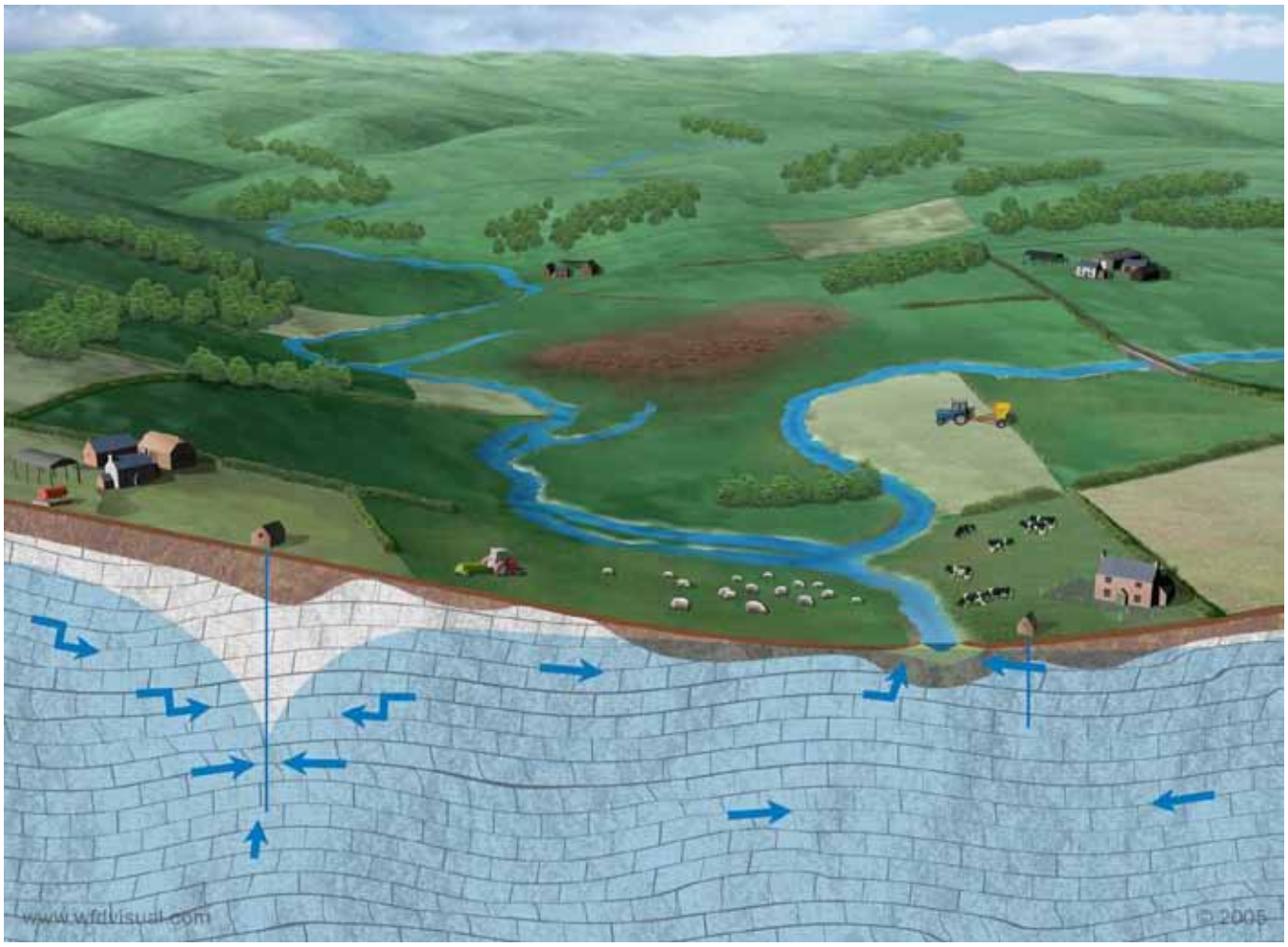
The Environmental Protection Agency

EPA DRINKING WATER ADVICE NOTE
Advice Note No. 11: Technical Assessments and Prior Investigations

epa
Office of Environmental Enforcement



EPA DRINKING WATER ADVICE NOTE
Advice Note No. 11:
European Communities (Good Agricultural Practice for Protection of Waters) Regulations S.I. NO. 610 OF 2010:
Advice Note for Local Authorities on Technical Assessments and Prior Investigations

Version 1

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1 BACKGROUND

This Advice Note was prepared by an EPA Office of Environmental Assessment/Office of Environmental Enforcement (OEA/OEE) Working Group consisting of Donal Daly (Chairperson), Patrick Byrne, Matthew Craig, Margaret Keegan, Darragh Page, Leo Sweeney and Brendan Wall with input from Mr. Pat Duggan, Department of Environment, Community and Local Government. It has been prepared by the EPA in accordance with Regulation 17(12) of the European Communities (Good Agricultural Practice for Protection of Waters) Regulations (S.I. No. 610 of 2010) to provide advice to local authorities in relation to technical assessments and prior investigations under these Regulations.

Article 17 of the GAP Regulations[1] (S.I. 610 of 2010) *inter alia* regulates the landspreading of organic fertilisers in the vicinity of drinking water abstraction points. Organic fertilisers are defined in the Regulations to mean *any fertiliser other than that manufactured by an industrial process, and includes livestock manure, dungstead manure, farmyard manure, slurry, soiled water, silage effluent, non-farm organic substances such as sewage sludge, industrial by-products and sludges and residues from fish farms.* Article 17 (2) lays down setback distances in the vicinity of drinking water abstraction points within which the land application of organic fertilisers is not permitted. These distances vary from 200 to 25 m, depending on the daily abstraction amount or number of people served by the drinking water source. Sub-article (3) enables a local authority to reduce these distances to 30 m or 15 m subject to the undertaking of a technical assessment as provided by sub-article (4) and where the local authority has determined that the distance does not give rise to a risk to the water supply or a potential danger to human health.

Sub-article (5) further allows that a local authority may decide to limit the landspreading restriction to the upstream catchment and the close proximity downstream, of the abstraction point in the case of a surface water abstraction serving 50 or more persons or supplying 10m^3 or more of water per day.

Sub-articles (6) and (7) enable local authorities to increase the distances specified in the Regulations (e.g. 200 m/100 m or 30/15 m) where, following 'prior investigations', this is considered necessary to protect the drinking water.

Sub-article (12) enables the Environmental Protection Agency to issue 'advice and/or direction' to local authorities in relation to any of the requirements arising under sub-articles (2), (3), (4), (5), (6), (7), (8) and (9), including requirements for 'technical assessments' and 'prior investigations'. A copy of the full text of the relevant sub-articles of the Regulations is given in Appendix 1. A local authority must comply with any advice or direction given by the Agency.

This Advice Note provides details on the evidence-based approach that the Agency requires to be taken into account in undertaking 'technical assessments' and 'prior investigations'; it replaces the Advice Note for Local Authorities on Technical Assessments, dated March 2011. In general, "technical assessments" are desk-based studies, which can be undertaken by local authority staff, whereas "prior investigations" may require field investigations and will usually require the input of suitably qualified personnel, with expertise on groundwater and/or surface water, as appropriate.

While undertaking either technical assessments or prior investigations, it is recommended that the opportunity should be taken to evaluate all potential sources of pollution; in many circumstances, point sources such as on-site wastewater treatment systems (OSWTSs), e.g., septic tank systems, and farmyards, or diffuse sources such as landspreading of inorganic fertilizers may pose an additional and greater threat to a drinking water supply.

1 European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2010.

2 GENERAL BASIS FOR SETTING SETBACK DISTANCES

In certain hydrogeological settings in Ireland, the laying down of large setback distances (e.g. 200m/100m) in the vicinity of drinking water abstraction points, within which the landspreading of organic fertilisers is restricted, may not always be scientifically justified as a protective measure. However, S.I. No. 610 of 2010 enables setback distances to be delineated in a more scientific manner.

