as outlined below:

Dilution in coastal & transitional waters = (2 x W x TR x 100) / Q

Where:

- W – Groundwater plume width in m
- TR – Tidal range in m, i.e. height difference between mean high and low water
- Q – Groundwater seepage rate in m^3/d, i.e. rate at which groundwater emerges from ground at low tide
- Calculation assumes a mixing zone of 100m measured from low tide and two tidal cycles per day.

Alternative approaches to calculating dilution[37], including detailed hydraulic modelling, may be acceptable.

[35] The DRN is published by the Centre for Ecology & Hydrology (CEH) and is based on 1;50,000 Ordnance Survey mapping.

[36] For non-nutrient inputs his can be considered to be exceeding the environmental standard over an area greater than or equal to $100x100x\pi$ m^2

[37] For example as described in Mixing in Inland and Coastal Waters by Fischer *et al* 1979.

The capacity of the surface waters, taking into account other inputs, should be taken into account in accordance with WAT-RM-21 Allocation of Capacity and Protection of the Water Environment.

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 will be measured in groundwater immediately prior to entry into the surface water.

A3.3.5 Assessing impacts on abstractions

Where the assessment point is an existing abstraction, the assessment limit should prevent an increase in the level of purification treatment applied. This means that where treatment is not currently applied for the substance in question, the assessment limit should ensure that future treatment will not be necessary. Where treatment is currently applied to such an abstraction, the assessment limit should ensure that the level of treatment does not increase. In all cases upgradient concentrations must be taken into account.

Where an abstraction exists at or within the distance of the future groundwater resource assessment point, in addition to calculating of the concentration at the future groundwater resource assessment point, there must also be calculation of the concentration at the abstraction assessment point, prior to any treatment the abstracted water might receive. The assessment limit adopted should be such as to protect both receptors. Note that the groundwater pollution and status standards for

abstractions are based on maximum, rather than annual average, values. Concentration trends must also be taken into account when assessing status.

Compliance will be measured in the abstracted groundwater (raw water) prior to any treatment this might receive.

Consultation with SEPA is recommended during assessment of impacts to existing abstractions for human consumption.

A3.3.6 Assessing impacts on groundwater dependent terrestrial ecosystems

Groundwater dependent terrestrial ecosystems (GWDTE), which are wetlands that are wholly or partially reliant on groundwater, can be damaged by contaminated groundwater.

There can be many pressures affecting a wetland, e.g. vegetation management, however this procedure only relates to chemical pressures transmitted through groundwater.

Criteria on which significant damage to a GWDTE is based is set out in EU CIS technical report no 6[38] . For example, for GWDTE that are part of the designation of Natura 2000 nature conservation sites, significant damage can equate to failure to meet conservation targets.

Groundwater nitrate threshold values are set out in the Scotland River Basin District (Standards) Directions. These values identify acceptable limits for groundwater nitrate concentrations in different wetland types at the relevant wetland assessment point. The standards are dependent on the type of GWDTE which is impacted. The wetland types are set out in these Directions.

Exceedance of these values does not automatically mean that the wetland that receives this water would be damaged, but that the risk of damage is significant.

[38] Technical report on groundwater dependent terrestrial ecosystems, December 2011, https://publications.europa.eu/en/publication-detail/-/publication/f7bd5cf8-c62c-41f6-8138-fe922a1f6410

The assessment point for the GWDTE should be:

- located at the up gradient boundary of the wetland in the relevant groundwater flow path; and
- in groundwater that is hydraulically linked to the GWDTE such that this groundwater is likely to be the irrigation source that critically supplies the GWDTE.

Where more than one groundwater layer is present at a GWDTE the vegetation composition of the GWDTE can often be used to identify the groundwater source. Advice should be sought where uncertainty exists, from a qualified wetland ecologist[39].

The nitrate standards set out in the 2014 Directions[40] should be applied to determine if the groundwater pressure is likely to be causing this significant damage where:

- a GWDTE is significantly damaged; and
- in SEPA's judgment the characteristics of the damage are due to nitrate reaching the wetland from groundwater[41]; and
- there is a direct hydraulic linkage between the polluted groundwater body and the GWDTE.

