Detailed guide: Cemeteries and burials: groundwater risk assessments

Updated: 1. You will need to do a risk assessment for on-going environmental management, for example grey water disposal.

2. If you dispose of water at a human burial site then you must check if you need an environmental permit for that activity.

You need to follow this guidance if you are examining the potential or current effect of burials in a cemetery or individually, as part of a risk assessment. You will need to undertake a risk assessment, for example:

- as part of a planning application or condition
- when altering existing facilities
- following a pollution incident
- when ongoing environmental management of the site is needed, for example disposal of grey water

These principles also apply to pet cemeteries and the emergency burial of animal carcasses.

You need to submit your risk assessment to the Environment Agency or your local authority, depending on who has requested it. Your assessment will need to be approved before you begin or continue your activity.

Human burials are not currently controlled through the permitting system under the Environmental Permitting (England and Wales) Regulations 2016. However, you should use the principles for a groundwater risk assessment to ensure you do not cause pollution. You may still need a permit if you dispose of any water from the site. Check the guidance Discharges to surface water and groundwater: environmental permits.

You need to check if you are in a sensitive location for groundwater and what restrictions apply. Use the interactive groundwater maps to find out if you're in a sensitive location. You must also find out about private water supplies by contacting your local council.

Read the restrictions in the Environment Agency's groundwater position statements for more information:

- section L – on the development of new cemeteries or the extension or redevelopment of existing cemeteries
- section M – for emergency disposal either on-farm or in similar locations and circumstances

Source, pathway and receptor

You should use a source-pathway-receptor approach to follow this guide's principles.

For groundwater risk assessments relating to burials the:

- source is the buried human or animal remains
- pathway is the subsoil or other medium through which substances from the source permeate and travel
- receptor is the groundwater

Groundwater receptors can include:

- any boreholes, wells and springs used for drinking supplies
- groundwater-dependent ecosystems (such as wetlands) or other identified conservation sites that may be at risk (such as a Site of Special Scientific Interest)

To assess the risk at a site you will need a realistic estimate of the yearly maximum number of burials that take place or will take place, and whether these involve human or animal remains.

You must ensure any subsurface investigation of the soil and rock is at least 1 metre below the base of the grave.

You should use site specific hydrogeological data.

Tiered approach to risk assessment

You must not pollute groundwater and you need to carry out a risk assessment to show that:

- hazardous substances have been or will be, prevented from entering groundwater
- any pollution from non-hazardous pollutants will be limited
- microbiological contaminants will not endanger water resources or supplies

You should use a tiered approach for risk assessments. The cost, time and effort in undertaking an assessment is proportional to the effort or measures required to make the risks from the activity acceptable.

For all tiers you need to develop a conceptual model.

Tier 1 risk assessment: risk screening

For a tier 1 assessment, you need to do a desk study and a qualitative risk assessment. Each risk is ranked using a scoring system to prioritise those of most concern. The overall risk of the proposal can then be assessed as low, medium or high. For high and medium risks you need to do a more detailed tier 2 or 3 risk assessment.

Tier 2 and 3 assessments: detailed risk assessments

For tier 2 and 3 assessments you need to build on the information you gathered in your tier 1 assessment and refine your conceptual model.

If your risk assessment shows pollution or a risk of pollution you need to work with your local authority and the Environment Agency on how to address this. At existing cemeteries you will have to stop burials until you have an agreed plan of action.

Tier 2 and 3 minimum risk assessment requirements

For tier 2 and 3 assessments you need to supply the following minimum information.