The role and effectiveness of setback distances (also referred to as buffer zones) need to take into account a number of different factors. These include:

- The pollutant loading arising from landspreading.
- The physical/hydrogeological setting in the catchment area of the drinking water source.
- Hydraulic connectivity and the potential for pollutant attenuation.
- Protection at the abstraction point.
- Existing water quality.
- The current or planned level of water treatment.

2.1 POLLUTANT LOADING

In Ireland, microbial pathogens, nitrate and ammonia are the main pollutants of concern to drinking water quality from a public health perspective. All three are present in organic fertilizers (such as animal slurry or soiled water). However, the potential threat posed by landspreading should generally be low provided the landspreading activity is undertaken in compliance with the EC (Good Agricultural Practice for Protection of Waters) Regulations 2010, and the physical conditions (for example, soil type, subsoil permeability or outcropping bedrock) at the landspreading site do not present any particular risk:

- The nutrient loadings from landspreading is generally less than that from grazing animals (15-35%, depending on the duration animals are housed, of the total organic loading arises as slurry that is mechanically landspread).
- The pathogen risk from landspreading can also be lower than from grazing animals, because the overall pathogen load from landspreading is less than from grazing animals, and also because some pathogen die-off occurs during storage in slurry pits and dungsteads.

2.2 HYDROGEOLOGICAL SETTING

2.2.1 GROUNDWATER SOURCES

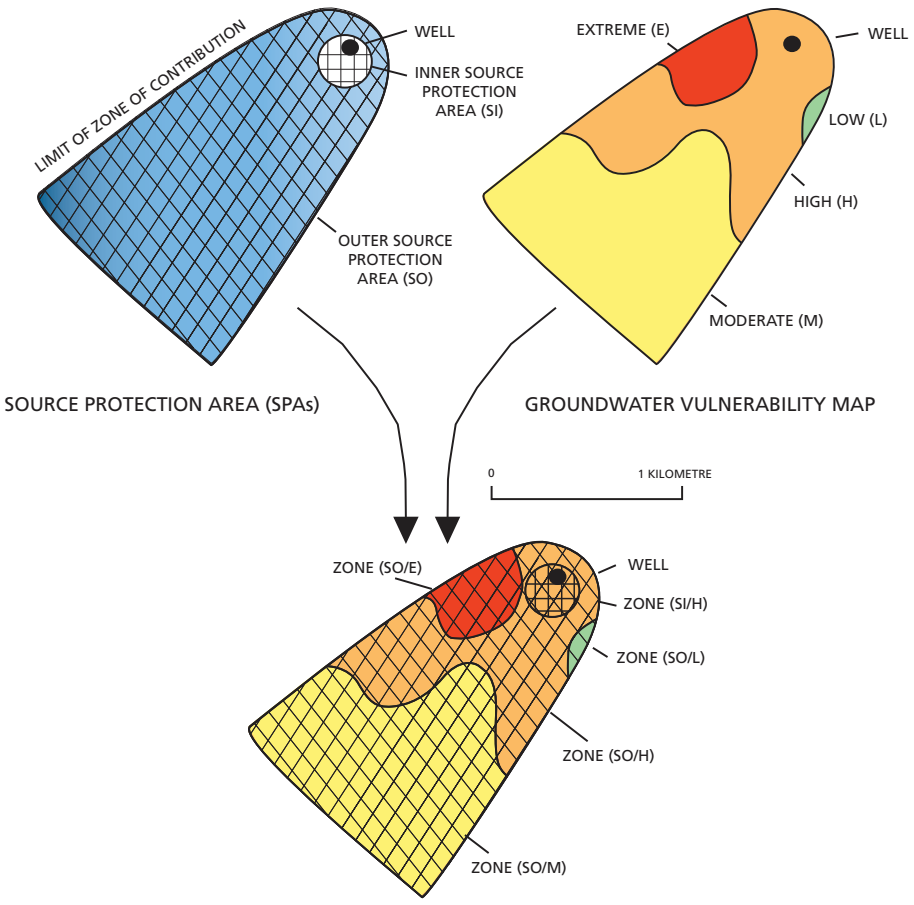
For any particular pollutant source, the following factors influence the risk to a well or spring water suppply:

- Zone of contribution (ZOC) (or catchment area) of well/spring – landspreading activities outside this area are not likely to pose a threat to the drinking water source.

- Proximity to the well/spring, in particular the position relative to the Inner Source Protection Area (SI)[2] as faecal bacteria arising outside this area are unlikely to reach the well/spring.
- Groundwater vulnerability (a combination of subsoil permeability and thickness, and the presence of karst features that enable bypassing of the subsoil) – the risk is greatest in extreme vulnerability areas. There are four vulnerability categories: extreme (E), which is sub-divided into outcrop and shallow rock (X) (i.e. outcrop and thin (<1 m) soil/subsoil) and 1-3 m soil/subsoil (E); high (H); moderate (M); and low (L) (see Appendix 2 for further details).
- Hydrogeological properties of the aquifer, as they influence pollutant attenuation and pollutant travel times. For example, the risk is greater if groundwater flow velocities are rapid in the immediate vicinity of wells in bedrock aquifers (generally >5 m/d and, in karstified limestone, >100 m/d) and where pollutant attenuation is limited.

Figure 1 illustrates a typical shape of a ZOC as well as Inner (SI) and Outer (SO) source protection areas, and illustrates how these combine with vulnerability categories to define Groundwater Protections Zones.

Figure 1: Illustration of zone of contribution (ZOC), inner (SI) and outer (SO) protection areas (SPAs), groundwater vulnerability and source protection zones (SPZs) around a public supply well (from DEHLG/EPA/GSI, 1999)



2 Further details are given in DELG/EPA/GSI, 1999. Groundwater Protection Schemes. Published by the Geological Survey of Ireland. Available on *www.gsi.ie*

2.2.2 SURFACE WATER SOURCES

The main factors influencing the risk to a surface water source are:

- Soil type – 'wet'/gley soils encourage rapid runoff, 'dry' soils enable percolation and reduced likelihood of runoff;
- Subsoil permeability – low subsoil permeability encourages rapid runoff to ditches and streams;
- Bedrock permeability in circumstances where the depth of subsoil is thin – low permeability bedrock associated with poor aquifers can lead to rapid runoff.
- Slope – greater slopes increase the likelihood of runoff.
- Surface drainage channels and covered land drains have the potential to enable bypassing of buffer zones.
- Location relative to water intake – landspreading of organic fertilizers down-gradient of the intake will not generally impact on the abstracted water.

2.2.3 HYDRAULIC CONNECTIVITY AND POLLUTANT ATTENUATION

The purpose of buffer zones is to provide a separation between a contaminant source and a drinking water receptor, which will serve to reduce or attenuate the level of pollutants reaching the receptor. The protection afforded by buffer zones will vary depending on the factors outlined in Sections 2.2.1 and 2.2.2.

2.2.3.1 Groundwater Sources

The horizontal velocity close to wells in Irish bedrock aquifers, where the hydraulic gradient is highest, is several metres/day and in many circumstances greater than 10 m/d. Where there is a pressure, such as landspreading, the critical factor in protecting wells is the overlying soil and subsoil rather than horizontal distance. It is the vertical dimension or perspective, expressed as vulnerability, which is important rather than the 'plan view' perspective, expressed as setback distances (see Figure 2). Therefore, an area of extreme vulnerability (e.g., bare rock and thin soil over karstified limestone) at a distance (several 10s-100s of metres) from a well/spring would be a high risk area where landspreading may be problematical.

