Water Framework Directive (WFD)
River Basin District Management Systems

METHODOLOGY FOR RISK CHARACTERISATION OF IRELAND'S GROUNDWATER

Paper by the Working Group on Groundwater

Guidance document no. GW8

This is a guidance paper on the application of a **Risk Characterisation Methodology**. It documents the principles to be adopted by River Basin Districts and authorities responsible for implementing the Water Framework Directive in Ireland.

REVISION CONTROL TABLE

Status	Approved by National Technical Co-ordination Group	WFD Requirement	Relevant EU Reporting Sheets	Date
Final	March 2005	Characterisation	GWPI 1, 2, 3, 4, 5, 6, 7 & 8	December 2004

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Methodology for Risk Characterisation of Ireland's Groundwater

1. Purpose of this paper

The paper sets out the detailed methodology and criteria for undertaking the risk characterisation of groundwater in Ireland.

The principles on which the methodology is based are given in Guidance Document GW4 'Pressures and Impacts Assessment Methodology' (GW WG, 2003). The approach used in undertaking the risk assessment is heavily influenced by the SEPA methodology (SEPA Groundwater Task Group, 2004).

2. Environmental Characterisation and Risk Characterisation

2.1 Role of the Risk Concept

Risk assessment is at the heart of effective river basin planning (SEPA, 2002) and therefore of the WFD. In implementing the WFD, risk assessment allows environmental problems to be identified, monitoring programmes to be designed, and appropriate, cost effective protection and improvement measures to be formulated and implemented. The basic unit of risk assessment is the 'groundwater body', which is defined in the Directive as 'a distinct volume of groundwater within an aquifer or aquifers'. The output of the risk assessment is a list of water bodies, including groundwater bodies, considered to be 'at risk' of failing to meet the environmental objectives of the Directive. The risk assessment approach is summarised in Figure 1.

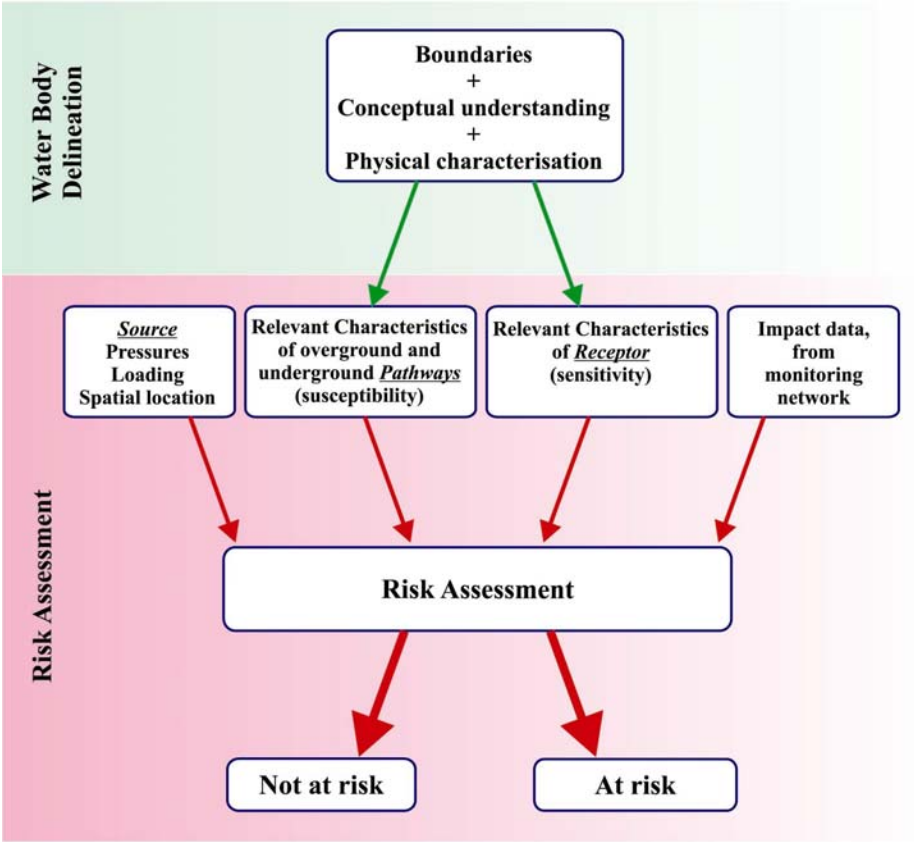

Figure 1: Summary of WFD risk assessment approach (adapted from WFD Guidance Document GW4, GWWG, 2004.)

The risk assessment approach is broad, in that:

- the receptors that must be considered are not just groundwater and drinking water abstraction points, but also groundwater dependent river and lakes and groundwater dependent terrestrial ecosystems (see Figure 2);
- the geological pathway includes, potentially, both vertical and horizontal components to the receptors (see Figure 3).

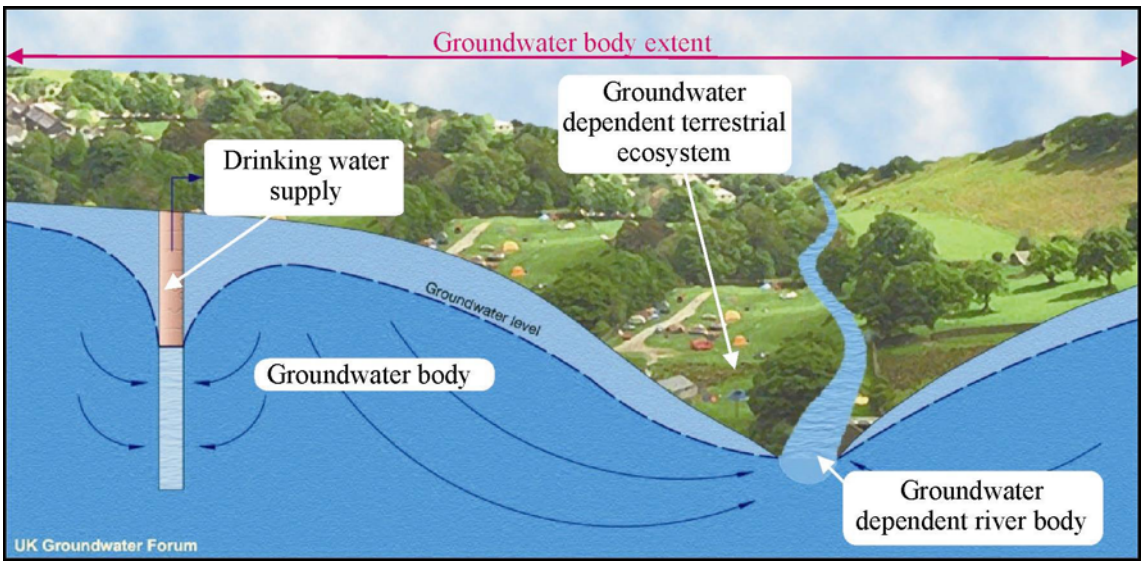

Figure 2: Diagrammatic illustration of a groundwater body showing the range of receptors that must be considered (adapted from NERC, 1998)

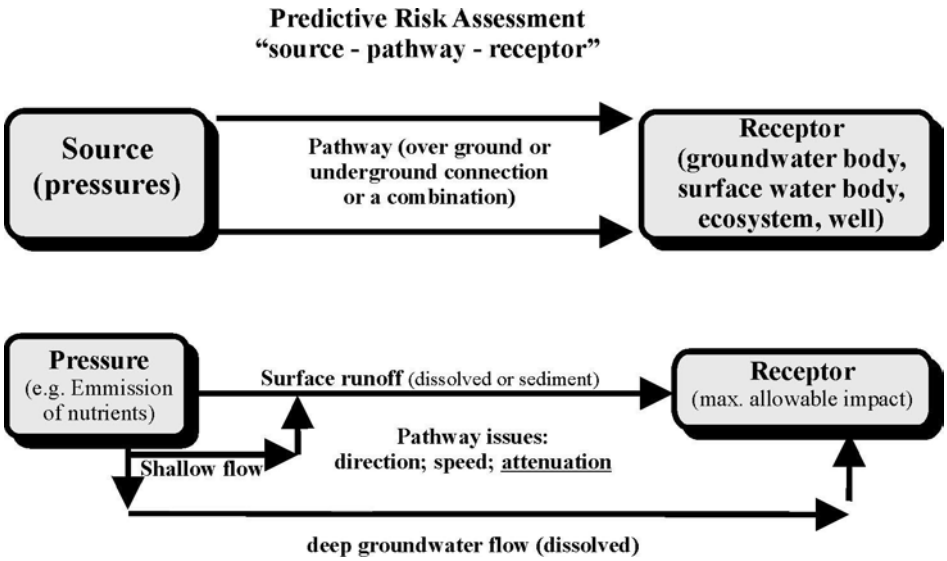

Figure 3: Pressure – pathway-receptor model for implementation of the WFD

The groundwater characterisation process for each RBD involves two elements (SEPA, 2004):

1. Physical characterisation.
2. Risk characterisation.

2.2 Physical Characterisation

Physical characterisation is a key first step in the risk assessment process. It provides relevant information on groundwater receptors and on the geological pathways that link pressures and receptors.

For each groundwater body in the country (~650), relevant layers of geological and hydrogeological information have been produced. These are summarised in Table 1.

Virtually for the first time in the Republic of Ireland, it is possible to characterise, at both a regional and local scale, all of the country in a way that enables water flow, particularly groundwater flow, and contaminant movement to be understood and described. Conceptual models, providing a relatively simple 3-D understanding of water flow, are now available for all of the land surface.

Physical characterisation enables one of the important elements of risk characterisation – pathway susceptibility – for pollutants to be determined. In undertaking the risk assessment, taking account of the pathway is required to enable:

- provision of the link between pressures and receptors;
- prediction of the likelihood of impact, where monitoring is inadequate;
- a description and understanding of 'why' there could be/has been an impact;
- monitoring data to be assessed;
- monitoring networks to be designed; and
- responses to the risk and appropriate measures to be implemented.