Water quality standards for other pollutants specific to wetlands have not yet been developed. A qualified wetland ecologist will need to be consulted to assess if other pollutants could cause significant damage and the concentrations that may cause significant damage[42].

[39] See Groundwater dependent terrestrial ecosystem threshold values

[40] Table 2 of Schedule 6 of The Scotland River Basin District (Standards) Directions 2014.

[41] A site specific assessment should be carried out where other (for example surface or air mediated) nitrate pressures are present to differentiate between damage caused by groundwater versus other nutrient sources

[42] pollutant criteria for water destined for human consumption may often be used to risk screen if these pollutants could cause significant damage

Compliance will be measured in groundwater immediately prior to entry into the GWDTE, with the compliance point located at the appropriate location and depth along the pathway to the GWDTE to monitor the pollutant plume.

A 3.4 Tier 3 Detailed QRA (natural attenuation)

Tier 3 assessment requires a detailed quantitative risk assessment (DQRA) to determine whether natural attenuation processes are sufficient to prevent the standards being exceeded. The DQRA must be supported by site-specific evidence obtained from site investigation and/or groundwater monitoring. Literature values may be used only if their relevance to the hydrogeological conditions at the site in question can be adequately demonstrated.

Unless previously explicitly stated otherwise (e.g. in A2.3), natural attenuation can be taken into consideration:

- In the unsaturated zone prior to entry into groundwater
- In the saturated zone between the source and the assessment point

Natural attenuation must not be taken into consideration:

- In the hyporheic zone when assessing risks to surface waters
- Within the surface water features
- Within the groundwater dependent terrestrial ecosystem

It must be noted that the subsurface has a limited and finite ability to retard contaminants. For inputs that will continue over long time scales (e.g. decades), it is recommended not to place significant reliance on retardation processes that might significantly decline, stop or be reversed.

Degradation may be considered only where the ground conditions are consistent with it plausibly occurring. The impacts of the resultant daughter products must also be taken into account.

Annex 4 Assessing future groundwater resource potential in superficial deposits

A4.1 Background

All groundwater within superficial deposits that have been mapped by SEPA as groundwater bodies is considered to have resource potential.

However, most superficial deposits are considered to be part of an amalgamated superficial/bedrock groundwater body. Some of these superficial deposits have low potential as a future groundwater resource. This annex sets out broad guidelines on the type of investigations that SEPA will consider acceptable for determining whether groundwater within superficial deposits that are not currently mapped by SEPA as individual groundwater bodies have future groundwater resource potential. This methodology only applies to onshore superficial deposits, located inland of the mean high water springs tidal limit.

Assessing the supply capacity of groundwater beneath the site will enable correct location of the assessment and compliance points to protect the future groundwater resource.

A4.2 Recommended approach

The methodology described below consists of three stages of increasing complexity and cost aimed at assessing whether the superficial deposits above bedrock fulfil the UK TAG criteria for a groundwater body. Those wishing to use this approach should start at Stage 1 as appropriate and continue to the next stage(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.

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 superficial deposit:

- areal extent
- average thickness

- physical properties
- permeability / productivity.

A4.2.1 Stage 1: Prior to site investigation

Assume that all saturated natural superficial strata, if more than 50m inland from the mean high water springs tidal limit, have future groundwater resources potential.

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 Stage 2; that is, the cost of the investigation could be offset by savings elsewhere.

A4.2.2 Stage 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 superficial strata are significant areal extent (>1 ha) and more than 5m thickness of continuous saturated sand or gravel (or coarser material) is found in any one excavation, then either a Stage 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’ should be made in one of two ways:

- Using field descriptions made by qualified personnel in accordance with British Standards (BS5930:2015 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 than 20% fines (silt and clay) in all samples, with average clay content of less than 13% clay[43].

Available geological mapping should be used to provide additional confidence to the conclusions drawn from site investigation, e.g. areal extent and connectivity of granular deposits.

