UK Technical Advisory Group on the Water Framework Directive

Groundwater spatial scale assessment

This Guidance Paper is a working draft defined by the UKTAG. It documents the principles to be adopted by agencies responsible for implementing the Water Framework Directive (WFD) and the Groundwater Daughter Directive in the UK. The methods will evolve as they are tested and further clarification on the requirements for trend assessment is provided by the European Commission through its Common Implementation Strategy Guidance. This draft will be amended accordingly.

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Contents

1 Purpose

1.1 This paper provides guidance on the spatial and scale issues that should be considered in the assessment of data and classification of groundwater bodies, as required by the Water Framework Directive (WFD) and the Groundwater Daughter Directive (GWD).

1.2 Physical characteristics, such as topographic or geological boundaries, have been used to delineate groundwater bodies. Nonetheless, significant spatial variations may still exist within groundwater bodies because of the heterogeneous nature of aquifers, and variability in groundwater vulnerability.

1.3 Substantial spatial variability in three dimensions is inherent in most groundwater systems, and groundwater flow in unfractured or intergranular media may be slower than that in the more dynamic groundwater systems such as karstified limestone.

1.4 Significant variation in land use may have a bearing on the nature and extent of anthropogenic pressures across groundwater bodies, i.e. there may be different pressures from an individual point source activity when compared to the pressures from widespread diffuse activities.

1.5 Temporal variability in water quality and flow is typically greater in surface waters than in groundwater because of their more dynamic nature and faster response time to precipitation events and pollution episodes. This is reflected in the frequency of monitoring that is necessary for many surface water regulatory regimes. Although there is temporal variability in groundwater systems, it is generally significantly lower than surface waters, and in part accounts for the less frequent monitoring that is typical of groundwater monitoring networks.

1.6 There may be natural variation in groundwater level, flow and quality within a groundwater body that is caused by seasonal fluctuations in the water table or different geological conditions, e.g. iron rich bedrock deposits. There may also be temporal variation in groundwater level, flow and quality because of seasonal land use activities e.g. irrigation or fertiliser applications.

2 Background and WFD/GWD requirements

2.1 A key concept of the WFD/GWD is that the status of groundwater bodies should reflect the hydrogeological conditions and impact of anthropogenic pressures across the whole groundwater body.

2.2 Therefore, the creation of very large groundwater bodies may potentially present a difficulty for classification, in that status is applied to the whole groundwater body and the anthropogenic pressures may only be impacting on a small area within the groundwater body, e.g. near a groundwater dependent terrestrial ecosystem.

2.3 Point source pressures that impact on a small area of a groundwater body, e.g. a landfill site, do not usually have a bearing on groundwater status unless they are impacting on key receptors. If there are many of these point source pressures across the groundwater body, the cumulative impact of the pressures may be enough to affect the overall status of the groundwater body.

2.4 Sufficient numbers of representative monitoring points are required to account for the spatial and temporal variations in hydrogeology and anthropogenic pressures across a groundwater body or group of groundwater bodies. In principle, greater variability requires a higher density of monitoring points to provide enough data to make suitably confident assessments of the status of a groundwater body or group of groundwater bodies.

2.5 Although status is applied to the whole groundwater body, the actual measures that are introduced may be focused on the areas within the groundwater body that have been impacted by anthropogenic activities.

3 Spatial assessment – supporting classification (Status Tests)

3.1 The assessment criteria outlined in UKTAG papers 11b(i) & 11b(ii) are based on the groundwater classification requirements of the WFD/GWD. As spatial variability across a groundwater body is already considered within the classification tests, there is no need for further spatial assessment to determine status.

3.2 A number of the classification tests take account of spatial variation across the groundwater body and provide an assessment of average groundwater body conditions, whilst for other classification tests, groundwater body status may be determined from assessments at a single monitoring point, e.g. a drinking water abstraction that has been impacted by anthropogenic pressures. Regardless of this scale of assessment, all of the tests give a classification that applies to the whole of the groundwater body.

3.3 In total there are five chemical and four quantitative tests; all of which must be passed for good status to be achieved. Each test also has a level of confidence assigned, e.g. good status, low confidence, with the “worst” scenario from all of the tests reported for the overall groundwater body.

3.4 Spatial considerations within each status test:

- *Intrusions Test* – This test is applied at boreholes in close proximity to the abstraction pressure. If sustained saline or other intrusions are caused by any significant groundwater abstraction, the whole groundwater body is classified as being at poor status, even though the intrusion may be restricted to a relatively small area of the groundwater body. Temporary, spatially limited changes in groundwater flow direction and chemical composition, that are caused by abstraction, are not regarded as

intrusions and therefore do not affect the status of the groundwater body. Natural intrusions, not caused by an abstraction, should be discounted.

- *Water Balance Test* – This test provides an assessment of the average water balance conditions over the whole groundwater body. The available groundwater resource is calculated, less the total groundwater abstraction volume and the combined ecological flow requirements for all surface water bodies over the groundwater body. If the groundwater body is at poor status, i.e. there is over abstraction, this reflects the average conditions across the whole groundwater body, although the over abstraction could be attributed to a single large abstraction, or the combined impacts of many smaller abstractions.