'Pathway susceptibility' is a measure of the degree of attenuation between source and receptor. It is a measure of the ability of the pathway to reduce the impact of a pressure, in terms of time to reach the receptor, pollutant load reaching the receptor, pollutant concentration level in the receptor and duration of the pollution event. Examples of the use and relevance of various pathway layers are given in Table 2.

2.3 Risk Characterisation

Risk characterisation integrates pressures and impacts with the physical characterisation, using the pressure-pathway-receptor approach, to derive an assessment of risk.

Following physical characterisation, the relevant factors involved in the risk assessment and the process followed are outlined below.

Source (pressure magnitude) Factors

- Identification of pressures.
- Estimation of pollutant loading (quantity and concentration) for main pollutant types (e.g. mobile inorganic (NO_3) and less mobile inorganic (PO_4) constituents).
- Development of threshold values for particular pressure magnitudes and pollutant types, in the form of matrices (e.g. more than a certain number of livestock units/ha could be categorised as a high pressure magnitude for both NO_3 and PO_4).
- For certain pollutants (e.g. trace organics), presence or absence is the determining factor.

Pathway (both over ground and underground) Factors

- Compilation and characterisation of relevant elements, such as soils, subsoils, aquifers, vulnerability.
- Classification of pathway information as 'pathway susceptibility' for the main pollutant types (e.g. the pathway susceptibility for NO_3 and PO_4 will differ) into 4 groups, varying from 'extremely high' to 'low'.

Receptor Factors

- Evaluation of the sensitivity of different receptors to pressures (pollutants and/or abstraction) and categorisation into high and moderate sensitivity, e.g. fens are more sensitive than raised bogs to groundwater abstraction but are less sensitive to nutrients.

Integrating Source, Pathway and Receptor Factors

- This integration enables the predicted Risk Assessment category to be determined.

Impact Data

- Where adequate representative impact data are available, the predicted risk category can be adjusted. However, data cannot be used to adjust the category downwards (i.e. to a lower risk category).

The general process is illustrated by the matrices below.

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway* **	Soil & subsoil	'Wet' soil				
		Subsoil permeability				
	Vulnerability	Extreme	**Extreme, High, Moderate or Low**			
		High				
		Moderate				
		Low				
		High to Low**				

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude		**High, Moderate, Low or Negligible**			

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Proportion of assessment area with high and moderate impact potential**					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High	**1a, 1b, 2a or 2b** (see Table 3)					
	Moderate						

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available groundwater impact data**	
	Data criteria	*Adjusted risk category*
1a, 1b, 2a or 2b	Usually these are threshold values	1a or 1b, depending on level of confidence in the monitoring data. 2a or 2b

Table 1 Layers of geoscientific information used in implementing the WFD

Map	Description	Organisation
Soils	A new digital map, which will be available for the whole country in late 2005, is being produced, which maps soils on the basis of whether they are mineral or organic, well drained or poorly drained and acidic or basic.	Spatial Analysis Group, Teagasc, as part of a DEHLG funded project, managed by the EPA.
Subsoils	A new digital map, which will be available for the country in mid 2005, is being produced, which is showing all the main subsoil types – sands/gravels, till, alluvium, lacustrine deposits, marine deposits and peat. GSI Quaternary geology maps, where available, are used as part of the mapping process.	Teagasc, as part of a DEHLG funded project, managed by the EPA.
Bedrock	The ~1140 formations and members in the detailed GSI country-wide digital bedrock map have been grouped into 28 rock units, based on similarities in hydrogeological properties. This map is now available on the GSI website.	GSI
Outcrop and depth to bedrock	All outcrops on the GSI 6 inch sheets have been digitised by the GSI together with more recent information. Subsequently, Teagasc have rectified and improved this map using digital photogrammetry techniques. All depth to bedrock readily available in GSI and in consultancies have been compiled by GSI and included in a digital database.	GSI and Teagasc
Subsoil permeability	Three subsoil permeability categories (high, moderate, low) have been mapped in 10 counties.	GSI
Vulnerability	Vulnerability maps produced by GSI are available for ~52% of the country; 'extremely' vulnerable areas are being delineated for the remainder of the country by RBD consultants.	GSI and RBD consultants
Aquifer	A draft national aquifer map has been completed and is now available on the GSI website. A report has been drafted, which will be finalised in early 2005.	GSI
Groundwater flow regime	The aquifer categories have been grouped into four flow regimes – karstic, fissured, poorly productive and granular – to aid surface water and groundwater characterisation.	GSI
Groundwater bodies (GWBs)	The boundaries of the ~410 GWBs have been delineated. Reports (3-6 pages) have been completed for each GWB using the following headings: Topography; Geology and Aquifers; Overlying Strata; Recharge; Discharge; Groundwater Flow Paths; Groundwater and Surface Water Interactions; Conceptual Model; Information Sources.	GSI (Acknowledgement: funding was provided to GSI by the DEHLG through the RBD projects)

Table 2 Examples of relevant characteristics of the pathway and their implication

Pathway layer	Relevant factor	Relevant characteristic	Implication	Receptor at risk
Soil	'wet' (gley)	Low permeability	Rapid runoff (sheet flow)	SW (via surface runoff)
	'dry' (e.g. Brown Earth)	Moderate/high permeability	Leaching of pollutants, e.g. NO_3 and P	GW & SW (via gw)
	acid/basic	Acid buffering capacity	Poor buffering of acidic inputs	SW
	'organic'	Low permeability and high CEC	Acidic, high runoff and attenuation	SW
Subsoil	Sand/gravel	High permeability	Leaching of pollutants, e.g. NO_3	GW and SW (via gw)
	clayey subsoil	Low permeability	Rapid runoff	SW (via surface runoff)
	Depth to bedrock	Bedrock at or near (<1 m) surface	a) Minimal protection of gw b) No acceptance of rainfall in low transmissivity rock areas, with rapid runoff	a) GW and SW (via gw) b) SW
		>3 m low permeability subsoil	Rapid runoff; gw protected	
Bedrock	Type of bedrock	Calcareous or siliceous	Influence on typology of rivers and lakes and buffering capacity	SW
Groundwater Vulnerability	'Extreme' and 'high'	High transit time	High leaching potential	GW and SW (via gw)
	'Low'	Low transit time and recharge; high attenuation	Minimal leaching potential & rapid runoff	SW
Aquifer flow regime	Pu, Pl and Ll	Low transmissivity; short underground flowpaths	High surface drainage	SW
	Rk, Rf, Lm	High/moderate transmissivity; long underground flowpaths	Low surface drainage; GW can act as pathway to SW GW an imp. resource	GW and SW (via gw)
	Karst aquifers (Rk)	High velocities; point recharge, minimal attenuation	Pollutants can reach receptor quickly	GW and SW (via gw)
	Sand/gravel aquifers (Rg and Lg)	High transmissivities	Mobility of nitrate (but not phosphate.)	GW and SW (via gw)
Karstification	Point recharge	Presence of swallow holes	No retardation of contaminants	GW & SW (via gw)
Climate	Rainfall Evapo-transpiration	Recharge	Quantitative status Baseflow in rivers Dilution	GW SW
Topography	Slope	Gradient	Rate of runoff	SW

GW = groundwater; SW = surface water
(Table from Guidance Document GW4, GWWG, 2004)

3. Risk Assessment

3.1 Risk Categories

The impact of human activities is described in terms of risk assessment for each water body as to whether it will achieve the required ecological status by 2015 or not. The assessment undertaken results in all water bodies being placed into one of three risk categories defined under by the European Commission's Reporting Sheets as follows:

- Water bodies for which it is already clear without the need for further characterisation or additional monitoring data, that the objectives will be failed;
- Water bodies for which it is possible that the objectives of the Directive will be failed but, because of inadequate data, further characterisation and operational monitoring are considered necessary to be sufficiently confident that this is the case;
- Water bodies for which it is already clear, without the need for further characterisation or additional monitoring data, that the achievement of the objectives are not at risk.

In Ireland, these three Categories have been further refined to four risk categories for the purpose of focussing actions during the next phase (2005-2008). These risk categories, designated as **2b, 2a, 1b and 1a**, and their relationship to the WFD reporting categories are shown in Table 3.

Table 3 Irish Risk Assessment Reporting Categories

<table>
<tr><th>WFD Risk Category</th><th>European Commission Reporting Sheet Risk Categories (Dec. 2004)</th><th>Irish Reporting Risk Categories</th></tr>
<tr><td rowspan="2">Water bodies at risk of failing to achieve an environmental objective</td><td>Water bodies for which it is already clear without the need for further characterisation or additional monitoring data, that the objectives will be failed</td><td>(1a) Water bodies at significant risk

Action: Identifies water bodies for which consideration of appropriate measures to improve status can start as soon as practical</td></tr>
<tr><td rowspan="2">Water bodies where, due to insufficient data, further characterisation and operational monitoring are necessary for a clear assessment of to be made</td><td>(1b) Water bodies probably at significant risk but for which further information will be needed to confirm that this view is correct

Action: Focus for more detailed risk assessments (including, where necessary, further characterisation) aimed at determining whether or not the water bodies in this category are at significant risk in time for the publication of the interim overview of significant water management issues in 2007</td></tr>
<tr><td rowspan="2">Water bodies not at risk of failing to achieve an environmental objective</td><td>(2a) Water bodies probably not at significant risk on the basis of available information for which confidence in the available information being comprehensive and reliable is lower

Action: Focus for more detailed risk assessments aimed at determining whether or not the water bodies in this category are not at significant risk in time for the publication of the draft River Basin Management Plan due to be completed in 2008</td></tr>
<tr><td>Water bodies for which it is already clear, without the need for further characterisation or additional monitoring data, that the achievement of the objectives are not at risk</td><td>(2b) Water bodies not at significant risk on the basis of available information for which confidence in the available information being comprehensive and reliable is high

Action: Identifies water bodies for which consideration of appropriate measures to ensure no deterioration in status can start as soon as practical</td></tr>
</table>

3.2 Risk Assessment Sheets

The risk assessment methodology is based on considering four receptors – groundwater bodies, groundwater dependent rivers and lakes, groundwater dependent terrestrial ecosystems and drinking water abstraction points. The environmental objectives, pathway susceptibility and sensitivity of the receptors frequently vary. Therefore, for each of these receptors, the impact of three pressure types – groundwater abstraction, diffuse source pollutants and point source pollutants – is considered separately. Risk assessment sheets have been prepared for each scenario listed in Table 4, and they are given in the following Sections.