The main pollutants of concern are nitrate, ammonia and microbial pathogens. Where the objective is to protect groundwater from nitrate pollution alone, setback distances for landspreading will generally have little beneficial impact, except perhaps in reducing peak nitrate concentrations in circumstances where soil/subsoil cover is thin and peak nitrate concentrations in groundwater are relatively high. In relation to ammonia, setback distances provide the opportunity for crop uptake, nitrification and retardation, although large distances are not normally required. With regard to pathogens, landspreading activities within the source protection zone of a drinking water source - where the boundary is usually hundreds of metres up-gradient of the source - increasing setback distances by an additional few tens of metres does not reduce the risk of pathogen pollution significantly.

In circumstances where overland and near surface (interflow and/or shallow groundwater) flows occur in the vicinity of wells, buffer zones reduce the pollutant concentrations, and therefore relatively small buffer zones, such as the 30 m setback distance, are a justifiable means of providing protection, especially where wellhead completion is inadequate.

2.2.3.2 Surface Water Sources

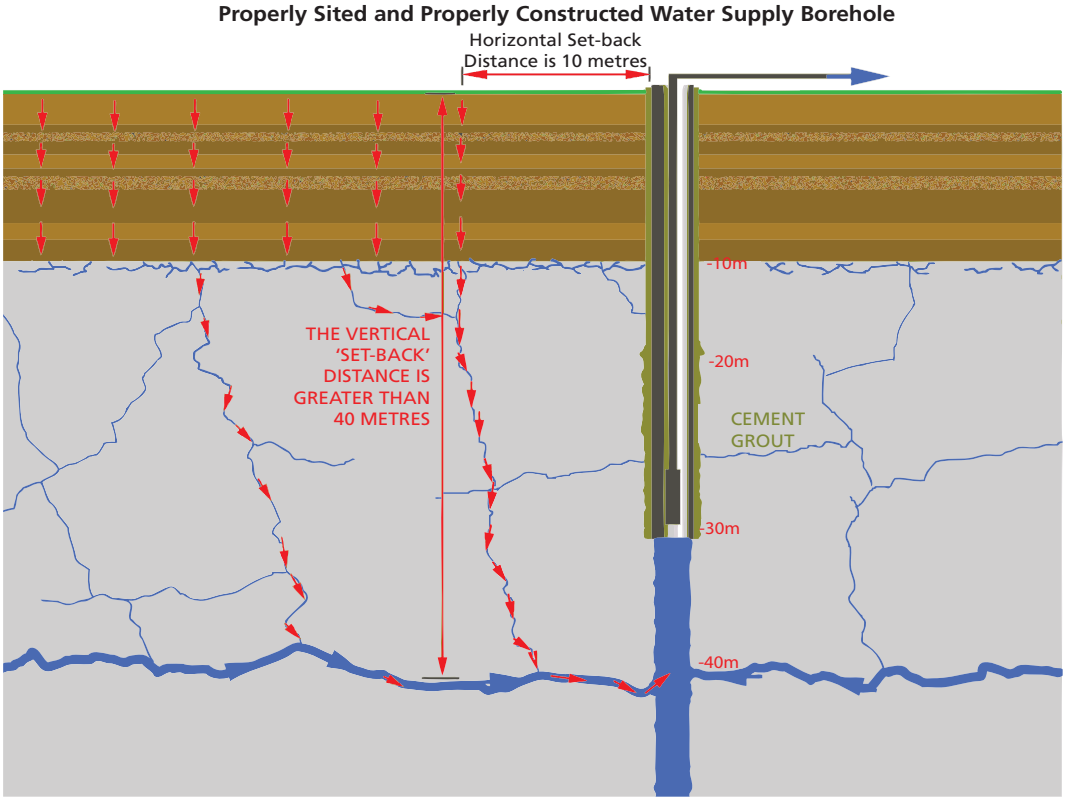
Buffer zones are a useful means of reducing the risks to drinking water sources, particularly in circumstances where overland flow and shallow subsurface flow occurs. They reduce the likelihood of pollutants reaching the abstraction point by filtering out sediment-borne pollutants, enabling plant uptake of nutrients, denitrification of nitrate, and facilitating die-off and predation of microbial pathogens.

2.3 PROTECTION AT THE ABSTRACTION POINT

2.3.1 WELLHEAD COMPLETION AND BOREHOLE CONSTRUCTION

In circumstances where the wellhead completion and borehole construction are inadequate, surface water and shallow groundwater can enter directly into the drinking water source by flowing down the outside of the well casing or over the top of the wellhead and directly into the borehole. Figure 2 illustrates a properly constructed well with cement grout around the outside of the well casing.

Figure 2: Illustration of a properly constructed well with cement grout around the outside of the well casing. The Figure also illustrates the role of the subsoil overlying the aquifer; it would take years (probably >10 years) for a drop of water to move vertically through the clayey subsoil to the top of the bedrock in this situation. In contrast, horizontal groundwater flow velocities in fractured (occasionally karstified) bedrock close to a well (where the hydraulic gradient is relatively high) would be several m/d and often >10 m/d. (Illustration drawn by David Ball).



2.3.2 SPRINGS AND WATERCOURSES

It is recommended that spring intake areas should be covered and, together with watercourses, sloped so that entry of overland and near surface flow is hindered.

2.4 EXISTING WATER QUALITY

Where the historical water quality is poor, it indicates that the drinking water source is susceptible to pollution. In these circumstances, landspreading exclusion zones need to be considered as a means of improving water quality. However, landspreading of organic fertilisers is only one of several possible pollution sources. Large landspreading setback distances should be considered when an investigation of all likely pollution sources indicates that landspreading of organic fertilisers in the vicinity of the abstraction point is a probable cause of pollution[3].

2.5 WATER TREATMENT

Protection of drinking water supplies is an important facet of the Nitrates Directive and the Water Framework Directive and delivery of wholesome and clean drinking water is a requirement of the Drinking Water Directive. Protection of drinking water supplies follows a Water Safety Plan approach, the objective of which is to provide 'safe and secure' drinking water. The Water Safety Plan approach involves carrying out a risk assessment of the water supply from catchment to consumer in tandem with effective operational monitoring and effective management of the risk identified. The water safety plan requires that the treatment process and distribution system be assessed, monitored and managed in conjunction with catchment management.

A multi-barrier approach is required to ensure a safe and secure supply, particularly with reference to the risk of *Cryptosporidium* for both surface water and groundwater sources. Disinfection as a minimum is required to be put in place for all water supplies. In cases where there is an insufficient natural barrier (in-situ subsoil thickness that provide *Cryptosporidium* protection to groundwater sources) and evidence of faecal contamination, additional treatment barriers capable of removal or inactivation of *Cryptosporidium* are necessary. The extent of the natural barrier is directly linked to the groundwater vulnerability and the management measures within the catchment. The groundwater vulnerability and the degree of water treatment should be determining factors in the assessment of the need/justification to increase the landspreading exclusion zones beyond those specified in sub-articles (2) and (3).

3 Sub-article 6 enables a local authority, following 'prior investigations' and consultation with the Agency, to specify greater distances to that specified in sub-articles (2) or (3) based on water quality evidence and trends. Sub-article 7 (a) requires a local authority to specify alternative distances and/or landspreading exclusion zones, following 'prior investigations' and consultation with the Agency, where, on the basis of monitoring carried out for the Drinking Water Regulations, there are water quality problems and it appears to the local authority that this is due to landspreading of organic fertilisers or soiled water.

3 TECHNICAL ASSESSMENTS AND PRIOR INVESTIGATIONS

A "technical assessment" is a desk-based study that can be undertaken directly by a local authority provided the necessary information is readily available. In circumstances where the information is not available, some field investigations will be required. The aim of a technical assessment is to enable a local authority to evaluate whether the setback distances prescribed in sub-article (2) of the Good Agricultural Practice Regulations can be reduced to either 30 m or 15 m, depending on the daily abstraction amount or number of people served by the source.

