

Evidence

Groundwater vulnerability maps technical summary

Project summary SC040016

The Environment Agency has updated its groundwater vulnerability maps to reflect improvements in data mapping and understanding of the factors affecting vulnerability. The new maps show the vulnerability of groundwater to a pollutant discharged **at ground level** based on the hydrological, geological, hydrogeological and soil properties within a one kilometer square grid.

The potential impact of groundwater pollution is considered using the aquifer designation status which provides an indication of the scale and importance of groundwater for potable water supply and/or in supporting baseflow to rivers, lakes and wetlands.

These maps provide key evidence for the Environment Agency's assessment of the exposure of groundwater to a pollution hazard from a given activity as part of its permitting activity work. They form part of a suite of tools developed by the Environment Agency for groundwater protection including source protection zones and position statements. Further information can be found in the Environment Agency's Groundwater protection guides available on Gov.uk.

Two map products are available:

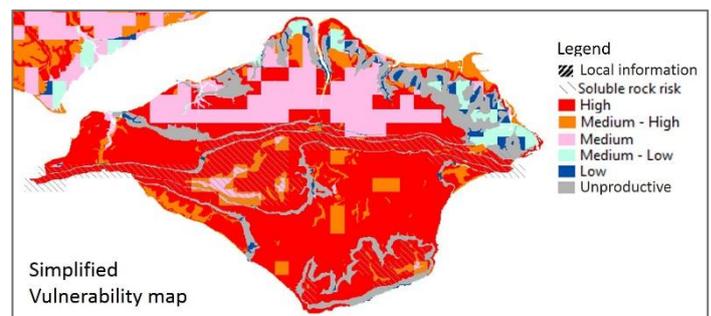
The combined groundwater vulnerability map.

This product is intended for use by groundwater technical specialists due to the complex nature of the legend which displays groundwater vulnerability (High, Medium, Low), the type of aquifer (bedrock, superficial, unproductive) and aquifer designation (Principal, Secondary, Unproductive). These maps require that users are able to understand the vulnerability assessment method and interpret the individual components of the legend. An example of a combined groundwater vulnerability map is provided on the following page.

The simplified groundwater vulnerability map.

This is designed for non-specialists who need to know the overall risk to groundwater from a particular activity, development or pollution incident but do not have extensive hydrogeological knowledge. The map has five risk categories (High, Medium-High, Medium, Medium-Low and Low) based on the likelihood of a pollutant reaching the groundwater (i.e. vulnerability), the type of

aquifers present and the potential impact (i.e. the aquifer designation). An example is provided below.



The main aim of the maps is as a high level screening tool to give Environment Agency staff, water companies, Local Authorities, consultants and other users an indication of whether a proposed development or activity is likely to be acceptable (e.g. located in an area of low vulnerability or over unproductive strata) or of potential concern (e.g. located in an area of high vulnerability on principal aquifer). The maps can also be used to inform and target environmental management and incident response so that preventative and/or remedial actions can be taken as early as possible to protect groundwater.

For the first time, the maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks, and those that comprise the underlying bedrock. These two rock types are defined as:

- **Superficial (drift):** permeable unconsolidated (loose) deposits, such as sands and gravels.
- **Bedrock:** solid permeable formations such as sandstone, chalk and limestone.

The vulnerability of these two rock types may differ due to their structure and location. Where both types are present, the maps display the most vulnerable category of the two.

The importance of the groundwater resource is reflected in the aquifer designation status. This is derived from the British Geological Survey's superficial and bedrock geological mapping. The definitions for the aquifer status are:

- **Principal:** These are rocks that provide significant quantities of water and can support water supply and/or baseflow to rivers, lakes and wetlands on a strategic scale. They typically have a high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage.
- **Secondary:** These rocks can provide modest amounts of water, but the nature of the rock or the aquifer's structure limits their use. They support water supplies at a local rather than strategic scale (such as for private supplies) and remain important for rivers, wetlands and lakes. They have a wide range of water permeability and storage.
- **Unproductive:** These rocks have negligible significance for water supply or baseflow to rivers, lakes and wetlands. They consist of bedrock or superficial deposits with low permeability that naturally offer protection to aquifers that may be present beneath.