Table 4 WFD Groundwater Risk Assessment Sheets for Relevant Receptors and Pressures

Receptor: **WFD Objective:** **Pressure:**	**Groundwater Body** Status, trends	**Groundwater dependent rivers, lakes & estuaries** Status	**Groundwater Dependent Terrestrial Ecosystems** Status	**Abstraction points** Drinking water protected areas
Groundwater Abstraction				
Water balance	GWRA1	SWRA1	GWDTERA1	-
Intrusion	GWRA2	-	-	-
Diffuse Source Pollutants				
Mobile nutrients (e.g. NO_3)	GWRA3	SWRA2		DWPARA1
Less mobile nutrients (e.g. PO_4)	-	SWRA3	GWDTERA2a GWDTERA2b	-
Mobile chemicals	GWRA4	SWRA4		DWPARA2
Clustered on-site systems & leaking urban sewerage systems	GWRA5	SWRA5	GWDTERA3	
Sheep dip	D	D	D	D
Less mobile chemicals	-	-	-	-
Microbial organisms	-	-	-	D
Point Source Pollutants				
Mining	GWRA6	SWRA6	GWDTERA4	
Quarries	GWRA7		GWDTERA5	
Landfills	GWRA8		GWDTERA6	
Oil industry infrastructure	GWRA9		GWDTERA7	
Contaminated land	GWRA10		GWDTERA8	
Trade effluent discharges	GWRA11			
Urban wastewater discharges	GWRA12		GWDTERA9	

Notes:

1. Each number represents a separate risk assessment sheet.
2. Where same heavy border colour is used, it indicates that the risk assessment matrices are identical.
3. "D": assessment planned but deferred until data become available.
4. "-": No assessment planned.

4. Groundwater Risk Assessment GWRA1

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA1**
Receptor type	Groundwater body
Pressure type	Abstraction
WFD objective	Quantitative status
Assessment area	Surface extent of the groundwater body

Note: Further information and explanation is given in Guidance Document GW5 "Guidance on the Assessment of the Impact of Groundwater Abstractions" (GW WG, 2004).

A. Recharge Estimation

a) Effective Rainfall Estimation

- Obtained from recently produced Meteorological Service maps.

b) Recharge Coefficient

- The Recharge coefficient is the proportion of Effective Rainfall that may become Recharge.
- It should be determined by using Table 1 (below).

c) Applying a Recharge Cap on Poorly productive Aquifers

- A recharge cap is applied to poorly productive aquifers, as they are not capable of accepting the available recharge due to their low transmissivity.
- The recharge cap for Locally Important aquifers, which are moderately productive only in local zones (**Ll**) is 200mm/yr, whereas the cap for Poor Aquifers (**Pl & Pu**) is 100mm/yr.

B. Impact potential

IMPACT POTENTIAL		**Aquifer Type**	
		Bedrock	***Sand/gravel***
GWABS as a % of average recharge	>30%	High	High
	20 to 30%	High	Moderate
	10 to 20%	Moderate	Low
	2 to 10%	Low	Low
	<2%	Negligible	Negligible

C. Risk category based on predictive risk assessment and available impact data

Potential Impact	**Evidence for GW level decline**	**No/ insufficient evidence for GW level decline**	**Evidence of no GW decline**
High	At Significant Risk (1a)	Probably at risk (1b)	Not at significant risk (low confidence) (2a) to Not at significant risk (2b) based on confidence in the data
Moderate	At Significant Risk (1a)	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)
Low	At Significant Risk (1a) to Probably at risk (1b) based on confidence in the data	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)

Table 1 Recharge coefficients for different hydrogeological settings

Vulnerability category		Hydrogeological setting	Recharge coefficient (rc)		
			Min (%)	*Inner Range*	*Max (%)*
Extreme	1.i	Areas where rock is at ground surface	60	80-90	100
	1.ii	Sand/gravel overlain by 'well drained' soil	60	80-90	100
		Sand/gravel overlain by 'poorly drained' (gley) soil			
	1.iii	Till overlain by 'well drained' soil	45	50-70	80
	1.iv	Till overlain by 'poorly drained' (gley) soil	15	25-40	50
	1.v	Sand/ gravel aquifer where the water table is ≤ 3 m below surface	70	80-90	100
	1.vi	Peat	15	25-40	50
High	2.i	Sand/gravel aquifer, overlain by 'well drained' soil	60	80-90	100
	2.ii	High permeability subsoil (sand/gravel) overlain by 'well drained' soil	60	80-90	100
	2.iii	High permeability subsoil (sand/gravel) overlain by 'poorly drained' soil			
	2.iv	Moderate permeability subsoil overlain by 'well drained' soil	35	50-70	80
	2.v	Moderate permeability subsoil overlain by 'poorly drained' (gley) soil	15	25-40	50
	2.vi	Low permeability subsoil	10	23-30	40
	2.vii	Peat	0	5-15	20
Moderate	3.i	Moderate permeability subsoil and overlain by 'well drained' soil	25	30-40	60
	3.ii	Moderate permeability subsoil and overlain by 'poorly drained' (gley) soil	10	20-40	50
	3.iii	Low permeability subsoil	5	10-20	30
	3. iv	Basin peat	0	3-5	10
Low	4.i	Low permeability subsoil	2	5-15	20
	4.ii	Basin peat	0	3-5	10
High to Low	5.i	High Permeability Subsoils (Sand & Gravels)	60	90	100
	5.ii	Moderate Permeability Subsoil overlain by well drained soils	25	60	80
	5.iii	Moderate Permeability Subsoils overlain by poorly drained soils	10	30	50
	5.iv	Low Permeability Subsoil	2	20	40
	5.v	Peat	0	5	20

5. Ground Water Risk Assessment GWRA2

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA2**
Receptor type	Groundwater body
Pressure type	Saline Intrusion
WFD objective	Chemical & quantitative status
Assessment area	Surface extent of the ground water body

This risk assessment only applies to those ground water bodies that are adjacent to transitional or coastal waters.

A. Pathway susceptibility

The pathway susceptibility depends on:

- Distance from saline water – a maximum distance of 5km from the transitional/coastal waters is sufficient for this risk assessment process;
- Groundwater flow regime, as indicated by aquifer type.
- The vertical pathway (as defined by vulnerability) is not relevant, unless the aquifer is confined.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from saline water	<100 m	E	E	H	M
	100-1000 m	H	H	M	L
	1000-3000 m	M	M	L	L

B. Impact potential

Pressure magnitude is a function of the quantity of groundwater abstracted.

Table B

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>5000 m^3/d	High	High	High	Moderate
	1000-5000 m^3/d	High	Moderate	Moderate	Moderate
	100-1000 m^3/d	Moderate	Low	Low	Low
	<100 m^3/d	Low	Low	Negligible	Negligible

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type**	*Adjusted risk assessment category*
High	1b	Average EC in excess of 1000 µS/cm at monitoring points within 2 km of coast where levels are not thought to be naturally derived	1a
Moderate	2a	Average EC in excess of 1000 µS/cm at monitoring points within 2 km of coast where levels are not thought to be naturally derived	1b
Low	2a		
Negligible	2b		

*Based largely on SEPA RA sheet.

Note: If sensitive receptors, such as GWDTEs, are present in an area of high, moderate and low impact potential, this risk assessment should be compared with the results of RA sheet GWDTERA1, to ensure that the risk assessment is sufficiently comprehensive.

D. Delineating Groundwater Bodies 'At Risk' from Point Saline Intrusion

In most GWBs, saline intrusion will affect only a small proportion of the GWB. In order to focus monitoring and further characterisation on relevant areas, it is recommended that where saline intrusion is considered to be putting a groundwater body 'at risk' (categories 1a or 1b) and the impacted area is <50% of the GWB, subdivision should normally be undertaken. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For instance, the surface water catchment may be used where it equates closely to the impacted catchment area. Alternatively, groundwater flow lines (estimated, in most instances) may be used.

6. Groundwater Risk Assessment GWRA3

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA3**
Receptor type	Groundwater body
Pressure type	Diffuse – mobile inorganics (NO_3)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway***	Soil & subsoil	'Wet' soil	L	L	L	L
		Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	M*
		High	H	H	H	M*
		Moderate	M	M	M	L*
		Low	L	L	L	L
		High to Low**	H	H	H	M

* In poorly productive aquifers where denitrification is not considered likely to occur, these categories should be the same as the karst and fissured aquifers categories.
** For areas where complete vulnerability map is not available from GSI.
*** The 'wet' soil and low permeability subsoil layers take precedence over the vulnerability layers.

B. Impact potential

IMPACT POTENTIAL*		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage	High	High	Moderate	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	Moderate	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Low	Low	Low	Low
	<1.0 LU ha^{-1} or <3% tillage	Negligible	Negligible	Negligible	Negligible

*Deriving Impact Potential
Individual Impact Potential maps are derived for the three types of pressures: cattle/sheep, pigs/poultry and tillage i.e. each grid cell within the maps will have three Impact Potential categories.
The ***highest*** Impact Potential category is taken for each cell, regardless of the type of pressure.
Within each GWB, the total area of **'H' plus 'M'** Impact Potential is used to determine whether the GWB is 'at risk' (see C below).

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		*>40%***	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity* (nitrate-limited ecosystems)	n/a	n/a	n/a	n/a	n/a	n/a
	Moderate	1b	2a	2a	2a	2b	2b

* Not applicable – see RA sheet SWRA2.