- *Surface Water Quality and Flow Tests* – Unless specific information is known about the impact of an abstraction or source of pollution (e.g. a contaminated land site) on a surface water body, then this assessment considers the average water flow, level and quality conditions for the whole groundwater body. If information is available on the interactions between groundwater and surface water and the impacts of groundwater abstractions or pollution on the surface water body are understood then this test may be undertaken using data from appropriate monitoring points in close proximity to the surface water body. This test is only undertaken if a surface water body fails to meet it's status objectives because the water chemistry or flow requirements of the surface water body do not provide appropriate conditions to support the ecology of the surface water body, and a significant contribution to the failure to provide these conditions can be attributed to contributions from the groundwater body. If groundwater is significantly contributing to the surface water body failure, then the whole groundwater body is also at poor status, even though the actual anthropogenic pressures may be confined to a small area within the groundwater body that is in close proximity to the surface water body that is failing to meet it's status objectives.

- *Wetland Water Quality and Flow Tests* – Unless specific monitoring data are available for the wetland and it's immediate surrounds, the assessment may have to be based on average water flow, level and quality conditions for the whole groundwater body. Where specific monitoring data are available, then this test may be undertaken using data from monitoring points in close proximity to the groundwater dependent wetland. If the ecology of a groundwater dependent wetland is damaged because of an alteration in groundwater flow, level or chemistry in the groundwater body that the wetland is dependant upon, and this alteration can be attributed to anthropogenic activities, e.g. groundwater abstraction, then the whole groundwater body is classified as being at poor status, regardless of the size of the wetland or even if the damage is restricted to a small area within the wetland, e.g. fen margins.

- *Drinking Water Protected Areas Test* – This test is applied at a representative selection of significant drinking water abstractions[1]. If there is a significant deterioration (both environmentally and statistically) in the quality of water at one of these abstractions, the whole groundwater body is classified as being at poor status, although the actual percentage area of the groundwater body that is contributing to the drinking water abstraction may be relatively small.

- *General Groundwater Assessment Test* – This assessment considers the average groundwater quality conditions across the whole groundwater body. Water quality data from a representative network of monitoring points across a groundwater body or group of bodies are assessed for determinands that are indicative of anthropogenic pressures. The average water quality for these determinands is compared with appropriate standards or threshold values and if the average concentration of any determinand is higher than the standard or threshold value, then the groundwater body is classified as

[1] A significant potable source is defined as one intended for human consumption that comes within the requirements of the Drinking Water Directive (Directive 80/778/EEC as amended by Directive 98/83/EC). That is a source where water abstracted from an individual supply provides 10 m^3 a day or more as an average or serves at least 50 persons, unless supplied as part of a commercial or public activity in which cases the thresholds do not apply.

being at poor status. Where significant variation in hydrogeology and anthropogenic pressures exist across a groundwater body, Member States should provide, where feasible, an estimate of the extent of the groundwater body having an annual arithmetic mean concentration of a pollutant higher than a groundwater quality standard or threshold value.

3.5 Robustness in the status assessment is associated with the development of a representative monitoring network and the establishing groups of groundwater bodies that are similar in nature. If a representative monitoring network has been established, the impact on a group of representative monitoring points should roughly be similar to the impact on the whole groundwater body, or group of groundwater bodies. Therefore, if the monitoring network is representative it should reflect the varying degrees of risk associated with different pressures and hydrogeology. If the monitoring data do not correlate with the higher risk areas, confidence in the assessment may be lower.

3.6 Improvements in the basic conceptual model and understanding of the groundwater system, through more accurate assessments of groundwater recharge, discharge and abstraction, and additional information on the spatial distribution and magnitude of the anthropogenic pressures, will help refine monitoring networks and may reduce spatial and temporal resolution errors, particularly in relation to the interactions between groundwater and surface water bodies.

3.7 Some additional work may need to be undertaken by each Agency to identify and sub-delineate areas within a groundwater body where measures should be applied. In time, groundwater bodies may be redefined, based on the outcome of initial and future status assessments.

4 Spatial assessment – measures and regulation

4.1 Although a groundwater body may be classified as being at poor or good status, this does not necessarily mean that all areas within the groundwater body are uniformly impacted or un-impacted by anthropogenic pressures. As such measures may be required within both good and poor status groundwater bodies to protect groundwater from future anthropogenic pressures.

4.2 The more widespread the impacts from anthropogenic pressures on the groundwater body become, the more likely it is that the groundwater body will not be of good status. Therefore, limit and compliance values may be used to protect groundwater flows, level and quality within a groundwater body, in the context of the ‘prevent or limit’ objective of the WFD/GWD. The limit and compliance values may be set to ensure that anthropogenic pressures that may be impacting on small areas within a groundwater body, e.g. a contaminated land site, do not have a significant detrimental impact on the status of the whole groundwater body. The limit and compliance values may be assessed at the point of compliance, e.g. at the boundary of a contaminated land site.

4.3 Therefore, the establishment of defensive monitoring networks in the proximity to point source pressures (or anthropogenic pressures that impact on small areas within a groundwater body), may assist in the delineation of the extent of the impacted area, e.g. for a contaminant plume from a landfill.

4.4 Improvements in the delineation of the impacted areas within a groundwater body may help focus measures towards those areas. In some instances measures may be focused towards particular areas within groundwater bodies, for example, with respect to the establishment of safeguard zones around drinking water sources.

4.5 The size of the safeguard zone may vary in relation to the nature and concentration of the pollutant, the aquifer type, groundwater vulnerability, abstraction volume and potential for dilution and attenuation of the pollutant. In this regard, safeguard zones may relate to Source Protection Areas around the drinking water source, or they may even potentially cover a whole groundwater body.

5 Reporting of spatial considerations

5.1 The status of each individual groundwater body should be reported, with good or poor status being applied to the whole groundwater body.

5.2 For some status tests, it may be beneficial to provide an estimation of the extent of the groundwater body having an annual arithmetic mean concentration of a pollutant higher than a groundwater quality standard or threshold value.