Where the superficial geological sequence is complex, or where there is doubt concerning any of the Stage 2 assessments, then a Stage 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.

A4.2.3 Stage 3: Productivity testing

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

The saturated superficial deposits 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 superficial strata is demonstrated to be less than 10 m^3/day.

Flow within the superficial strata should be assessed taking into account the following factors:

- Average[44] transmissivity of the superficial strata
- Lateral extent of the permeable superficial strata perpendicular to the dominant groundwater flow direction

[43] Based on low permeability indicator quoted in Swartz, M., Misstear, B.D.R, Daly, D. and Farrell, E.R., 2003. Assessing subsoil permeability for groundwater vulnerability. Quarterly Journal of Engineering Geology and Hydrogeology, v36, p173-184.

[44] Taking into account the relative thicknesses and hydraulic conductivities of the various lithological horizons within the saturated superficial deposits.

- Hydraulic regime within the superficial deposits, taking into account potential interactions with the underlying bedrock and with surface waters.

Depending on the degree of uncertainty, this assessment should 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 testing should be undertaken in accordance with British Standards (BS5930:2015 Code of Practice for Site investigations).

Note that it is the potential sustainable yield of the superficial aquifer as a whole that is to be considered in the assessment, rather than the potential yield from any individual borehole.

Glossary

Term	Definition
Assessment limit	The concentration of a substance which should not be exceeded. 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.
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.
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; • other factors such as technical feasibility etc.

Term	Definition
Conceptual Site Model	A written or graphical representation of a site that presents the available information in a clear and transparent structure to aid decision making.
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.
Deterioration	A worsening of the water body status class
Detailed Quantitative Risk Assessment	Numerical assessment of risk posed to a receptor, taking into account the hydrogeological regime and factors influencing the fate and transport of the contaminants. Usually undertaken using numerical models.
Direct discharge	The introduction of substances into groundwater without percolation through the ground or subsoil.
Drinking Water Standards (DWS)	Standards adopted by the Scottish Government and used by SEPA to define when water is fit for human consumption
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 Standards Directions 2014
Groundwater	Water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil (defined in the GWD and the WFD).
Hazardous substance	Substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other

Term	Definition
	substances which give rise to an equivalent level of concern (defined in the WFD).
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 (defined in the WFD).
Input	The introduction of pollutants into groundwater as a result of past or present human activity, from a point or diffuse source.
JAGDAG	Joint Agency Groundwater Directive Advisory Group
Limit of detection (LoD)	The output signal or concentration value above which it can be affirmed, with a stated level of confidence that a sample is different from a blank sample that does not contain the substance of interest.
Limit of quantification (LoQ)	The output signal or concentration value above a substance can not only be detected but predefined goals for bias and precision are also met.
Pathway	A route for contaminant migration between source and receptor.
Plume	A volume of contaminated groundwater that extends beyond the original source of the contamination due to transport of the contaminant mass in groundwater. The size and shape of the plume is influenced by the local

Term	Definition
	geology, the groundwater flow regime, the nature of the contaminants and the time since the contamination first entered the groundwater.
Pollution	Anthropogenic contamination causing harm to a receptor. Receptors include surface waters, GWDTEs, current abstractions and future groundwater resource potential.
Pollutant linkage	A connection existing between an input and a receptor via a pathway.
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. Relevant receptors for groundwater include: • surface waters; • dependent terrestrial ecosystems; • current abstractors; • future groundwater resource.
Saturation zone	The part of the ground below the water table in which all accessible voids (spaces and fissures) are filled with water.
Source	Contamination hazard with the potential to cause harm
Status	The physical, chemical or ecological condition of a water body, defined in accordance with the WFD
Surface water	Surface water means inland waters (other than groundwater), transitional waters, and coastal waters

Term	Definition
	(defined in the WFD). In this context SEPA regards springs as surface waters.
Threshold values	Standards based upon risk to human health and used to maintain a minimum level of groundwater quality with respect to potable use.
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).

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