Site description

Your risk assessment must show for:

- tier 2, a local survey to supplement Ordnance Survey maps
- tier 3, an accurate site survey based on location, area and topography – mark any landscaping included in the proposal

Number, type and sequence of burials

Your risk assessment must show for:

- tier 2, projections on which annual numbers are based should be available with supporting data and explanation
- tier 3, use the tier 2 projections and a plan of the proposed sequence of burial area usage with indication of expected progression over time

Meteorological factors

Your risk assessment must show for:

- tier 2, long-term average data on local rainfall and Met Office Rainfall and Evaporation Calculation System (MORECS) soil moisture data
- tier 3, analysis of available data to find out the monthly mean, maximum and minimum effective rainfall, and soil moisture data for bare soil, short-rooted vegetation and deep-rooted vegetation

Soil and subsoil characteristics

Your risk assessment must show for:

- tier 2, soil survey maps, and possible site investigation and percolation tests
- tier 3, site survey with augering and trial pits

Geology (including superficial) and hydrogeology

For tier 2, you must show geological and hydrogeological maps and histories.

You may also need to include:

- limited site investigation (like trial pits and drilling)
- groundwater vulnerability
- source protection zones (SPZs)
- an assessment of the aquifer characteristics from available published data

For tier 3, you need to provide the tier 2 information, plus:

- rock and soil characteristics
- presence of shallow groundwater
- variations in water table recorded for at least 1 year of monthly measurements

Boreholes must be at least 10 metres below the minimum groundwater level. Gather data and carry out investigations (for example, to estimate permeability based on falling head test, bailing test, tracer tests).

A minimum of 3 investigation boreholes are required – 1 on the up-gradient side of the site and 2 close to the down-gradient boundary.

Monitoring

Your risk assessment must show:

- tier 2, groundwater monitoring data
- tier 3, groundwater monitoring data – off-site monitoring may be necessary

Proximity to water source or resource

Your risk assessment must show for:

- tier 2, Environment Agency records of licensed abstractions and local authority records of private water supplies (include surface and groundwater supplies)
- tier 3, as tier 2 plus any additional water features including all groundwater, drainage, flood risk and surface water features (read more about water features surveys)

The area of the water features survey will depend on the size of the site, proposed abstraction rate and the aquifer type. The Environment Agency will determine the radius of the survey.

Data assessment

Your risk assessment must show for:

- tier 2, simple pollutant flux and water balance calculations, such as dilution at the water table
- tier 3, possible use of more sophisticated models to assess attenuation

Proximity to housing or other developments

Tier 2 and 3 risk assessments must check local, regional or national planning authority for potential:

- residential, educational, commercial or industrial developments
- roads, rail and mineral extractions

Monitoring groundwater

You don't need to monitor sites where the risk assessment shows that the risk to groundwater is low. You will need to monitor other sites, with the frequency depending on the degree of risk.

Follow the groundwater monitoring principles and the technical guidance for monitoring groundwater.

You may also need to carry out monitoring outside the burial boundary. For example, if burials are close to the perimeter of cemetery grounds.

You need to carry out monitoring to:

- define the baseline water quality and physical conditions in surrounding groundwater and surface waters before development
- identify all vulnerable receptors and help identify potential pathways
- provide an early warning of adverse environmental impacts

If monitoring identifies groundwater pollution, you must stop burials and carry out further investigations to find out the cause. You must also contact the Environment Agency who may require you to take action to sort out the pollution before burials can start again. Remember this applies to human and pet cemeteries.

Minimum monitoring requirements

You may need to consider what parameters you're monitoring on a site-specific basis. For example, you may need to include formaldehyde, organics, hazardous substances and bacterial indicators.

Where you need to monitor groundwater, you must meet the following minimum requirements for pre-development and ongoing burials.

Minimum number of boreholes

You should have at least 1 borehole up-gradient of the boundary of the site and 2 boreholes down-gradient of the boundary of the site. The down-gradient boreholes should be spaced no more than 100 metres apart. You should work out the groundwater flow direction from your monitoring boreholes.

Minimum borehole monitoring period

You should monitor:

- 12 months before site development
- for a period of 3 years after first interment

For higher risk sites, the Environment Agency may require an increase in the frequency of monitoring, both prior to development and longer term. This will depend on the sensitivity of the site and the results of the monitoring and can be reviewed accordingly.

Surface water monitoring points

For surface waters that are at risk you should have 1 monitoring point upstream and 1 downstream. These should be monitored on a monthly basis.