While there are similarities, a "prior investigation" is a more comprehensive scientific evaluation than that undertaken for a "technical assessment". It enables a local authority to specify greater distances that those given in sub-articles (2) and (3) in circumstances where a) the catchment characteristics indicate that landspreading may pose a threat to human health and/or b) there are water quality problems which constitute a danger to public health and these are considered to be caused by landspreading.

"Technical assessments" and "prior investigations" can be undertaken separately. However, it may be more effective for local authorities to evaluate the need for "prior investigations" while undertaking the "technical assessments".

The **risk-based approach** to decision-making, using the Source – Pathway – Receptor (S-P-R) model for environmental management, provides the framework for "technical assessments" and "prior investigations". The Agency requires assessment of factors relating to the pressure or hazard (in this case organic fertilizers), the receptor (well, spring, watercourse, lake) and the pathway(s) for potential pollutants to the abstraction point.

4 TECHNICAL ASSESSMENTS

4.1 INFORMATION REQUIREMENTS FOR GROUNDWATER SOURCES

4.1.1 PRESSURES

- Nature of the organic materials to be landspread, i.e. the origin of the material (cow/cattle farmyard slurry/manure, industrial and sewage sludge, soiled water, imported pig or poultry manure etc).
- The likely pollutants present in the materials, e.g. nitrogen, phosphorus, metals, pathogens, including a conclusion on the pollutant/s posing the greatest threat to the abstraction source (usually these will be microbial pathogens and nitrate).
- Location of areas, if present, used for landspreading of soiled water using irrigation systems.

4.1.2 RECEPTOR

- Type of receptor – well or spring groundwater source.
- Summary details on abstraction source, e.g. location, depth and diameter, well design and construction, abstraction rate and daily volume of water supplied (m^3), depth to bedrock, etc.
- Summary of existing relevant water quality data[4], including parameters that are indicative of contamination, such as nitrate, ammonia, chloride, potassium, *E. Coli.* Graphs of relevant pollutant concentrations showing temporal variations and trends should be prepared.
- Details on existing or proposed water treatment.
- Details on the *Cryptosporidium* Risk Assessment Score and Risk Classification, including the individual Catchment Risk Score and the Treatment, Operation and Management Risk Score.

4.1.3 PATHWAYS

The required pathway information will vary depending on the type of receptor being considered, the hydrogeological setting, groundwater quality and likely risk to the source. In assessing the pathway factors, the technical specifications set out in "Groundwater Protection Schemes" (DELG/EPA/GSI, 1999) should be followed where relevant.

The essential information required is as follows:

- Vulnerability of groundwater in the vicinity (in the zone of contribution (ZOC)[5] or, if not available, within 1 km of the source).

4 The existing water quality data for both surface and groundwater sources is mainly for treated water samples. While these data should be assessed, particularly for parameters such as nitrate and ammonium, data from untreated water samples are more useful and relevant. Analyses of untreated water samples from about 200 groundwater sources are undertaken as part of the EPA national groundwater monitoring programme. For all other sources, sampling and analysis of untreated water is recommended.

5 ZOC s for all drinking water sources in the EPA national groundwater monitoring programme have been delineated and source protection zones, with accompanying reports, have been delineated for a proportion of them.

6 Existing GSI data on groundwater, such as aquifer categories, vulnerability and karst features can be obtained from the following web link: *http://spatial.dcenr.gov.ie/imf/imf.jsp?site=Groundwater* However, while it is advisable to check this website, the GSI has not mapped all the karst features in the country.

- Location of karst features[6], if bedrock is limestone.
- Thickness of unsaturated zone in vicinity of source, where source is in a sand/gravel aquifer,

In addition, it would be helpful and preferable if the following information was available for evaluation:

- Inner and Outer protection area boundaries.
- Aquifer category (to enable bedrock permeability to be assessed).
- Conceptual model of zone of contribution.

4.2 INFORMATION REQUIREMENTS FOR SURFACE WATER SOURCES

4.2.1 PRESSURES

- Nature of the organic materials to be landspread, i.e. the origin of the material (cow/cattle farmyard slurry/manure, industrial and sewage sludge, soiled water, imported pig or poultry manure).
- The likely pollutants present in the materials, e.g. nitrogen, phosphorus, metals, pathogens, including a conclusion on the pollutant/s posing the greatest threat to the abstraction source (usually these will be microbial pathogens).

4.2.2 RECEPTOR

- Type of receptor – river, lake or reservoir.
- Population served by the water scheme and volume of drinking water supplied per day (m3).
- Summary details on abstraction source.
- Summary of existing relevant water quality data, including parameters that are indicative of contamination, such as nitrate, ammonia and *E. Coli*. Where possible, graphs of pollutant concentrations showing temporal variations and trends should be prepared.
- Details on existing or proposed water treatment.
- Details on the *Cryptosporidium* Risk Assessment Score and Risk Classification, including the individual Catchment Risk Score and the Treatment, Operation and Management Risk Score.

4.2.3 PATHWAYS

The essential information required, for the catchment area of the source, is as follows:

- Soil type, particularly where gleys or 'wet' soils are present;
- Slope;
- Presence of land drains.

In addition, it would be helpful and preferable if the following information was available for evaluation:

- Subsoil permeability (available from the GSI for several counties)
- Aquifer category (to enable bedrock permeability to be assessed).

4.3 BASIS FOR DECISION-MAKING

Agency advice on reducing the setback distances to either 30 m or 15 m is influenced by the following factors:

- A risk-based, 'weight of evidence' approach should be taken, as there is no definitive scientific solution to delineating exclusion zones.
- Adequate information must be provided to enable a good conceptual understanding of the hydrogeological setting (this information should, in any case, be already available to enable proper development and protection of the source).
- Three pollutants – microbial pathogens, nitrate and ammonium – pose the greatest threat associated with landspreading of organic fertilisers.
- Maintenance of the safety and security of drinking water sources by ensuring the absence of microbial pathogens, which is based on taking a dual approach – prevention of contamination and treatment of the abstracted water prior to distribution. The dual approach is particularly important in relation to *E. coli* and *Cryptosporidium*.
- In areas where nitrate concentrations are relatively high, the landspreading of organic fertilizers may not be the main cause of nitrate pollution where the landspreading activity is undertaken in accordance with the requirements of the Good Agricultural Practice Regulations. In addition, where average nitrate concentrations are >50 mg/l, it is unlikely that prohibiting landspreading, except in the autumn as leaching could occur over the winter period, will reduce concentrations significantly.
- Disposal of soiled water by landspreading (via soiled water irrigation systems) can result in excessive leaching and localised plumes of high nitrate concentrations in groundwater. Therefore, it is essential that there is compliance with Article 18 (5) and Article 18 (6) of the GAP Regulations. Also, it is preferable that the spreading of soiled water should occur outside the ZOCs of groundwater drinking water sources.

4.3.1 GROUNDWATER SOURCES

4.3.1.1 Category 1

At drinking water sources where the following circumstances are present, the setback distance can be reduced:

- Groundwater vulnerability (from Geological Survey of Ireland (GSI) maps or from maps where the GSI mapping approach is followed) is high (H), moderate (M) or low (L) in all of the ZOC of the source (or within 1 km of the abstraction point).

  and
- Mean nitrate concentrations are <37.5 mg/l.

  and
- Peak nitrate concentrations are <50 mg/l.

  and
- *E. coli* counts in untreated water samples are <10/100 ml.