**The basis for this threshold is given in guidance document no. GW10 (GW WG, 2004).

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available groundwater impact data**	
	Data criteria	*Adjusted risk category*
All categories	Available representative monitoring data show an environmentally significant upward trend in groundwater nitrate concentrations	1a
1b	Weighted mean NO_3-N >11.3 mg l^{-1}	1a or 1b, depending on level of confidence in the monitoring data
2a 2b	Weighted mean NO_3-N 8.5-11.3 mg l^{-1}	1b or 2a, depending on level of confidence in the monitoring data
2b	Weighted mean NO_3-N 5.65-8.5 mg l^{-1}	2a
	Weighted mean NO_3-N <5.6 mg l^{-1}	2b

7. Groundwater Risk Assessment GWRA4

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA4**
Receptor type	Groundwater body
Pressure type	Diffuse – mobile organics (pesticides and PAHs)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Sub-soil	Low permeability subsoil*	L	L	L	L
	Vulnerability	Extreme	E	E	H	E
		High	H	H	H	H
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to low**	H	H	H	M

* In areas where GSI subsoil permeability map is unavailable, use vulnerability map alone.
** For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

* Pressure magnitude
The pressures that are considered to pose a significant threat to groundwater are: urban and industrial areas, tillage, major roads and railways.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Proportion of assessment area with high and moderate impact potential**					
		>50%	*25-50%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity (all GW bodies)	1b	1b	1b	2a	2a	2b
	Moderate/Low sensitivity	n/a	n/a	n/a	n/a	n/a	n/a

n/a = not applicable

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available groundwater impact data**	
	*Data criteria***	*Adjusted risk category*
1b	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05 µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01 µg/l in more than 2 samples, OR Maximum trace organic >100 µg/l in any one sample.	1a or 1b, depending on level of confidence in the monitoring data
2a	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01µg/l in more than 2 samples, OR Maximum total trace organic >0.1 µg/l in any one sample.	1b
2b	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01µg/l in more than 2 samples, OR Maximum total trace organic >0.1 µg/l in any one sample.	2a or 1b, depending on level of confidence in the monitoring data

** copied from SEPA approach.

8. Groundwater Risk Assessment GWRA5

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA5**
Receptor type	Groundwater body
Pressure type	Clustered on-site systems & leaking urban sewerage systems* – inorganics (N & P)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

* Both pressures are assumed to produce similar pollutants. However, where the receptor is a groundwater body, the only pollutant considered is nitrate.

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY FOR NITRATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	M*
		High	H	H	H	M*
		Moderate	M	M	M	L*
		Low	L	L	L	L*
		High to Low	H	H	H	M*

*In poorly productive aquifers where denitrification is not considered likely to occur, these categories should be the same as the karst and fissured aquifers categories.

B. Impact Potential

The presence of urban and discontinuous urban fabric from CORINE and/or build up areas from the Ordnance survey maps make up the pressure layer on the groundwater body.

IMPACT POTENTIAL		**Nitrogen Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity* (nitrate-limited ecosystems)	n/a	n/a	n/a	n/a	n/a	n/a
	Moderate	1b	2a	2a	2a	2b	2b

* Not applicable – see RA sheet GWDTERA3.

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	Adjustments made using available impact data	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by GSI, EPA, local authorities or RBD consultants	1a
2a	Where significant impacts are known to occur by GSI, EPA, local authorities or RBD consultants	1b or 1a, depending on confidence in data and/or degree of impact.

9. Groundwater Risk Assessment GWRA6

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA6**
Receptor type	Groundwater body
Pressure type	Mining – mobile inorganics
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

As mines are generally deep, this is not a factor in the RA process. The value of the groundwater resource is taken into account in considering the potential impacts.

B. Impact potential

		Impact Potential
Pressure magnitude*	High (based largely on expert judgement)	High
	Low (based largely on expert judgement)	Low

*expert judgement provided by GSI, report by Grennan (1996), RPS-KMM and EPA.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Impact potential (from Table B)**	
		High	*Low*
Receptor Sensitivity	High sensitivity*	n/a	n/a
	Moderate	1b	2a

*not applicable – see RA sheet GWDTERA4.

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by GSI, EMD, EPA, RBD consultants or local authorities	1a
2a	Where impacts are known to occur by GSI, EMD, EPA, RBD consultants or local authorities	1b or 1a, depending on confidence in data and/or degree of impact.

E. Delineating Groundwater Bodies 'At Risk' from Point Sources

In most GWBs, point sources will affect only a small proportion of the GWB. In order to focus monitoring and further characterisation on relevant areas, it is recommended that where a point

source(s) is considered to be putting a groundwater body ‘at risk’ (categories 1a or 1b) and the impacted area is <50% of the GWB, subdivision should normally be undertaken. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For instance, the surface water catchment may be used where it corresponds closely to the impacted catchment area. Alternatively, groundwater flow lines (estimated, in most instances) may be used.

10. Groundwater Risk Assessment GWRA7

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA7**
Receptor type	Groundwater body
Pressure type	Quarries – mainly mobile organics
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

This RA is based on expert judgement and impact data; consequently, pathway susceptibility is not included in the process.

B. Impact potential

		Impact Potential
Pressure magnitude*	High (based largely on expert judgement)	High
	Low (based largely on expert judgement)	Low

*expert judgement provided by GSI, RPS-KMM and EPA.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Impact potential (from Table B)**	
		High	*Low*
Receptor Sensitivity	High sensitivity*	n/a	n/a
	Moderate	1b	2a

*not applicable – see RA sheet GWDTERA5.

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by GSI, EMD, EPA, RBD consultants or local authorities	1a
2a	Where impacts are known to occur by GSI, EMD, EPA, RBD consultants or local authorities	1b or 1a, depending on confidence in data and/or degree of impact.

E. Delineating Groundwater Bodies 'At Risk' from Point Sources

In most GWBs, point sources will affect only a small proportion of the GWB. In order to focus monitoring and further characterisation on relevant areas, it is recommended that where a point source(s) is considered to be putting a groundwater body 'at risk' (categories 1a or 1b) and the

impacted area is <50% of the GWB, subdivision should normally be undertaken. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For instance, the surface water catchment may be used where it corresponds closely to the impacted catchment area. Alternatively, groundwater flow lines (estimated, in most instances) may be used.

11. Groundwater Risk Assessment GWRA8

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA8**
Receptor type	Groundwater body
Pressure type	Landfill Sites
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

This RA is based on expert judgement and impact data; consequently, a pathway susceptibility matrix is not included in the process.

B. Impact potential

		Impact Potential*
Pressure magnitude**	High (based largely on expert judgement)	High
	Low (based largely on expert judgement)	Low

* expert judgement provided by EPA and RPS-KMM.

** Modern engineered landfills with fully lined cells are considered to exert a low pressure magnitude on groundwater, whereas, older un-lined cells in landfills and older closed landfills are assumed to exert a high pressure magnitude on the groundwater.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Impact potential (from Table B)**	
		High	*Moderate/Low*
Receptor Sensitivity	High sensitivity*	n/a	n/a
	Moderate	1b	2a

*not applicable – see RA sheet GWDTERA6.

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by EPA, RBD consultants or local authorities	1a
2a	Where impacts are known to occur by EPA, RBD consultants or local authorities	1b or 1a, depending on confidence in data and/or degree of impact.

E. Delineating Groundwater Bodies 'At Risk' from Point Sources

In most GWBs, point sources will affect only a small proportion of the GWB. In order to focus monitoring and further characterisation on relevant areas, it is recommended that where a point source(s) is considered to be putting a groundwater body 'at risk' (categories 1a or 1b) and the impacted area is <50% of the GWB, subdivision should normally be undertaken. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For instance, the surface water catchment may be used where it corresponds closely to the impacted catchment area. Alternatively, groundwater flow lines (estimated, in most instances) may be used.

12. Groundwater Risk Assessment GWRA9

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA9**
Receptor type	Groundwater body
Pressure type	Oil Industry Infrastructure
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

This RA is based on expert judgement and impact data; consequently, a pathway susceptibility matrix is not included in the process.

B. Impact potential

		Impact Potential*
Pressure magnitude**	High (based largely on expert judgement)	High
	Low (based largely on expert judgement)	Low

* expert judgement provided by EPA and RPS-KMM.
** The EPA list of VOC licensed activities where there is large-scale storage of petroleum products is used as the national available dataset.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Impact potential (from Table B)**	
		High	*Moderate/Low*
Receptor Sensitivity	High sensitivity*	n/a	n/a
	Moderate	1b**	2a**

*not applicable – see RA sheet GWDTERA7.
**based on expert judgement of EPA staff

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by EPA, RBD consultants or local authorities	1a
2a	Where significant impacts are known to occur by EPA, RBD consultants or local authorities	1b or 1a, depending on confidence in data and/or degree of impact.

E. Delineating Groundwater Bodies 'At Risk' from Point Sources

In most GWBs, point sources will affect only a small proportion of the GWB. In order to focus monitoring and further characterisation on relevant areas, it is recommended that where a point source(s) is considered to be putting a groundwater body 'at risk' (categories 1a or 1b) and the impacted area is <50% of the GWB, subdivision should normally be undertaken. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For instance, the surface water catchment may be used where it corresponds closely to the impacted catchment area. Alternatively, groundwater flow lines (estimated, in most instances) may be used.

13. Groundwater Risk Assessment GWRA10

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA10**
Receptor type	Groundwater body
Pressure type	Contaminated Land
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

This RA is based on expert judgement and impact data; consequently, a pathway susceptibility matrix is not included in the process.

B. Impact potential

		Impact Potential*
Pressure magnitude*	High (based largely on expert judgement)	High
	Low (based largely on expert judgement)	Low

* expert judgement provided by EPA and RPS-KMM.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Impact potential (from Table B)**	
		High	*Moderate/Low*
Receptor Sensitivity	High sensitivity*	n/a	n/a
	Moderate	1b	2a

* not applicable – see RA sheet GWDTERA8.

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by EPA, RBD consultants or local authorities	1a
2a	Where impacts are known to occur by EPA, RBD consultants or local authorities	1b or 1a, depending on confidence in data and/or degree of impact.

E. Delineating Groundwater Bodies 'At Risk' from Point Sources

In most GWBs, point sources will affect only a small proportion of the GWB. In order to focus monitoring and further characterisation on relevant areas, it is recommended that where a point source(s) is considered to be putting a groundwater body 'at risk' (categories 1a or 1b) and the

impacted area is <50% of the GWB, subdivision should normally be undertaken. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For instance, the surface water catchment may be used where it corresponds closely to the impacted catchment area. Alternatively, groundwater flow lines (estimated, in most instances) may be used.