Baseline conditions

The minimum frequency for monitoring of baseline conditions and the monitoring suite (the determinands) prior to development is either quarterly or 6 monthly.

Minimum frequency	Suite of determinands
Quarterly	water level, pH, temperature, electrical conductivity, dissolved oxygen, ammonium, nitrogen, chlorine
6 monthly	sulphate, total oxidised nitrogen (nitrate and nitrite), total organic carbon, biological oxygen demand, chemical oxygen demand, alkalinity, sodium, potassium, calcium, magnesium, iron, manganese, cadmium, chromium, copper, nickel, lead, zinc, phosphorus

Long-term monitoring

The frequency of monitoring and suite of determinands for long-term monitoring once the site is in use (indicators of pollution) is 6 monthly.

Minimum frequency	Suite of determinands
6 monthly	water level, pH, temperature, electrical conductivity, dissolved oxygen, total oxidised nitrogen (nitrate and nitrite), total organic carbon, biological oxygen demand, chemical oxygen demand, ammonium, sulphate, chlorine, sodium, potassium, calcium, magnesium, iron, phosphorus

You may also need to increase the frequency of monitoring for higher risk sites or decrease it to annual monitoring if monitoring shows stable conditions.

Calculate your site’s pollutant release

You can use the following information to calculate the potential release of pollutants from your site.

Composition of the human body:

Composition	% weight
Water	64
Protein	20
Carbohydrate	1
Mineral Salts	5
Fat	10

Element components:

Elemental Component	% dry weight
Carbon	80.6
Nitrogen	9.2
Calcium	5.6
Magnesium	0.1
Sodium	0.3
Potassium	0.7
Phosphorus	2.5
Sulphur	0.7
Chloride	0.3
Iron	«0.01
Heavy Metals	Trace

Rates of release

Micro-organisms are mainly responsible for the breakdown of human remains. The rate of decay depends on the extent of microbial growth and activity. The proportions of degradable matter in a human body are:

- readily degradable – 60%
- moderately degradable – 15%
- slowly degradable – 20%
- inert (non-degradable) – 5%

The slowly degradable and inert rates assume that mineral salts (ashes) form a final stable residue. The slowly degradable component of bones may be considered for practical purposes.

The rate of microbial activity is influenced by the:

- availability of nutrients (carbon, nitrogen, phosphorus, sulphur) and moisture content
- pH conditions
- climate – warm temperatures speed up decomposition
- soil characteristics – well-drained soil will speed up decomposition, whereas poorly-drained soil like peat has the reverse effect
- burial practice – depth of burial and coffin construction control the ease with which micro-organisms and other invertebrates and vertebrates may gain access

Pathogens (mainly micro-organisms such as a virus or bacteria that cause disease) may also be present. They will die off naturally and rapidly reduce in concentration with increasing distance from the grave. Physical conditions like temperature, moisture content, organic content and soil pH will also affect their survival time.

There is also the potential, depending on the natural soil characteristics, for an increased soil pH resulting from a high proportion of calcium. This may impact upon degradation rates and micro-organism activity.

Typical pollutant half-lives

A buried human body normally decays to skeleton within 10 to 20 years. Pollutants from human remains come from dissolved and gaseous organic compounds and dissolved nitrogenous forms, especially ammoniacal nitrogen.

Estimates suggest that more than half the pollutant total leaches within the first year and halves year-on-year after that. Less than 0.1% of the original pollutant total may remain after 10 years.

Potential pollutant release (kg) from a single 70kg burial

Year	Total organic carbon	Ammonium	Calcium	Magnesium	Sodium
1	6.00	0.87	0.56	0.010	0.050
2	3.00	0.44	0.28	0.005	0.025
3	1.50	0.22	0.14	0.003	0.013
10	0.01	<0.01	<0.01	<0.001	<0.001

Year	Potassium	Phosphorus	Sulphate	Chloride	Iron
1	0.070	0.250	0.210	0.048	0.020
2	0.035	0.125	0.110	0.024	0.010
3	0.018	0.063	0.054	0.012	0.005
10	<0.001	<0.001	<0.001	<0.001	<0.001

Typical infiltration rates

The time it takes to flush pollutants from the buried body relates directly to effective rainfall and the infiltration rate through the soil and grave.