4.3.1.2 Category 2

At sources where the following circumstances apply, the setback distances should NOT be reduced:

- There are areas of X Extreme (bedrock is <1 m from the ground surface) groundwater vulnerability within the ZOC (or within 1 km of the abstraction point).

or

- Karst features such as swallow holes and collapse features are present in the ZOC or within 1 km of the abstraction point.

or

- Mean nitrate concentrations are ≥37.5 mg/l.

or

- Peak nitrate concentrations are ≥50 mg/l.

or

- Faecal bacteria counts in untreated water samples are >100/100 ml and an adequate *Cryptosporidium* barrier is not present.

Where any of these criteria are met a 'prior investigation', undertaken by a suitably qualified person, will be needed to justify or establish alternative landspreading exclusion zones.

4.3.1.3 Category 3

Some sources will not fit in either category 1 or 2. A risk-based, 'weight of evidence' approach should be taken when assessing these sources. An example is given in Appendix 3.

4.3.2 SURFACE WATER SOURCES

It is likely that the setback distance can be reduced, in the majority of circumstances, particularly downstream of the abstraction point. However, a risk assessment should first be undertaken which would include consideration of:

- The likelihood of rapid runoff of polluted surface water in circumstances where;
  - **a.** the soil, subsoil and/or bedrock permeability (where close to the surface) is low,
  - **b.** there is a steep slope (e.g. >10%) and/or
  - **c.** there are drainage ditches/pipes in the vicinity of the abstraction point.
- Existing water quality, both untreated and treated.
- Water treatment facilities.
- *Cryptosporidium* risk score.

A brief walk-over survey is recommended to verify the likely extent and risk of landspreading in the vicinity of the abstraction point.

A similar assessment should be undertaken in the vicinity of spring sources, in addition to that outlined in Section 4.3.1.

Sub-article (5) enables a local authority to reduce the setback distance[7] down-gradient of the abstraction point where the assessment shows landspreading activities will not have an impact on the abstracted water, i.e. water down-gradient of the abstraction point cannot flow back to the abstraction point.

If the evaluation of the water quality and of the pressure and pathway information suggests that landspreading is or could pose a significant risk to the source, the distances should not be reduced and a "prior investigation" should be undertaken.

7 This distance is taken from the bank of the river nearest to the water intake point.

5 PRIOR INVESTIGATIONS

5.1 INTRODUCTION

The aim of a "prior investigation" is to provide sufficient scientific evidence to enable the delineation of landspreading exclusion areas that occur outside the minimum setback distances given in sub-articles (2) and (3). In most circumstances, this area will not be defined by a radius around an abstraction point. The need for a "prior investigation" will arise where either a) the physical setting in the catchment area of the abstraction is susceptible to water pollution and/or b) the water quality indicates that a landspreading activity may be posing a threat to the drinking water supply and human health.

Where a "prior investigation" is required it will generally be a relatively high risk scenario; consequently, input from a suitably qualified person is advisable.

5.2 EVALUATING THE NEED FOR A PRIOR INVESTIGATION

Prior investigations must be undertaken if the following circumstances arise:

1. All category 2 groundwater sources as outlined in Section 4.3.1.2.
2. Certain category 3 groundwater sources (Section 4.3.1.3) arising from the conclusions of the 'technical assessment' process.
3. All surface water and groundwater sources where either the existing water quality, e.g. *presence of Cryptosporidium*, or the catchment risk assessment indicate that the landspreading of organic fertilizers constitutes a risk to the water abstraction source and subsequently a potential danger to human health (See sub-articles (6) and (7) in Appendix 1).

5.3 INFORMATION REQUIREMENTS FOR GROUNDWATER SOURCES

All the information requirements listed in Section 4.1 for "technical assessments" are also required for "prior investigations". These are shown below in italics, whereas the additional requirements are given in normal script.

5.3.1 PRESSURES

- Nature of the organic materials to be landspread, i.e. the origin of the material (cow/cattle farmyard slurry/manure, industrial and sewage sludge, soiled water, imported pig or poultry manure etc).
- The likely pollutants present in the materials, e.g. nitrogen, phosphorus, metals, pathogens, including a conclusion on the pollutant/s posing the greatest threat to the abstraction source (usually these will be microbial pathogens and nitrate).
- Location of areas, if present, used for landspreading of soiled water using irrigation systems.
- Intensity of farming activities in the vicinity.

5.3.2 RECEPTOR

- Type of receptor – well or spring groundwater source.
- Summary details on abstraction source, e.g. location, depth and diameter, well design and construction, abstraction rate, depth to bedrock, etc.

- Summary of existing relevant water quality data[8], including parameters that are indicative of contamination, such as nitrate, ammonia, chloride, potassium, *E. Coli*. Graphs of relevant pollutant concentrations showing temporal variations and trends should be prepared.
- Specific attention should be given to parameters that pose a danger to human health, such as *E. Coli* and nitrate.
- Details on existing or proposed water treatment.
- Details on the *Cryptosporidium* Risk Assessment Score and Risk Classification, including the individual Catchment Risk Score and the Treatment, Operation and Management Risk Score.
- An evaluation of water quality data arising from monitoring carried out for the purposes of Article 7 of the EC (Drinking Water) (no. 2) Regulations 2007, as required by sub-article (7)(a).

5.3.3 PATHWAYS

The required pathway information required for "prior investigations" is more comprehensive than that required for "technical assessments".

The information required is as follows:

- A map showing the zone of contribution (ZOC) of the source.
- A map of the groundwater vulnerability in the zone of contribution (ZOC) undertaken by the GSI or to the standard of GSI vulnerability mapping.
- Location of karst features, if bedrock is limestone.
- Aquifer category (to enable bedrock permeability to be assessed).
- A map of source protection zones, accompanied by a report detailing the information on which the source protection zones are based.
- Conceptual model of zone of contribution.

5.4 INFORMATION REQUIREMENTS FOR SURFACE WATER SOURCES

All the information requirements listed in Section 4.2 for "technical assessments" are also required for "prior investigations". These are shown below in italics, whereas the additional requirements are given in normal script.

5.4.1 PRESSURES

- Nature of the organic materials to be landspread, i.e. the origin of the material (cow/cattle farmyard slurry/manure, industrial and sewage sludge, soiled water, imported pig or poultry manure).
- The likely pollutants present in the materials, e.g. nitrogen, phosphorus, metals, pathogens, including a conclusion on the pollutant/s posing the greatest threat to the abstraction source (usually these will be microbial pathogens).
- Intensity of farming activities in the vicinity.

8 Existing water quality data for both surface and groundwater sources is mainly for treated water samples. While these data should be assessed, data from untreated water samples are more useful and relevant.

5.4.2 RECEPTOR

- Type of receptor – river, lake or reservoir.
- Population served by the water scheme and volume of drinking water supplied per day (m^3).
- Summary details on abstraction source.
- Summary of existing relevant water quality data, including parameters that are indicative of contamination, such as nitrate, ammonia and *E. Coli.* Where possible, graphs of pollutant concentrations showing temporal variations and trends should be prepared.
- Details on existing or proposed water treatment.
- Details on the *Cryptosporidium* Risk Assessment Score and Risk Classification, including the individual Catchment Risk Score and the Treatment, Operation and Management Risk Score.
- An evaluation of water quality data arising from monitoring carried out for the purposes of Article 7 of the EC (Drinking Water) (no. 2) Regulations 2007, as required by sub-article (7)(a).

5.4.3 PATHWAYS

The essential information required, for the catchment area of the source, is as follows:

- Soil type, particularly where gleys or 'wet' soils are present;
- Slope;
- Presence of land drains.
- Subsoil permeability (available from the GSI for several counties).
- Aquifer category (to enable bedrock permeability to be assessed).
- Presence of karst features where karstified limestones are present in the catchment.