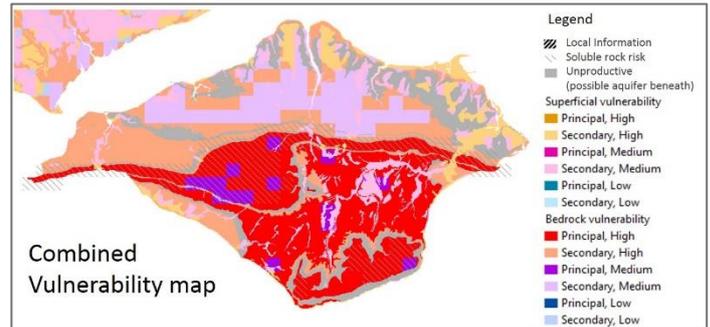
For principal and secondary aquifers, we have processed national data covering information on recharge (rainfall and infiltration), soil leaching, superficial cover (thickness and permeability) and the unsaturated zone in order to classify groundwater vulnerability to pollution as:

- **High:** Areas able to easily transmit pollution to groundwater. They are characterised by high leaching soils and the absence of low permeability superficial deposits.
- **Medium:** Areas that offer some groundwater protection. Intermediate between high and low vulnerability.
- **Low:** Areas that provide the greatest protection to groundwater from pollution. They are likely to be characterised by low leaching soils and/or the presence of low permeability superficial deposits.

Activities in areas of unproductive strata are unlikely to represent a risk to groundwater due to the low permeability of the deposits and the protection which they provide to any aquifers that may be present beneath. However, water run-off from these areas may represent a risk to surface water or adjacent groundwaters.

The maps also identify areas where solution features that enable rapid movement of a contaminant may be present (identified as stippled areas) and areas where local information affecting vulnerability is held by the Environment Agency (identified as dashed areas).

The Environment Agency or Natural Resources Wales can provide additional information if there is local information or potential solution features present, and can advise in areas of high groundwater vulnerability.



Some problems to illustrate how the maps could be used are:

- **Proposed petrol station in a high vulnerability area on principal aquifer (i.e. high/medium-high risk).** Activity represents a significant risk and should be relocated to a lower vulnerability area, unless supporting information can be provided to demonstrate that local factors (e.g. presence of low permeability superficial deposits) provide adequate protection to groundwater.
- **Proposed land spreading at a site located close to the boundary between areas of high and low vulnerability.** Review soil and geological maps and/or any local information available to establish the site-specific vulnerability and note whether there is potential for lateral movement to areas of higher vulnerability. This review may help to influence the movement of the proposed area of spreading to the lower risk area, where the spreading can be undertaken with minimal risk to groundwater.
- **Proposed housing development in medium-low/low risk area.** Likely to be acceptable, although further assessment will be needed to assess risk if connection to mains sewerage is not feasible.
- **Treated sewage effluent to ground (e.g. discharge from septic tank).** This activity will result in the release of pollutants (such as ammonium) below the soil zone and therefore vulnerability of the aquifer will be higher than shown on the maps. If the disposal is in an area of high or medium vulnerability (i.e. high, medium-high or medium risk), then the following should be considered: connection to mains sewerage, relocation of disposal area (lower vulnerability), or further investigation to demonstrate that the discharge will not represent a risk to groundwater.
- **Site underlain by unproductive strata.** Activity likely to be acceptable, although risk to surface water should be considered (e.g. the distance to surface water features and whether a pathway is present).
- **An incident has resulted in a chemical spill.** You should contact the Environment Agency immediately on our pollution incident reporting

number (on 0800 80 70 60) and check the simplified vulnerability and source protection maps. If the spill is located within an area of high, medium-high or medium risk and/or in a source protection zone 1 (SPZ1) then immediate action is required to contain and manage the spill. Environment Agency staff can help advise on the most appropriate actions to take. In medium-low and low risk areas, the risk to strategic groundwater supplies is low but pollution could still impact private water supplies and/or local rivers and wetlands fed by groundwater. The nature of the pollutant and proximity of such receptors as well as possible surface and groundwater pathways to these receptors should be considered.