Estimate the possible average composition of effluent reaching the water table beneath the burial ground by dividing the pollutant release by the total annual infiltration.

This table gives an estimate of water infiltration (litres per year) through a typical grave plot.

Surface cover	Infiltration from grass surrounds	Infiltration from surface	Total annual infiltration
Chippings	2,000	750	2,750
Grass	2,000	500	2,500

Surface cover	Infiltration from grass surrounds	Infiltration from surface	Total annual infiltration
Tress/shrubs (green burial)	2,600	250	2,850

This table is based on a mean annual rainfall of 650mm and typical evapotranspiration losses. Each grave and surrounding area is considered to be centred on:

- 5.06 metres squared for a typical municipal cemetery with a grave density of 1976 per hectare
- 6.32 metres squared for green burial sites with a grave density of 1580 per hectare

Green burial sites

Green burial sites usually have more rapid decay rates compared with conventional cemeteries because of:

- relatively shallow depth of burial
- biodegradable nature of the coffins or shrouds
- lack of embalming fluids

You will need to consider infiltration rates, and adjust your calculations accordingly when carrying out your risk assessment. Infiltration rates may be lower on such sites due to increased evapotranspiration by trees and shrubs.

You should tailor the monitoring to suit products of aerobic decay processes such as nitrate and sulphate. This is because green burials are less polluting than anaerobic decay and for example, don’t usually include formaldehyde.

Attenuation of pollutants from burial sites

Pollutants from a burial site may migrate into the:

- soil zone surrounding the burial
- unsaturated zone of the underlying aquifer
- saturated zone of the aquifer

Where there are shallow soil zones or deep graves, burials will affect the unsaturated zone directly.

Following burial the breakdown by the main processes of attenuation are summarised as:

- in the soil zone, intense chemical and biochemical degradation, filtration and sorption takes place
- in the unsaturated zone, sorption and filtration continue but there is reduced chemical and biochemical degradation
- in the saturated zone, dilution and dispersion dominate – the extent of filtration is dependent on the nature of the aquifer, and chemical

reactions dependent on the groundwater chemistry

Soils have complex content, with the potential for intense biochemical reactions, meaning contaminants may change while passing through them. Unless there is waterlogging, air access is generally good and this encourages rapid oxidation of pollutants.

Below the soil, in the unsaturated zone, less chemical and biological activity takes place. Oxygen diffusion from the surface is low and low oxygen (anoxic) conditions may develop. However, chemical and biochemical reactions may continue to attenuate pollutants. Filtration and sorption may continue to de-mobilise particulates and some dissolved pollutants.

The potential for the aquifer matrix to remove micro-organisms and pathogens by filtration depends on the nature of the matrix. Where the major route for groundwater flow is through a porous intergranular matrix, like sandstone aquifers, there is a high filtration potential.

Conversely, aquifers where fractures are the main flow route, like chalk aquifers, offer limited potential for filtration.

Transport of micro-organisms and pathogens

The transport of micro-organisms and pathogens in groundwater depends on their size, shape and their means of being transported through the aquifer.

Water abstracted from a shallow depth has a shorter travel time within the aquifer. Therefore it is more likely to be at risk of transporting micro-organisms and pathogens than water abstracted from a greater depth, which has a longer residence time.

Because of the short travel time, many springs and shallow wells are more vulnerable to microbial pollution problems than deep wells or boreholes.

Guidance: Groundwater protection position statements

Updated: Updated The Environment Agency’s approach to groundwater protection.

These position statements describe the Environment Agency’s approach to managing and protecting groundwater. They update Groundwater protection: principles and practice (GP3).

This document helps anyone whose current or proposed activities have an impact on, or are affected by groundwater such as:

- developers
- planners
- environmental permit applicants and holders
- water abstractors

Many of the approaches set out in the position statements are not statutory but may be included in, or referenced by, statutory guidance and legislation.