5.5 BASIS FOR DECISION-MAKING

Agency advice on delineating source specific landspreading exclusion zones as part of the process of undertaking "prior investigations" is influenced by the following factors:

- A safe and secure source of drinking water is essential to protect human health.
- Maintenance of the safety and security of drinking water sources requires a combination of catchment measures aimed at preventing contamination, followed by adequate treatment.
- Distances from the water source are generally less relevant as an outcome of prior investigations, as the landspreading exclusion areas are based largely on consideration of site specific features such as groundwater vulnerability and runoff susceptibility, which constitute the catchment characteristics.
- Consideration is given to the requirements of sub-articles (6) and (7):
- Sub-article (6) requires a risk-based evaluation, based on hydrogeological and water quality information, of the likelihood of landspreading posing a threat to human health. In general, the results of the "technical assessment" process will provide the basis for the requirement to undertake a "prior investigation" under this sub-article.
- Sub-article (7) (a) requires a prior investigation to be undertaken where there are water quality problems which constitute a potential danger to human health, and where these are considered to be caused by landspreading of organic fertilizers. In most circumstances, a detailed investigation will be needed to provide adequate evidence.

- Sub- article (7) (b) applies to circumstances where investigations undertaken by a water services authority indicate a threat to a water supply scheme from landspreading.
- Landspreading exclusion zones must be based on a clear 'weight of evidence' process. As they impinge on farming practices, a clear justification is required; this justification should be available to affected landowners.

In circumstances where the water quality data indicate that there is a threat to human health, the water services authority must determine whether landspreading is the cause. Where landspreading is not considered to be the cause, then other mechanisms, such as the Water Pollution Regulations, should be used the deal with the issue. Where landspreading is identified as the cause, in addition to the delineation of landspreading exclusion zones, compliance with the other Articles of the GAP regulations should be checked.

5.5.1 GROUNDWATER SOURCES – RECOMMENDED APPROACH

Step 1: Undertake the "technical assessment", which provides the list of sources that fall into either category 2 or 3 (see Section 4.3.1).

Step 2: Evaluate the water quality data for the source, with particular emphasis on evidence of pollution by an organic pollutant source, such as OSWTS effluent, faeces from grazing animals, landspreading of organic fertilizers, manure, slurry or soiled water in farmyards, leaky sewers.

Step 3: Locate the vulnerable areas within the ZOC of the source (areas where pathway factors enable pollutants to enter groundwater without adequate attenuation, e.g. extremely vulnerable areas, karst features such as sinking streams and dolines (collapse features).

Step 4: Locate and evaluate the potential pollution sources in the ZOC and, in particular, in the Inner Protection Area.

Step 5: Evaluate the likelihood that landspreading of organic fertilizers or soiled water is either causing or is likely to cause water quality problems.

Step 6: Delineate the landspreading exclusion area, based on the above, if appropriate.

Step 7: If it is concluded that landspreading of organic fertilizers or soiled water is not posing a threat to the water supply, the likely pollution source/s should be located and mitigation measures undertaken.

An example of this process is given in Appendix 4.

5.5.2 SURFACE WATER SOURCES – RECOMMENDED APPROACH

Step 1: Undertake the "technical assessment" (see Section 4.3.2).

Step 2: Evaluate the water quality data for the source, with particular emphasis on evidence of pollution by an organic pollutant source, such as OSWTS effluent, landspreading of organic fertilizers, and manure, slurry or soiled water in farmyards.

Step 3: Locate the areas within the catchment where rapid runoff of rainfall and associated pollutants is likely, e.g. areas with low permeability soil, subsoil and/or bedrock (where close to the ground surface), catchment areas with sinking streams, particularly where downstream of urban wastewater treatment plants.

Step 4: Locate and evaluate the potential pollution sources in the catchment area and, in particular, in the areas delineated in Step 3.

Step 5: Evaluate the likelihood that landspreading of organic fertilizers or soiled water is either causing or is likely to cause water quality problems.

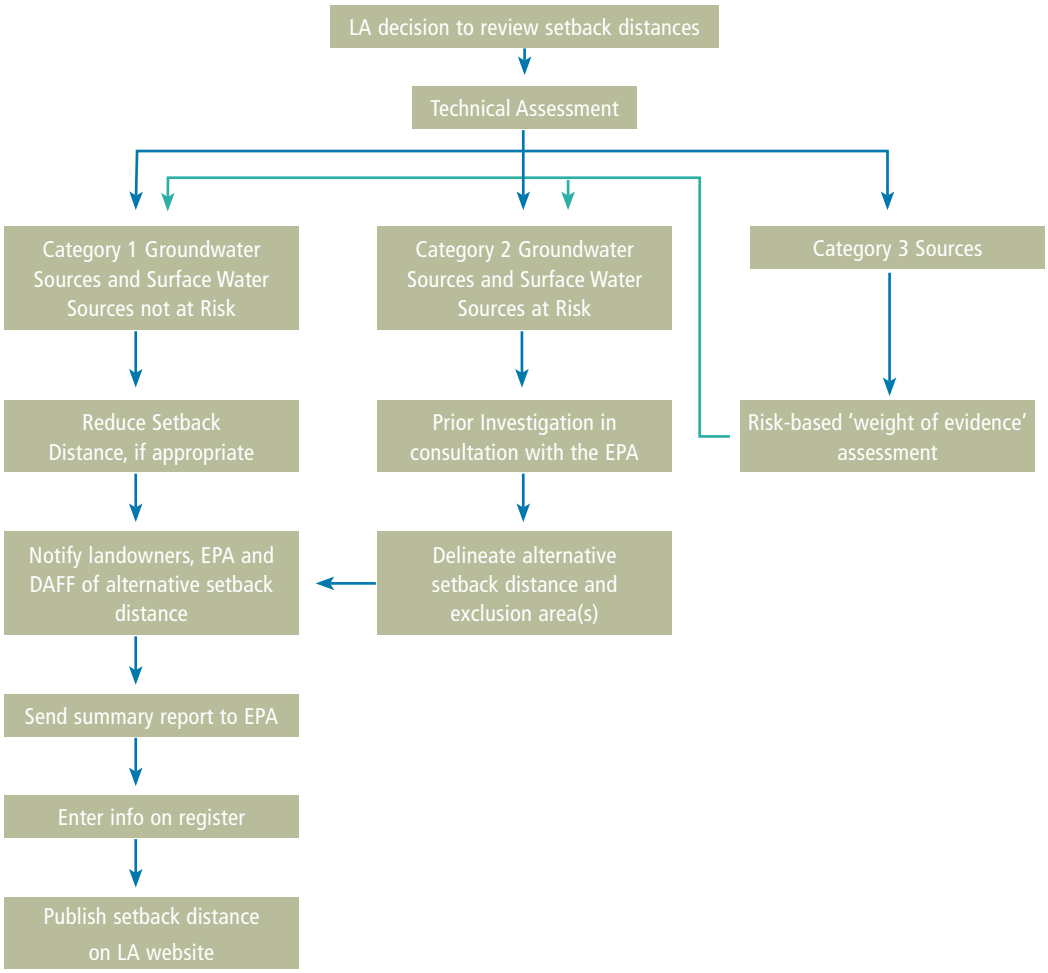
Step 6: Delineate the landspreading exclusion area, based on the above, if appropriate.

Step 7: If it is concluded that landspreading of organic fertilizers or soiled water is not posing a threat to the water supply, the likely pollution source/s should be located and mitigation measures undertaken.

6 IMPLEMENTATION DETAILS

A flow chart outlining the approach to implementation of Article 17 is shown on Figure 3.

Figure 3. Flowchart outlining the requirements of Article 17



Where distances have been changed, sub-article (10) requires local authorities to 'notify the affected landowners, the Environmental Protection Agency and the Department of Agriculture, Fisheries and Food of the distance so specified". In addition, the details should be entered in the registry maintained in accordance with Article 30(6), and should be published on the local authority website.