This project was funded by the Environment Agency's Research, Analysis and Evaluation group, which provides scientific knowledge, tools and techniques to enable us to protect and manage the environment as effectively as possible.

This summary relates to information from project SC040016 reported in detail in the following output:

Report: SC040016/R

Title: New Groundwater Vulnerability mapping methodology

Project Manager: Natalie Phillips, Evidence Directorate

Research Contractor: Neil Thursten, AMEC Environment and Infrastructure UK, Canon Court North, Abbey Foregate, Shrewsbury, Shropshire, SY2 5DE.

September 2017

Enquiries: enquiries@environment-agency.gov.uk.

© Environment Agency

How to use the maps

1. In preparing the maps the Environment Agency has adopted a precautionary approach to indicate the risk to groundwater across each 1 kilometre square. Consequently, the maps may not reflect the exact geological and hydrogeological conditions at a specific site. Local and site-specific data (e.g. depth to water table) should be considered where available and should be collected for high vulnerability areas and some activities in medium vulnerability areas if not already available.
2. If vulnerability is 'patchy' this is generally indicative of highly variable geology and soils, but may also be due to 'edge effects' (e.g. in coastal areas) where some data used to calculate vulnerability is missing. Missing data, visible in the underlying map table, can cause an artificially high vulnerability score. Activities in these areas, particularly if a site is close to or overlapping the boundary of two cells with differing vulnerability, should be examined in more detail using the information in the map tables. Where site-specific data is available this should be given precedence.
3. Human activities such as mine workings, excavations or pipe work, particularly in urban areas, are not included in the maps but could increase vulnerability locally. For example, the presence of man-made excavations that have been backfilled with permeable, readily compacted material will make a location significantly more vulnerable. Nearly all civil engineering construction, but especially underground pipes, will provide rapid pollution routes that are not characterised by the data included in the maps. Alternatively, the vulnerability may be decreased if the area has been backfilled by less permeable material (i.e. replacement of weathered/fractured bedrock by sand).
4. The soil zone can contribute up to 50% of the vulnerability score for superficial aquifers and up to 17% of the score for bedrock aquifers, reflecting the importance of superficial deposits in protecting bedrock aquifers. In some areas, soils may be removed by natural processes (soil erosion) or as a result of human activity (e.g. quarrying), which will increase the vulnerability of the underlying aquifer. This will need to be taken into account when using the maps.
5. If a development or activity is below the soil layer (e.g. the overflow from a septic tank) or where the soil layer has been removed (e.g. for construction purposes) the soil will offer no protection and the groundwater vulnerability will be higher.
6. If a development or activity is below the ground surface in an area shown as unproductive it could still pose a risk to aquifers if present below the unproductive strata. The vulnerability of those aquifers would depend on the depth of the activity relative to the base of the unproductive strata.
7. The nature of a pollutant will affect the specific vulnerability at a location. While the soil leaching classes indicate something of the likely speed of movement of pollutants through the soil and take into account the adsorptive capacity of the soil, they are by nature a generalisation based on the dominant soil type present in the area.
8. The maps are not suitable for insoluble pollutants, the movement of which depends on their individual properties such as density and viscosity. The maps should not be used to assess land already contaminated by pollutants.
9. The maps should be used with care if the pollutant is being applied intensively over a small area such that the protective capacity of the soil is overwhelmed. This may be the case for incidents and spills or poorly managed land spreading.
10. To summarise, the maps are intended as an initial screening tool and should be used in conjunction with other data such as source protection zones and site and activity specific information.