Environment Agency staff use these position statements as a framework to make decisions on activities that could impact on groundwater. This clear approach aims to remove uncertainty and potentially inconsistent decision-making.

Research and analysis: ACRE advice: application for a trial of GM Adenovirus 4 (16/R49/01)

This document is the Advisory Committee on Releases to the Environment (ACRE's) advice to government in considering a request from Imperial College London (16/R49/01). The application is for a deliberate release of genetically modified virus (the vaccine) based on Adenovirus 4.

ACRE is satisfied that the trial will not have an adverse effect on human health or the environment.

News story: Focus on driving excellence in the nuclear sector

NSAN was established by nuclear employers and Government to address the skills challenges facing the nuclear sector. It provides a forum in which organisations can come together to discuss these challenges and develop solutions to address them. It currently has around 145 member organisations drawn from both the public and private sectors.

Ann McCall, Waste Management Director at RWM said: "Having worked closely with NSAN in recent months we are thrilled to be confirmed as a member. We are committed to maintaining and driving up skills within our organisation and we look forward to playing an active role within the Skills Academy."

NSAN works with employers in the nuclear sector to develop a range of

solutions which can help train staff and support them in developing their skills. One example is the Nuclear Training Network, an online portal where staff can access a range of training courses.

RWM has recently produced a new e-learning training course which is now available via the NSAN portal. Aimed primarily at those involved in decommissioning and waste management, the course provides an overview of RWM, its role as the public sector delivery body for a geological disposal facility (GDF) and the support it provides to radioactive waste packagers. More than 150 people have already signed up for the course from across the nuclear industry.

Further information on the course can be found here

Guidance: Mid Tier manual for 1 January 2017 agreements: Countryside Stewardship

Updated: Passed 10 July deadline for late revenue claims and amendments.

Use the manual to understand the rules and conditions that apply to Mid Tier (including water quality capital items) agreements.

Use the options, supplements and capital items document:

- to understand the rules for each option, supplement and capital item
- for advice on carrying out options, supplements and capital items

Use the Countryside Stewardship (CS) forms to support your agreement.

The manual has been designed with portrait and landscape pages. To make sure these print correctly, select ‘auto rotate’ in your printer settings before you print.

Overlap of CS options with Ecological Focus Areas (EFAs)

In 2018, you can overlap the following CS options with EFAs declared on your Basic Payment Scheme (BPS) 2018 application:

- AB1 Nectar flower mix
- AB3 Beetle banks
- AB4 Skylark plots
- AB5 Nesting plots for lapwing and stone curlew

- AB6 Enhanced overwinter stubble
- AB8 Flower rich margins and plots
- AB9 Winter bird food
- AB11 Cultivated areas for arable plants
- AB15 Two year sown legume fallow
- AB16 Autumn sown bumblebird mix
- HS2 Take historic and archaeological features out of cultivation
- OP2 Organic wild bird seed mixture
- SW1 4 to 6 metre buffer strip on cultivated land
- SW3 In-field grass strips
- SW4 12 to 24 metre watercourse buffer strips on cultivated land
- SW6 Winter cover crops
- WD3 Woodland edges on arable land
- WT2 Buffering in-field ponds and ditches on arable land

Your CS options that share land with BPS claims (known as ‘double funding’) will receive a reduced payment rate. You can find the rate in the page for each listed option, under ‘How much will be paid’, and in the manual (section 3.3.1).

From 1 January 2019, you will not be able to overlap the 18 CS ‘double funding’ options with EFAs declared for BPS. You can however place the options and EFAs in the same land parcel but they cannot overlap.

You can include hedges in both CS options and EFAs without payment deductions.

Revenue claims

The deadline for Natural England to receive late revenue claims and amendments was 10 July 2018. Natural England will not accept any further revenue claims in 2018.

Contact

Contact Natural England if you have any queries:

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Find out about call charges at www.gov.uk/call-charges.