The report to the Agency following the Technical Assessment or Prior Investigation should be focussed on providing a concise basis for the proposed setback distances. It should summarise and evaluate the factors that are considered relevant to the particular water supply. Clear justifications, based on risk-based decision-making, should be provided for all proposed distances.

In addition, summary details on how the local authority plans to implement the set back distances should be covered in the report. This should include, for example, details on informing and training the caretaker at the works on the new setback distances, liaison with relevant landowners and other relevant organisations such as the Department of Agriculture, Fisheries and Food. Details on any compliance checks or inspections planned by the local authority to verify that the setback distances are being adhered to should also be documented. Any other measures being used or proposed to reduce the risk to the abstraction source should be summarised.

A drawing showing the extent of the set back distances for the application of organic fertiliser and soiled water should be maintained at each drinking water plant.

FURTHER INFORMATION

4. Reports on EPA-funded research several research projects undertaken in Ireland, e.g. ERTDI Project LS-2.3 and ERTDI Report 27 (see *www.epa.ie* for project reports.)
5. Bartley, P and Johnston, P., 2005. Nitrate leaching – groundwater. Final Report, Eutrophication from Agricultural Sources, 2000-LS-2-MS. Available on: *www.epa.ie*
6. Blackwell, M. S. A., Hogan, D. V. and Maltby, E. 1999. The use of conventionally and alternatively located buffer zones for the removal of nitrate from diffuse agricultural runoff. Wat. Sci. Tech. Vol. 39, No. 12.
7. Daly, D. 2010. Landspreading of organic fertilizers and setback distances from groundwater sources. Proceedings of the 30th Annual IAH (Irish Group) Groundwater Conference, Tullamore.
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10. DEHLG/EPA/GSI (1999). Groundwater Protection Schemes. Published by Geological Survey of Ireland. Available on: *www.gsi.ie*
11. DEHLG/EPA/GSI (1999). Groundwater protection responses to the landspreading of organic wastes. Published by Geological Survey of Ireland. Available on: *www.gsi.ie*
12. EPA (2009). Drinking water advice note No. 3. Available on: *www.epa.ie*
13. Fitzsimons, V.P. and Misstear, B. D. R., 2005. Estimating groundwater recharge through tills: a sensitivity analysis of soil moisture budgets and till properties in Ireland. Hydrogeology Journal.
14. IGI, 2007. Water well guidelines. Institution of Geologists of Ireland. Available on: *www.igi.ie/publications/codes-guidelines.htm*
15. Kramers, G., Richards, K. G. and Holden, N. M. In Press. Assessing the potential for the occurrence and character of preferential flow in three grassland soils using image analysis.
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18. Pekdeger, A. and Matthess, G. 1983. Factors of bacteria and virus transport in groundwater. Environmental Geology, Vol. 5, No. 2, 49-52.

APPENDIX 1 EXTRACT OF RELEVANT SUB-ARTICLES FROM ARTICLE 17

PART 4 PREVENTION OF WATER POLLUTION FROM FERTILISERS AND CERTAIN ACTIVITIES

DISTANCES FROM A WATER BODY AND OTHER ISSUES

1. Chemical fertiliser shall not be applied to land within 2m of any surface waters.
2. Organic fertiliser or soiled water shall not be applied to land within –
   a. 200m of the abstraction point of any surface waters, borehole, spring or well used for the abstraction of water for human consumption in a water scheme supplying 100m3 or more of water per day or serving 500 or more persons,
   b. 100m of the abstraction point (other than an abstraction point specified in paragraph (a)) of any surface waters, borehole, spring or well used for the abstraction of water for human consumption in a water scheme supplying 10m3 or more of water per day or serving 50 or more persons,
   c. 25m of any borehole, spring or well used for the abstraction of water for human consumption other than a borehole, spring or well specified in paragraph (a) or (b),
   d. 20m of a lake shoreline,
   e. 15m of exposed cavernous or karstified limestone features (such as swallow-holes and collapse features), or
   f. subject to sub-articles (13) and (14), 5m of any surface waters (other than a lake or surface waters specified at paragraph (a) or (b)).
3. Notwithstanding the requirements of sub-articles (2)(a), (2)(b) and (2)(c), the following distances shall apply from 12 January 2011 (in the case of drinking water abstractions located in counties Carlow, Cork, Dublin, Kildare, Kilkenny, Laois, Offaly, Tipperary, Waterford, Wexford and Wicklow), from 15 January 2011 (in the case of drinking water abstractions located in counties Clare, Galway, Kerry, Limerick, Longford, Louth, Mayo, Meath, Roscommon, Sligo and Westmeath) and from 31 January 2011 (in the case of drinking water abstractions located in counties Cavan, Donegal, Leitrim and Monaghan) or as soon as may be thereafter-
   a. 30m from the abstraction point in the case of any surface waters, borehole, spring or well used for the abstraction of water for human consumption in a water scheme supplying 10m3 or more of water per day or serving 50 or more persons,
   b. 15m from the abstraction point in the case of any borehole, spring or well used for the abstraction of water for human consumption other than a borehole, spring or well specified in paragraph (a).
4. Sub-article (3) shall only apply in situations where a local authority has completed a technical assessment of conditions in the vicinity of the abstraction point, including taking into account variation in soil and subsoil conditions, the landspreading pressures in the area, the type of abstraction, available water quality evidence and the likely risk to the water supply source and the local authority has determined that the distance does not give rise to a risk to the water supply and a potential danger to human health.
5. A local authority may decide to apply the landspreading restriction to the upstream catchment area and to the close proximity downstream of the abstraction point in the case of any surface waters.
6. A local authority may, in the case of any particular abstraction point and following consultation with the Agency, specify a greater distance to that specified in sub-articles (2) or (3) where, following prior investigations, the authority is satisfied that such distance is appropriate for the protection of waters being abstracted at that point. The distance so specified shall be determined by the local authority using an evidence-based approach which takes into account the natural vulnerability of the waters to contamination from land spreading, the potential risk to human health arising from the landspreading activity as well as the water quality evidence, including information on water quality trends.

7. Notwithstanding the provisions of sub-articles (2), (3) and (6) a local authority shall as soon as may be practicable, following prior investigations and following consultation with the Agency, specify an alternative distance, including a landspreading exclusion area where necessary, in the case of a water abstraction for human consumption in a scheme supplying 10m3 or more of water per day, or serving 50 or more persons, where -
    a. on the basis of the results of monitoring carried out for the purposes of Article 7 of the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. No. 278 of 2007), the quality of water intended for human consumption does not meet the parametric values specified in Part I of the Schedule of those Regulations or the quality of water constitutes a potential danger to human health, and it appears to the local authority that this is due to the landspreading of organic fertilisers or soiled water in the vicinity of the abstraction point, or
    b. investigations undertaken by a water services authority as part of the management of a water supply scheme indicate that the landspreading activity presents a significant risk to the drinking water supply or a potential danger to human health having regard to catchment factors in the vicinity of the abstraction point including but not limited to slope, vulnerability, and hydrogeology, the scale and intensity of land spreading pressures, the type of water supply source and water quality evidence, including information on water quality trends.
8. A distance specified by a local authority in accordance with sub-articles (3), (5), (6) and (7) may be described as a distance or distances from an abstraction point, a hydrogeological boundary or topographical feature or as an area delineated on a map or in such other way as appears appropriate to the authority.
9. In relation to sub-articles (6) and (7), "prior investigations" means, in relation to an abstraction point, an assessment of the susceptibility of waters to contamination in the vicinity of the abstraction point having regard to—
    a. the direction of flow of surface water or groundwater, as the case may be,
    b. the slope of the land and its runoff potential,
    c. the natural geological and hydrogeological attributes of the area including the nature and depth of any overlying soil and subsoil and its effectiveness in preventing or reducing the entry of harmful substances to water, and
    d. where relevant, the technical specifications set out in the document "Groundwater Protection Schemes" published in 1999 (ISBN 1-899702-22-9) or any subsequent published amendment of that document.
10. Where a local authority specifies a distance in accordance with either of sub-articles (3), (5), (6) or (7) the authority shall, as soon as may be –
    a. notify the affected landowners, the Agency and the Department of Agriculture, Fisheries and Food of the distance so specified,
    b. send to the Agency a summary of the report of any investigations undertaken and the reasons for specifying the alternative distance,
    c. make an entry in the register maintained in accordance with Article 30(6), and
    d. publish and maintain on the local authority website an updated schedule of setback distances specified for each drinking water supply.
11. The requirements under sub-article (10) shall apply in the case of each local authority water supply and all other supplies for which the local authority has supervisory authority.
12. The Agency may issue advice and/or direction to a local authority in relation to any requirements including requirements for technical assessments and prior investigations arising under sub-articles (2), (3), (4), (5), (6), (7), (8) or (9) and a local authority shall comply with any such advice or direction given.