14. Groundwater Risk Assessment GWRA11

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA11**
Receptor type	Groundwater body
Pressure type	Trade Effluent Discharges
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pressure Magnitude

Licensed discharges to groundwater, by virtue of their regulation either by a local authority or by the EPA (Section 4 licences and IPPC licences respectively) are assumed to exert a low pressure magnitude on the groundwater.

B. Pathway susceptibility

As most discharges to groundwater are directly into the ground, the soil layer is by-passed and hence groundwater vulnerability may be more appropriate than pathway susceptibility to represent the influence of the pathway. This assumption was made on the basis of expert opinion of the GSI, EPA and RPS-KMM.

C. Impact potential

With the assumption that licensed discharges to groundwater do not constitute a high pressure magnitude, an impact potential matrix is not required as the impact potential will be low in all cases. Therefore, the predicted risk category will always be 2a.

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available impact data**	
	Data criteria	Adjusted risk category
2a	Where significant impacts are known to occur by EPA, local authorities or RBD consultants	1b or 1a, depending on confidence in data and/or degree of impact.

15. Groundwater Risk Assessment GWRA12

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWRA12**
Receptor type	Groundwater body
Pressure type	Wastewater Licensed Discharges to Groundwater – inorganics (N&P)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pressure Magnitude

Local Authority wastewater discharges to groundwater that have discharge consents from the EPA and Local Authority Section 4 licenses are assumed to exert a low pressure on the groundwater as opposed to non-consented discharges that are assumed to exert a high pressure on the groundwater. EPA expert judgement is also used to determine other instances of high pressure magnitude discharges.

B. Pathway susceptibility

As some of the urban waste-water discharges to groundwater are direct and others are indirect via percolation areas etc. it is not possible to factor in one single pathway into the risk assessment. For this risk assessment, EPA expert knowledge was used to assign a risk rating on a case-by-case basis.

C. Impact potential

		Impact Potential
Pressure magnitude	High (based largely on expert judgement)*	High
	Low (based largely on expert judgement)	Low

*expert judgement provided by EPA and RPS-KMM.

D. Risk category based on predictive risk assessment

RISK CATEGORY		**Impact potential**	
		High	*Low*
Receptor Sensitivity	High sensitivity*	n/a	n/a
	Moderate	1b	2a

*not applicable – see RA sheet GWDTERA9.

E. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by EPA, RBD consultants or local authorities	1a
2a	Where impacts are known to occur by EPA, RBD consultants or local authorities	1b or 1a, depending on confidence in data and/or degree of impact.

16. Groundwater Risk Assessment SWRA1

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA1**
Receptor type	Groundwater Dependent Ecosystems in Rivers and Lakes
Pressure type	Abstraction
WFD objective	Quantitative status
Assessment area	Surface extent of the groundwater body

Note: Further information and explanation is given in the Groundwater Working Group Report GW5 (2004) "Guidance on the Assessment of the Impact of Groundwater Abstractions".

A. Recharge Estimation

a) Effective Rainfall Estimation

- Obtained from recently produced Meteorological Service maps.

b) Recharge Coefficient

- The Recharge coefficient is the proportion of Effective Rainfall that may become Recharge.
- It should be determined by using Table 1 (below).

c) Applying a Recharge Cap on Poorly productive Aquifers

- A recharge cap is applied to poorly productive aquifers, as they are not capable of accepting the available recharge due to their low transmissivity.
- The recharge cap for Locally Important aquifers, which are moderately productive only in local zones (**Ll**) is 200mm/yr, whereas the cap for Poor Aquifers (**Pl & Pu**) is 100mm/yr.

B. Impact potential

IMPACT POTENTIAL		**Aquifer Type**	
		Bedrock	***Sand/gravel***
GWABS as a % of average recharge	>30%	High	High
	20 to 30%	High	Moderate
	10 to 20%	Moderate	Low
	2 to 10%	Low	Low
	<2%	Negligible	Negligible

C. Risk category based on predictive risk assessment and available impact data

Potential Impact	**Evidence for GW level decline**	**No/ insufficient evidence for GW level decline**	**Evidence of no GW decline**
High	At Significant Risk (1a)	Probably at risk (1b)	Not at significant risk (low confidence) (2a) to Not at significant risk (2b) based on confidence in the data
Moderate	At Significant Risk (1a)	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)
Low	At Significant Risk (1a) to Probably at risk (1b) based on confidence in the data	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)

Table 1 Recharge Coefficients for different hydrogeological settings

Vulnerability category		Hydrogeological setting	Recharge coefficient (rc)		
			Min (%)	*Inner Range*	*Max (%)*
Extreme	1.i	Areas where rock is at ground surface	60	80-90	100
	1.ii	Sand/gravel overlain by 'well drained' soil	60	80-90	100
		Sand/gravel overlain by 'poorly drained' (gley) soil			
	1.iii	Till overlain by 'well drained' soil	45	50-70	80
	1.iv	Till overlain by 'poorly drained' (gley) soil	15	25-40	50
	1.v	Sand/ gravel aquifer where the water table is ≤ 3 m below surface	70	80-90	100
	1.vi	Peat	15	25-40	50
High	2.i	Sand/gravel aquifer, overlain by 'well drained' soil	60	80-90	100
	2.ii	High permeability subsoil (sand/gravel) overlain by 'well drained' soil	60	80-90	100
	2.iii	High permeability subsoil (sand/gravel) overlain by 'poorly drained' soil			
	2.iv	Moderate permeability subsoil overlain by 'well drained' soil	35	50-70	80
	2.v	Moderate permeability subsoil overlain by 'poorly drained' (gley) soil	15	25-40	50
	2.vi	Low permeability subsoil	10	23-30	40
	2.vii	Peat	0	5-15	20
Moderate	3.i	Moderate permeability subsoil and overlain by 'well drained' soil	25	30-40	60
	3.ii	Moderate permeability subsoil and overlain by 'poorly drained' (gley) soil	10	20-40	50
	3.iii	Low permeability subsoil	5	10-20	30
	3. iv	Basin peat	0	3-5	10
Low	4.i	Low permeability subsoil	2	5-15	20
	4.ii	Basin peat	0	3-5	10
High to Low	5.i	High Permeability Subsoils (Sand & Gravels)	60	90	100
	5.ii	Moderate Permeability Subsoil overlain by well drained soils	25	60	80
	5.iii	Moderate Permeability Subsoils overlain by poorly drained soils	10	30	50
	5.iv	Low Permeability Subsoil	2	20	40
	5.v	Peat	0	5	20

17. Groundwater Risk Assessment SWRA2

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA2**
Receptor type	Groundwater dependent ecosystems in rivers, lakes, estuaries and lagoons
Pressure type	Diffuse – mobile inorganics (NO_3)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers**
Vertical pathway***	Soil & subsoil	'Wet' soil	L	L	L	L
		Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	L
		High	H	H	H	L
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to Low**	H	H	H	M

* These aquifers are not considered to be contributing a significant proportion of water to rivers and lakes and therefore are not included in pathway susceptibility.
** For areas where complete vulnerability map is not available form GSI.
*** The 'wet' soil and low permeability subsoil layers take precedence over the vulnerability layers.

B. Impact potential

IMPACT POTENTIAL*		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage	High	High	Moderate	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	Moderate	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Low	Low	Low	Low
	<1.0 LU ha^{-1} or <3% tillage	Negligible	Negligible	Negligible	Negligible

*Deriving Impact Potential
Individual Impact Potential maps are derived for the three types of pressures: cattle/sheep, pigs/poultry and tillage i.e. each grid cell within the maps will have three Impact Potential categories.
The ***highest*** Impact Potential category is taken for each cell, regardless of the type of pressure.
Within each GWB, the total area of **'H' plus 'M'** Impact Potential is used to determine whether the GWB is 'at risk' (see C below).

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		>50%	*25-50%**	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity (nitrate-limited ecosystems)	1b	1b	1b	2a	2a	2b
	Moderate (Rivers)	1b	1b	2a	2a	2b	2b

*The basis for this threshold is given in Guidance Document no. GW10 (GW WG, 2004).

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available groundwater impact data**	
	Data criteria	*Adjusted risk category*
1b	Weighted mean NO_3-N >11.3 mg l^{-1}	1a or 1b, depending on level of confidence in the monitoring data
2a 2b	Weighted mean NO_3-N 5.65-11.3 mg l^{-1}	1b or 2a, depending on level of confidence in the monitoring data
2b	Weighted mean NO_3-N 2.0-5.65 mg l^{-1}	2a
	Weighted mean NO_3-N <2.0 mg l^{-1}	2b

18. Groundwater Risk Assessment SWRA3

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA3**
Receptor type	Groundwater Dependent Ecosystems in river, lake, estuary and lagoon Water Bodies
Pressure type	Diffuse – low mobility inorganics (PO_4)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (horizontal pathway)**						
			Karst aquifers		*Fissured aquifers*		*Intergranular aquifers*	*Poorly productive aquifers*	
Vertical pathway	Soil & karst features		Dry soil	Wet soil	Dry soil	Wet soil	n/a	Dry soil	Wet soil
	Vulnerability	Extreme 0-1 m soil & subsoil	E	E	E	H	n/a **	H	M
		Extreme 1-3 m soil subsoil	E	E*	H	M	n/a	M	L
		High	M		M		M	L	
		Moderate	L		L		L	L	
		Low	L		L		L	L	
		High to low***	M		M		M	L	

n/a = not applicable

* This ranking allows for bypass of the soil/subsoil at swallow holes; where swallow holes are absent, the appropriate ranking is 'H'. However, the default ranking is 'E'.

** Where sand/gravel aquifers are classed as 'extremely' vulnerable due to the presence of a shallow water table, the pathway susceptibility is considered to be moderate.

*** For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL*		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage	High	High	Low	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	High	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Moderate	Low	Low	Low
	0.5-1.0 LU ha^{-1} or <3% tillage	Moderate	Negligible	Negligible	Negligible
	<0.5 LU ha^{-1}	Low	Negligible	Negligible	Negligible

*Deriving Impact Potential

Individual Impact Potential maps are derived for the three types of pressures: cattle/sheep, pigs/poultry and tillage i.e. each grid cell within the maps will have three Impact Potential categories.

The ***highest*** Impact Potential category is taken for each cell, regardless of the type of pressure.