APPENDIX 2 TERMINOLOGY

ORGANIC FERTILIZER

This is defined in the GAP Regulations as "any fertilizer other than that manufactured by an industrial process and includes livestock manure, dungstead manure, farmyard manure, slurry, soiled water, silage effluent, non-farm organic substances such as sewage sludge, industrial by-products and sludges and residues from fish farms".

WELL

A well can either be a bored well or a dug well.

SOURCE PROTECTION TERMINOLOGY

Source Protection Areas (SPAs)

The source protection area (SPA) around a well or spring is the groundwater/underground catchment area or the zone of contribution (ZOC) of the well/spring, i.e. the area needed to support an abstraction from long-term groundwater recharge (the proportion of effective rainfall that infiltrates to the water table). In some publications, it is called the 'capture zone'. Precipitation falling outside the boundary of the SPA/ ZOC cannot flow to the well/spring. Note that the terms SPA and ZOC are interchangeable.

The SPA is sub-divided into two source protection areas: Inner Protection Area (SI) and Outer Protection Area (SO).

Inner Protection Area (SI)

This zone is designed to protect against the effects of human activities that might have an immediate effect on the source and, in particular, against microbial pollution. The area is defined by a 100-day time of travel (TOT) from any point below the water table to the source. It is based on the horizontal flow of water to the abstraction point.

Outer Protection Area (SO)

This area covers the remainder of the ZOC (or complete catchment area) of the groundwater source. Therefore, the SO boundary is the same as the ZOC boundary.

Vulnerability Categories

In concept, vulnerability encompasses the vertical movement of water and contaminants through the subsoil to groundwater in bedrock and sand/gravel, and through swallow holes in the case of karstic limestones. The vulnerability categories of extreme (X & E), high (H), moderate (M) and low (L) are based on likelihood of attenuation of potential contaminants occurring along the vertical pathway.

Groundwater vulnerability classification based on subsoil characteristic

Vulnerability Categories	Subsoil Characteristics
Extreme (**E** and **X**)	Areas of outcropping bedrock and shallow soil/subsoil (<1 m) (**X**) Areas with thin (1-3 m) subsoil (**E**)
High (**H**)	Areas with >3 m of highly permeable subsoil Areas with 3-10 m of moderately permeable subsoil Areas with 3-5 m of low permeability subsoil
Moderate (**M**)	Areas with >10 metres of moderately permeable subsoil Areas with 5-10 metres of low permeability subsoil
Low (**L**)	Areas with thick (>10 metres) low permeability subsoil

Source Protection Zones

Source protection zones (SPZs) are derived by integrating SPAs with the vulnerability map (see Figure 1), giving ten possible source protection zones (see Table 1). As vulnerability accounts for the vertical movement of water and contaminants and source protection areas account for the horizontal pathway, the source protection zone concept encompasses the total pathway from the land surface to the groundwater abstraction point.

Table 1 Matrix of Source Protection Zones

Vulnerability	Source Area	Protection
RATING	Inner (SI)	Outer (SO)
Extreme (X & E)	SI/X	SO/X
	SI/E	SO/E
High (H)	SI/H	SO/H
Moderate (M)	SI/M	SO/M
Low (L)	SI/L	SO/L

APPENDIX 3 DELINEATION OF LANDSPREADING EXCLUSION AREAS – OUTLINE OF EXAMPLE FOR SECTION 4.3.1.3

SCENARIO: PUBLIC SUPPLY BOREHOLE

Pressures

- Land in ZOC used for dairy farming (medium intensification).
- Spreading area for soiled water not known

Well head construction

- IGI guidelines not followed.

Existing (untreated) water quality

- Occasional incidences in autumn with *E.Coli* numbers <10/100ml.
- Average NO3 concentration = ~27 mg/l.
- Peak nitrate concentrations <40 mg/l.

Hydrogeological Setting

- Subsoil: moderately permeable limestone till, classed as SILT (BS5930) by GSI.
- Vulnerability: varying generally from extreme (E) to high in ZOC, with a small (<1%) proportion of the ZOC area classed as X vulnerability. Area within 100 m of well has high vulnerability (>3 m of moderate permeability subsoil over bedrock)
- Bedrock: Pure Limestone.
- Aquifer: Regionally Important karstified aquifer (limestone).
- Karst features: none evident.

Risk to well from landspreading of organic fertilizers

- Medium
- Main threats: microbial pathogens – *E.Coli* and *Cryptosporidium* – and nitrate.

Proposed landspreading exclusion area in ZOC

- 30 m radius of well. Also, in the extreme (E) vulnerability area (i.e. 0-3 m soil/subsoil), the requirement of Article 18 (6), regarding the application of soiled water, should be complied with.

Water Treatment Requirement

- Disinfection and a treatment barrier for *Cryptosporidium*.

APPENDIX 4 DELINEATION OF LANDSPREADING EXCLUSION AREAS – OUTLINE OF EXAMPLE FOR SECTION 5.5.1

SCENARIO: PUBLIC SUPPLY BOREHOLE

Pressures

- Land in ZOC used for dairy farming (medium intensification).
- Spreading area for soiled water known

Well head construction

- IGI guidelines followed.

Existing (untreated) water quality

- Occasional incidences in autumn with E.Coli numbers >100/100 ml.
- Average NO3 concentration = ~34 mg/l.
- Peak nitrate concentrations between 40-50 mg/l.
- Occasional high (>30 mg/l) chloride concentrations.
- Occasional high (>0.15 mg/l) ammonium concentrations.

Hydrogeological Setting

- Subsoil: moderately permeable limestone till, classed as SILT (BS5930) by GSI.
- Vulnerability: varying generally from extreme (E) to high in ZOC, with ~5% proportion of the Inner Protection Area classed as X vulnerability (<1 m soil/subsoil over rock) and with several outcrops of bedrock.
- Bedrock: Pure Limestone.
- Aquifer: Regionally Important karstified aquifer (limestone).
- Karst features: one swallow hole with a small ephemeral sinking stream. Two dolines present (hollows, usually circular, due to solution in the limestone underneath and collapse of the subsoil).

Risk to well from landspreading of organic fertilizers

- High
- Main threats: microbial pathogens – *E.Coli* and *Cryptosporidium* – and nitrate.

Proposed landspreading exclusion area in ZOC

- 30 m radius of well.
- Area of X vulnerability within the Inner Protection Area.
- Within 15 m of the swallow hole and 5 m of the sinking stream.
- Within 15 m of the dolines.
- In the extreme (E) vulnerability area (i.e. 0-3 m soil/subsoil), the requirement of Article 18 (6), regarding the application of soiled water, should be complied with.

Water Treatment Requirement

- Disinfection and a treatment barrier for *Cryptosporidium*.