Within each GWB, the total area of **'H' plus 'M'** Impact Potential is used to determine whether the GWB is 'at risk' (see C below).

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity*	1b	1b	2a	2a	2a	2b
	Moderate	1b	2a	2a	2a	2b	2b

* high sensitivity refers to certain sensitive lakes and lagoons

D. Risk category of groundwater body adjusted using available impact data (*)

Adjustments for rivers and lakes in GWB		
Predictive Risk Category	*Data Criteria***	*Adjusted risk category*
1b	MRP > 60 µg l^{-1}	1a
2a	MRP 30-60 µg l^{-1}	1b
2b	MRP 30-60 µg l^{-1} [1]20-30 µg l^{-1}	2a or 1b, depending on level of confidence in the monitoring data
	MRP < 30µg l^{-1} [1]<20 µg l^{-1}	2b

* Note: generally only MRP data will be available for groundwater, in which case only river criteria can apply.
** Median unfiltered Molybdate Reactive Phosphorus based on Phosphorus regulations which indicate that when in-river median MRP> 30µg l^{-1} the Q-value is generally less than Q4 (reference: McGarrigle *et al*. (2002) Appendix I). The 60 µg l^{-1} threshold is taken from SEPA, but is used here to highlight particular hotspots.

[1] For protected areas (SPA and SAC) more stringent criteria apply. The 20 µg l^{-1} threshold is taken from McGarrigle *et al*. (2002) Appendix I, which indicates that when in-river median MRP> 20 µg l^{-1} the Q-value is generally less than Q4-5.

19. Groundwater Risk Assessment SWRA4

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA4**
Receptor type	Groundwater Dependent Ecosystems in River & Lake Water Bodies
Pressure type	Diffuse – mobile organics (pesticides and PAHs)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater bodies contributing significant flows to surface waters (i.e. productive aquifers).

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Sub-soil	Low permeability subsoil*	L	L	L	L
	Vulnerability	Extreme	E	E	H	M
		High	H	H	H	L
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to low**	H	H	H	M

* In areas where GSI subsoil permeability map is unavailable, use vulnerability map alone.
** For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

* Pressure magnitude
The pressures that are considered to pose a significant threat to groundwater are: urban and industrial areas, tillage, major roads and railways.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Proportion of assessment area with high and moderate impact potential**					
		>50%	*25-50%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	High sensitivity (all GW bodies)	1b	1b	1b	2a	2a	2b
	Moderate/Low sensitivity	n/a	n/a	n/a	n/a	n/a	n/a

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available groundwater impact data**	
	*Data criteria***	*Adjusted risk category*
1b	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05 µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01 µg/l in more than 2 samples, OR Maximum trace organic >100 µg/l in any one sample.	1a or 1b, depending on level of confidence in the monitoring data
2a	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01µg/l in more than 2 samples, OR Maximum total trace organic >0.1 µg/l in any one sample.	1b
2b	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01µg/l in more than 2 samples, OR Maximum total trace organic >0.1 µg/l in any one sample.	2a or 1b, depending on level of confidence in the monitoring data

** copied from SEPA approach.

20. Groundwater Risk Assessment SWRA5

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA5**
Receptor type	Groundwater Dependent Ecosystems in Rivers, Lakes & Estuaries
Pressure type	Clustered on-site systems & Leaking Urban Sewerage Systems* – inorganics (N & P)
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

* Both pressures are assumed to produce similar pollutants. Nitrates and phosphate are the pollutants considered in this RA.

A. Pathway susceptibility

Table A1

PATHWAY SUSCEPTIBILITY FOR NITRATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	M*
		High	H	H	H	M*
		Moderate	M	M	M	L*
		Low	L	L	L	L*
		High to Low	H	H	H	M*

*In poorly productive aquifers where denitrification is not considered likely to occur, these categories should be the same as the karst and fissured aquifers categories.

Table A2

PATHWAY SUSCEPTIBILITY FOR PHOSPHATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	n/a *	H
		High	M	M	n/a *	M
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to Low**	M	M	M	M

*Where sand/gravel aquifers are classed as 'extremely' vulnerable due to the presence of a shallow water table, the pathway susceptibility is considered to be moderate.
**Where complete GSI vulnerability map is not available.

B. Impact Potential

The presence of urban and discontinuous urban fabric from CORINE and/or built up areas from the Ordnance Survey maps make up the pressure layer on the groundwater body.

IMPACT POTENTIAL		Nitrate Pathway Susceptibility (from Table A1)			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

IMPACT POTENTIAL		Phosphate Pathway Susceptibility (from Table A2)			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Pollutant	Phosphate	1b	1b	1b	2a	2a	2b
	Nitrate	1b	2a	2a	2a	2b	2b

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	Adjustments made using available impact data	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by GSI, EPA, local authorities or RBD consultants	1a
2a	Where significant impacts are known to occur by GSI, EPA, local authorities or RBD consultants	1b or 1a, depending on confidence in data and/or degree of impact.

21. Groundwater Risk Assessment SWRA6

Summary details on pressures, receptors and WFD objective

RA Sheet	**SWRA6**
Receptor type	Groundwater dependent ecosystems in River, Lake and Estuary Water Bodies
Pressure type	Mining – mobile inorganics
WFD objective	Chemical status
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

As mines are generally deep, this is not a factor in the RA process. The value of the groundwater resource is taken into account in considering the potential impacts.

B. Impact potential

		Impact Potential
Pressure magnitude	High (based largely on expert judgement)*	High
	Low (based largely on expert judgement)	Low

*expert judgement provided by Grennan (1996), RPS-KMM and EPA.

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Impact potential (from Table B)**	
		High	*Low*
Receptor Sensitivity	High sensitivity*	n/a	n/a
	Moderate	1b	2a

*not applicable – see RA sheet GWDTERA4.

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by GSI, EMD, EPA, RBD consultants or local authorities	1a
2a	Where impacts are known to occur by GSI, EMD, EPA, RBD consultants or local authorities	1b or 1a, depending on confidence in data and/or degree of impact.

22. Groundwater Risk Assessment GWDTERA1

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA1**
Receptor type	Groundwater Dependent Terrestrial Ecosystems (incl. turloughs)
Pressure type	Abstraction
WFD objective	Quantitative status
Assessment area	Catchment area of ecosystem

A. Recharge Estimation

a) Effective Rainfall Estimation

- Obtained from recently produced Meteorological Service maps.

b) Recharge Coefficient

- The Recharge coefficient is the proportion of Effective Rainfall that may become Recharge.
- It should be determined by using Table 1 (below).

c) Applying a Recharge Cap on Poorly productive Aquifers

- A recharge cap is applied to poorly productive aquifers, as they are not capable of accepting the available recharge due to their low transmissivity.
- The recharge cap for Locally Important aquifers, which are moderately productive only in local zones (**Ll**) is 200mm/yr, whereas the cap for Poor Aquifers (**Pl & Pu**) is 100mm/yr.

B. Catchment Area of GWDTE

The RA applies to the area contributing water to the GWDTE. Therefore, the catchment area of the GWDTE must be delineated, even if only approximately. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For instance, the surface water catchment may be used where it equates closely to the catchment area. Alternatively, groundwater flow lines (estimated, in most instances) may be used.

C. Impact potential

The impact of abstraction may result from general abstraction in the catchment area and/or from wells in the immediate vicinity of the boundary of the GWDTE. Impacts can also be caused by drainage; only arterial drainage is considered in this assessment.

C1. Potential impact resulting from abstraction in GWDTE catchment area

Use Table below.

IMPACT POTENTIAL		**GWDTE Sensitivity to Abstraction**	
		High	*Moderate to Low*
GWABS as a % of average recharge in 'catchment' of GWTDE	>20%	High	High
	10 to 20%	High	Moderate
	5 to 10%	High	Low
	<5%	Moderate	Low

C2. Local abstraction & arterial drainage

Use Table below.

IMPACT POTENTIAL			GWDTE Sensitivity to Abstraction	
			High	*Moderate to Low*
Local abstractions & arterial drainage		Within GWDTE	High	Moderate/low
	>100 m^3/d	Within GWDTE	High	High
		Within 100 m of boundary	High	Moderate/low
	>500 m^3/d.	Within GWDTE	High	High
		Within 100 m of boundary	High	High
		Within 500 m of boundary	High	Moderate/low
	Arterial drainage	Within 100 m of boundary	High	High

D. Risk category based on predictive risk assessment and available impact data

Potential Impact	**Evidence for GW level decline**	**No/ insufficient evidence for GW level decline**	**Evidence of no GW decline**
High	At Significant Risk (1a)	Probably at risk (1b)	Not at significant risk (low confidence) (2a) to Not at significant risk (2b) based on confidence in the data
Moderate	At Significant Risk (1a)	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)
Low	At Significant Risk (1a) to Probably at risk (1b) based on confidence in the data	Not at significant risk (low confidence) (2a)	Not at significant risk (2b)

Table 1 Recharge coefficients for different hydrogeological settings

Vulnerability category		Hydrogeological setting	Recharge coefficient (rc)		
			Min (%)	*Inner Range*	*Max (%)*
Extreme	1.i	Areas where rock is at ground surface	60	80-90	100
	1.ii	Sand/gravel overlain by 'well drained' soil	60	80-90	100
		Sand/gravel overlain by 'poorly drained' (gley) soil			
	1.iii	Till overlain by 'well drained' soil	45	50-70	80
	1.iv	Till overlain by 'poorly drained' (gley) soil	15	25-40	50
	1.v	Sand/ gravel aquifer where the water table is ≤ 3 m below surface	70	80-90	100
	1.vi	Peat	15	25-40	50
High	2.i	Sand/gravel aquifer, overlain by 'well drained' soil	60	80-90	100
	2.ii	High permeability subsoil (sand/gravel) overlain by 'well drained' soil	60	80-90	100
	2.iii	High permeability subsoil (sand/gravel) overlain by 'poorly drained' soil			
	2.iv	Moderate permeability subsoil overlain by 'well drained' soil	35	50-70	80
	2.v	Moderate permeability subsoil overlain by 'poorly drained' (gley) soil	15	25-40	50
	2.vi	Low permeability subsoil	10	23-30	40
	2.vii	Peat	0	5-15	20
Moderate	3.i	Moderate permeability subsoil and overlain by 'well drained' soil	25	30-40	60
	3.ii	Moderate permeability subsoil and overlain by 'poorly drained' (gley) soil	10	20-40	50
	3.iii	Low permeability subsoil	5	10-20	30
	3. iv	Basin peat	0	3-5	10
Low	4.i	Low permeability subsoil	2	5-15	20
	4.ii	Basin peat	0	3-5	10
High to Low	5.i	High Permeability Subsoils (Sand & Gravels)	60	90	100
	5.ii	Moderate Permeability Subsoil overlain by well drained soils	25	60	80
	5.iii	Moderate Permeability Subsoils overlain by poorly drained soils	10	30	50
	5.iv	Low Permeability Subsoil	2	20	40
	5.v	Peat	0	5	20

23. Groundwater Risk Assessment GWDTERA2a

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA2a**
Receptor type	Groundwater Dependent Terrestrial Ecosystems: Turloughs
Pressure type	Diffuse – low mobility inorganics (PO_4)
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

Note: Further information and explanation is given in the Groundwater Working Group Report GW9 (2004)

A. Pathway susceptibility

Catchment area of the turlough

The RA applies to the area contributing water to the GWDTE. Therefore, the catchment area of the GWDTE must be delineated, even if only approximately. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow. For turlough catchments this will include an assessment of the flow types in the catchment i.e. epikarstic, conduit type, or a combination thereof, and identification of dominant flow routes. Delineation will then include one or more of topographic, bedrock or groundwater catchment delineation.

PATHWAY SUSCEPTIBILITY				**Flow Regime (horizontal pathway)**			
				Karst aquifers		*Poorly productive and/or fissured aquifers contributing surface waters to turlough catchment.*	
Vertical pathway	Soil & contributing area			*Dry soil*	*Wet soil*	*<50 m from a stream channel*	*Remainder of catchment area*
	Vulnerability	Extreme	0-1 m soil & subsoil	E	E	E	H
			1-3 m soil subsoil	E	E*		
		High		M			
		Moderate		L			
		Low		L			

n/a = not applicable

*This ranking allows for bypass of the soil/subsoil at swallow holes; where swallow holes are absent, the appropriate ranking is 'H'. However, the default ranking is 'E'.

B. Impact potential

	IMPACT POTENTIAL	**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage Heavily fertilized forestry on peat* Q value < 4** in surface water	High	High	Low	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	High	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Moderate	Low	Low	Low
	0.5-1.0 LU ha^{-1} or <3% tillage	Moderate	Negligible	Negligible	Negligible
	<0.5 LU ha^{-1}	Low	Negligible	Negligible	Negligible

*Heavily fertilized forestry (on peat) corresponds almost completely to Sitka spruce. This measure is taken to be a surrogate measure of associated nutrient load from forestry.

**Q value of surface water contributed by poorly productive and/or fissured aquifers and/or of any surface waters within the catchment area. A Q value of ≥4 corresponds to <30µg/l MRP

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of turlough catchment with high and moderate impact potential					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	Extreme sensitivity*	1b	1b	1b	2a	2a	2b
	High sensitivity	1b	1b	2a	2a	2b	2b
	Moderate sensitivity	1b	2a	2a	2b	2b	2b

*Extreme, high and moderate receptor sensitivity classes were defined by NPWS using turlough vegetation data.

D. Risk category of turlough catchment adjusted using available impact data

Adjustments for turlough catchment						
Predictive Risk Category	Turlough data Criteria*			Groundwater data criteria***		
	*High/moderate sensitivity receptors***	*Extremely sensitive receptors*	*Adjusted Risk Category*	*High/moderate sensitivity receptors***	*Extremely sensitive receptors*	*Adjusted Risk Category*
1b	Total P > 30 µg l^{-1}	Total P >10 µg l^{-1}	1a	MRP >30 µg l^{-1}	MRP >10 µg l^{-1}	1a
2a	Total P 20-30 µg l^{-1}		1b	MRP 20-30 µg l^{-1}		1b
2b	Total P 10-20 µg l^{-1}	Total P <10 µg l^{-1}	2a or 1b depending on confidence in the monitoring data	MRP 10-20 µg l^{-1}	MRP <10 µg l^{-1}	2a or 1b depending on confidence in the monitoring data
	Total P <10 µg l^{-1}		2b	MRP <10µg l^{-1}		2b

* Mean TP of turlough water, based on a mean of monthly sampling during the flood period, but excluding the extreme beginning and end of the flood period. Thresholds are based on the Phosphorus Regulations' standards for total phosphorus (TP) in lakes, which indicate that when mean TP ≤10 µg l^{-1} the lake is oligotrophic and >10 to ≤20 µg l^{-1} mesotrophic. (Reference: McGarrigle *et al*. (2002) Appendix I).

** Sensitivity of receptor (turlough) is that defined by NPWS from turlough vegetation studies.

*** Groundwater data is expressed as median unfiltered Molybdate Reactive Phosphorus (MRP). As many turloughs are conduit fed it is assumed that there will be very little attenuation in phosphorus concentrations in groundwater discharges to the turlough. For this reason it was considered more appropriate to use lake rather than river phosphorus regulation standards. See note (*) above.

E. Additional Impact data

In addition to the type of phosphorus data described in Table D above, a number of turloughs have been assessed by the Ecological sub-group of the Turloughs Working Group, and the degree to which they are impacted has been described qualitatively. These data may be used to adjust the risk category of the turlough catchment, with the proviso that the data apply only to the immediate turlough basin and not the catchment, and that the data may not be consistent, as they reflect the focus of the visiting ecologist.

F. Expert Review Recommendations

Expert review of the outcome of this risk assessment is recommended by EPA staff with field experience of the catchment area of the GWDTE and knowledge of surface water impacts.

Final expert review is recommended by National Parks and Wildlife Service staff who may recommend upgrading of the risk category based on available impact data and local knowledge of the SAC/SPA involved.

24. Groundwater Risk Assessment GWDTERA2b

Summary details on pressures, receptors and WFD objective

RA Sheet	GWDTERA2b
Receptor type	Groundwater Dependent Terrestrial Ecosystems (excluding turloughs)
Pressure type	Diffuse – low mobility inorganics (PO_4)
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

Note: Further information and explanation is given in the Groundwater Working Group Report GW11 (2004)

A. Pathway susceptibility

Catchment area of the GWDTE

The RA applies to the area contributing water to the GWDTE. Therefore, the catchment area of the GWDTE must be delineated, even if only approximately. The boundaries must be based on the conceptual understanding of the area and on hydrogeological boundaries to flow.

Table A1

PATHWAY SUSCEPTIBILITY				Flow Regime (horizontal pathway)						
				Karst aquifers		*Fissured aquifers*		*Intergranular aquifers*	*Poorly productive aquifers*	
Vertical pathway	Soil & karst features			*Dry soil*	*Wet soil*	*Dry soil*	*Wet soil*	*n/a*	*Dry soil*	*Wet soil*
	Vulnerability	Extreme	0-1 m soil & subsoil	E	E	E	H	n/a **	H	M
			1-3 m soil & subsoil	E	E*	H	M	n/a	M	L
		High		M		M		M	L	
		Moderate		L		L		L	L	
		Low		L		L		L	L	
		High to low***		M		M		M	L	

n/a = not applicable

* This ranking allows for bypass of the soil/subsoil at swallow holes; where swallow holes are absent, the appropriate ranking is 'H'. However, the default ranking is 'E'.

** Where sand/gravel aquifers are classed as 'extremely' vulnerable due to the presence of a shallow water table, the pathway susceptibility is considered to be moderate.

*** For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL*		Pathway Susceptibility (from Table A)			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage	High	High	Low	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	High	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Moderate	Low	Low	Low
	0.5-1.0 LU ha^{-1} or <3% tillage	Moderate	Negligible	Negligible	Negligible
	<0.5 LU ha^{-1}	Low	Negligible	Negligible	Negligible

*Deriving Impact Potential

Individual Impact Potential maps are derived for the three types of pressures: cattle/sheep, pigs/poultry and tillage i.e. each grid cell within the maps will have three Impact Potential categories.

The ***highest*** Impact Potential category is taken for each cell, regardless of the type of pressure.

Within each GWB, the total area of **'H' plus 'M'** Impact Potential is used to determine whether the GWB is 'at risk' (see C below).

C. Risk category based on predictive risk assessment

RISK CATEGORY		Proportion of assessment area with high and moderate impact potential					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Receptor Sensitivity	Extreme sensitivity*	1b	1b	1b	2a	2a	2b
	High/Moderate	1b	1b	2a	2a	2b	2b

*Receptor sensitivity refers to certain sensitive GWDTE as determined by NPWS

D. Risk category of GWDTE adjusted using available groundwater data (*)

Adjustments for GWDTE catchment			
Predictive Risk Category	**Groundwater data criteria****		
	*High/moderate sensitivity receptors***	*Extremely sensitive receptors*	*Adjusted Risk Category*
1b	MRP >30 µg l^{-1}	MRP >15 µg l^{-1}	1a
2a	MRP 20-30 µg l^{-1}		1b
2b	MRP 15-20 µg l^{-1}	MRP <15 µg l^{-1}	2a or 1b depending on confidence in the monitoring data
	MRP <15 µg l^{-1}		2b

* Note: generally only MRP data will be available for groundwater, in which case only river criteria can apply.
** Groundwater data are expressed as median unfiltered Molybdate Reactive Phosphorus (MRP) based on Phosphorus regulations which indicate that when in-river median MRP >15µg l^{-1}, >20µg l^{-1} and > 30µg l^{-1} the Q-value is generally less than Q5, Q4-5 and Q4 respectively. (Reference: McGarrigle *et al*. (2002) Appendix I).

E. Expert Review Recommendations

Expert review of the outcome of this risk assessment is recommended by EPA staff with field experience of the catchment area of the GWDTE and knowledge of surface water impacts.

Final expert review is recommended by National Parks and Wildlife Service staff who may recommend upgrading of the risk category based on available impact data and local knowledge of the SAC/SPA involved.

25. Groundwater Risk Assessment GWDTERA3

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA3**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Clustered on-site systems & Leaking Urban Sewerage Systems* – inorganics (N & P)
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

* Both pressures are assumed to produce similar pollutants. Nitrates and phosphate are the pollutants considered in this RA.

A. Pathway susceptibility

Table A1

PATHWAY SUSCEPTIBILITY FOR NITRATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	M*
		High	H	H	H	M*
		Moderate	M	M	M	L*
		Low	L	L	L	L*
		High to Low	H	H	H	M*

*In poorly productive aquifers where denitrification is not considered likely to occur, these categories should be the same as the karst and fissured aquifers categories.

Table A2

PATHWAY SUSCEPTIBILITY FOR PHOSPHATES			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	n/a *	H
		High	M	M	n/a *	M
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to Low**	M	M	M	M

*Where sand/gravel aquifers are classed as 'extremely' vulnerable due to the presence of a shallow water table, the pathway susceptibility is considered to be moderate.
**Where complete GSI vulnerability map is not available.

B. Impact Potential

The presence of urban and discontinuous urban fabric from CORINE and/or built up areas from the Ordnance Survey maps make up the pressure layer on the groundwater body.

IMPACT POTENTIAL		**Nitrate Pathway Susceptibility (from Table A1)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

IMPACT POTENTIAL		**Phosphate Pathway Susceptibility (from Table A2)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

C. Risk category based on predictive risk assessment

RISK CATEGORY		**Proportion of assessment area with high and moderate impact potential**					
		>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
Pollutant	Phosphate	1b	1b	1b	2a	2a	2b
	Nitrate	1b	2a	2a	2a	2b	2b

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available impact data**	
	Data criteria	*Adjusted risk category*
1b	Where significant impacts are known to occur by NPWS or RBD consultants	1a
2a	Where significant impacts are known to occur by NPWS or RBD consultants	1b or 1a, depending on confidence in data and/or degree of impact.

26. Ground Water Risk Assessment GWDTERA4

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA4**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Mining
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	E	E	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, GSI, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

27. Ground Water Risk Assessment GWDTERA5

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA5**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Quarries
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	E	E	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, GSI, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

28. Ground Water Risk Assessment GWDTERA6

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA6**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Landfills
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	E	E	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

29. Ground Water Risk Assessment GWDTERA7

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA7**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Oil industry infrastructure
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	E	E	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

30. Ground Water Risk Assessment GWDTERA8

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA8**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Contaminated land
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	E	E	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

31. Ground Water Risk Assessment GWDTERA9

Summary details on pressures, receptors and WFD objective

RA Sheet	**GWDTERA9**
Receptor type	Groundwater Dependent Terrestrial Ecosystems
Pressure type	Urban Wastewater Discharges
WFD objective	Chemical status
Assessment area	Catchment area of GWDTE

This risk assessment process is based largely on expert judgement. The matrices below are intended to assist the process; however, expert judgement and, where available, impact data can override the conclusions in the matrices.

A. Pathway susceptibility

The pathway susceptibility is assumed to depend on:

- Groundwater flow regime, as indicated by aquifer type.
- Length of pathway or distance from boundary of GWDTE. A maximum distance of 3km is likely to be sufficient for this risk assessment process.

Table A

PATHWAY SUSCEPTIBILITY		**Flow Regime**			
		Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Distance from GWDTE boundary	<100 m	E	E	H	H
	100-1000 m	H	H	M	M
	1000-3000 m	M	M	M	L
	>3000 m	L	L	L	L

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude*	Present within 3000 m	High	High	High	Low
	Absent	None	None	None	None

* Based on expert judgement of NPWS, EPA and RBD consultants.

C. Risk category based on predictive and impact risk assessments

Assessments made on the basis of predictions from pressure-susceptibility analysis		**Adjustments to risk assessment category based on available impact data**	
Impact potential (from Table B)	*Risk category for whole groundwater body*	*Data type*	*Adjusted risk assessment category*
High	1b	NPWS or RBD consultants identify known impact with a high level of certainty	1a
Low	2a	NPWS or RBD consultants identify impact with a low level of certainty	1b
None	2b		

32. Groundwater Risk Assessment DWPARA1

Summary details on pressures, receptors and WFD objective

RA Sheet	**DWPARA1**
Receptor type	Groundwater drinking water supply
Pressure type	Diffuse – mobile inorganics (NO_3)
WFD objective	Drinking Water Protected Area
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Soil & subsoil	'Wet' soil	L	L	L	L
		Low permeability subsoil	L	L	L	L
	Vulnerability	Extreme	E	E	H	M*
		High	H	H	H	M*
		Moderate	M	M	M	L*
		Low	L	L	L	L
		High to Low**	H	H	H	M

*In poorly productive aquifers where denitrification is not considered likely to occur, these categories should be the same as the karst and fissured aquifers categories.
**For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL*		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	>2.0 LU ha^{-1} or >33% tillage	High	High	Moderate	Low
	1.5-2.0 LU ha^{-1} or 18-33% tillage	Moderate	Moderate	Low	Low
	1.0-1.5 LU ha^{-1} or 3-18% tillage	Low	Low	Low	Low
	<1.0 LU ha^{-1} or <3% tillage	Negligible	Negligible	Negligible	Negligible

*Deriving Impact Potential
Individual Impact Potential maps are derived for the three types of pressures: cattle/sheep, pigs/poultry and tillage i.e. each grid cell within the maps will have three Impact Potential categories.
The ***highest*** Impact Potential category is taken for each cell, regardless of the type of pressure.
Within each GWB, the total area of **'H' plus 'M'** Impact Potential is used to determine whether the GWB is 'at risk' (see C below).

C. Risk category based on predictive risk assessment

	Proportion of assessment area with high and moderate impact potential					
	*>40%**	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
RISK CATEGORY	1b	2a	2a	2a	2b	2b

*The basis for this threshold is given in guidance document no. GW10 (GW WG, 2004).

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category	**Adjustments made using available groundwater impact data**	
	Data criteria	*Adjusted risk category*
All categories	Available representative monitoring data show an environmentally significant upward trend in groundwater nitrate concentrations	1a
1b	Weighted mean NO_3-N >11.3 mg l^{-1}	1a or 1b, depending on level of confidence in the monitoring data
2a 2b	Weighted mean NO_3-N 8.5-11.3 mg l^{-1}	1b or 2a, depending on level of confidence in the monitoring data
2b	Weighted mean NO_3-N 5.65-8.5 mg l^{-1}	2a
	Weighted mean NO_3-N <5.6 mg l^{-1}	2b

33. Groundwater Risk Assessment DWPARA2

Summary details on pressures, receptors and WFD objective

RA Sheet	**DWPARA2**
Receptor type	Groundwater drinking water supply
Pressure type	Diffuse – mobile organics (pesticides and PAHs)
WFD objective	Drinking Water Protected Area
Assessment area	Surface extent of the groundwater body

A. Pathway susceptibility

PATHWAY SUSCEPTIBILITY			**Flow Regime (Horizontal pathway)**			
			Karst aquifers	*Fissured aquifers*	*Intergranular aquifers*	*Poorly productive aquifers*
Vertical pathway	Subsoil	Low permeability subsoil*	L	L	L	L
	Vulnerability	Extreme	E	E	H	E
		High	H	H	H	H
		Moderate	M	M	M	L
		Low	L	L	L	L
		High to low**	H	H	H	M

* In areas where GSI subsoil permeability map is unavailable, use vulnerability map alone.
** For areas where complete vulnerability map is not available from GSI.

B. Impact potential

IMPACT POTENTIAL		**Pathway Susceptibility (from Table A)**			
		Extreme	*High*	*Moderate*	*Low*
Pressure magnitude	Present	High	Moderate	Low	Negligible
	Absent	Negligible	Negligible	Negligible	Negligible

* Pressure magnitude
The pressures that are considered to pose a significant threat to groundwater are: urban and industrial areas, tillage, major roads and railways.

C. Risk category based on predictive risk assessment

	Proportion of assessment area with high and moderate impact potential					
	>40%	*25-40%*	*15-25%*	*10-15%*	*5-10%*	*<5%*
RISK CATEGORY	1b	1b	1b	2a	2b	2b

D. Risk category of groundwater body adjusted using available impact data

Predictive risk category (from Table C)	**Adjustments made using available groundwater impact data**	
	*Data criteria***	*Adjusted risk category*
1b	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05 µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01 µg/l in more than 2 samples, OR Maximum trace organic >100 µg/l in any one sample.	1a or 1b, depending on level of confidence in the monitoring data
2a	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01µg/l in more than 2 samples, OR Maximum total trace organic >0.1 µg/l in any one sample.	1b
2b	One or more groundwater sampling stations have EITHER: Any individual selected trace organic >0.05µg/l in more than 25% of groundwater samples, OR Total trace organic >0.01µg/l in more than 2 samples, OR Maximum total trace organic >0.1 µg/l in any one sample.	2a or 1b, depending on level of confidence in the monitoring data

** copied from SEPA approach.

34. Membership of Groundwater Working Group

Organisation	Representative(s)
Geological Survey of Ireland (GSI)	Donal Daly (Convenor) Geoff Wright Vincent Fitzsimons Coran Kelly Taly Hunter Williams Monica Lee
Camp Dresser McKee (CDM)	Henning Moe
Compass Informatics Ltd.	Paul Mills
Department of the Environment, Heritage and Local Government (DEHLG)	Pat Duggan Jim Ryan (NPWS) Aine O'Connor (NPWS)
Environment and Heritage Service/ Geological Survey of Northern Ireland (EHS/GSNI)	Peter McConvey
Environmental Protection Agency (EPA)	Margaret Keegan Micheal McCarthaigh
RPS-Kirk McClure Morton (RPS-KMM)	Grace Glasgow Kieran Fay
O'Callaghan Moran (OCM)	Sean Moran Gerry Baker
O'Neill Groundwater Engineering (OGE)	Shane O'Neill
Shannon Pilot River Basin – EPA/TCD Research Fellow	Garrett Kilroy
Southeastern River Basin District (SERBD)	Colin Byrne
Teagasc	Karl Richards
Trinity College, Dublin (TCD)	Paul Johnston Catherine Coxon

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