

Practice guide for forest managers to assess and protect Groundwater Dependent Terrestrial Ecosystems when preparing woodland creation proposals

1. Purpose of this guide

This practice guide intends to help forest managers in identifying Groundwater Dependent Terrestrial Ecosystems (GWDTE) and assessing the risk of woodland creation operations to them and their related groundwater flows.

The Water Framework Directive and the Groundwater Directive place a duty on responsible authorities, such as FCS, to protect GWDTE from 'significant damage' caused by, for example, pollution and abstraction or diversion of groundwater flows. The 'significant damage' is a combination of the conservation importance of the habitat (often expressed as 'botanical richness') and the scale of the damage caused by the changes to the groundwater inflow to the habitat. The legislation supports a risk-based approach to land management to protect both the quality and the quantity of water - see Annex 1 for further information.

GWDTE are a category of wetlands, understood to be ecologically critically dependent upon groundwater. They derive their water supply primarily from a groundwater body, rather than deriving their water from rain and surface water saturated soils, and they can support biodiverse, botanically rich ground-flora communities.

The [UK Forestry Standard](#) (UKFS) place specific protection on wetlands by defining appropriate buffer areas to protect them from the risk of diffuse pollution from operations on adjacent or upslope ground and to minimise a potential reduction in water quantity. **This practice guide expands on the UKFS for wetlands that are critically dependent upon groundwater.**

The flow chart in Section 4 summarises a step-by-step approach to guide forest managers through the development of the planting proposal, based on four basic questions:

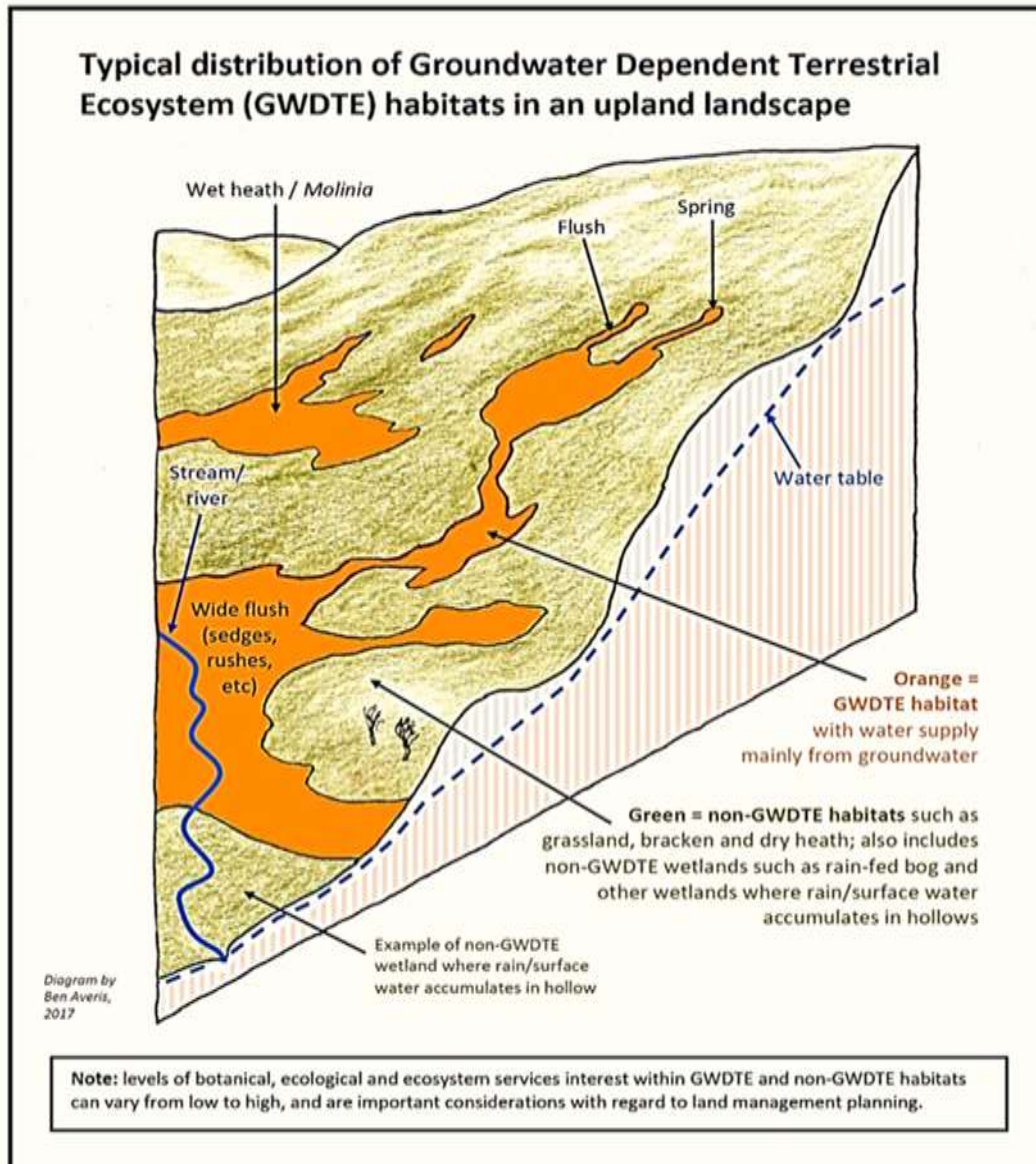
- Are there GWDTE on site?
- Are you intending to carry out operations that will affect the groundwater flow (e.g. deep excavation)?
- Are the GWDTE botanically rich?
- What are the mitigation measures in place?

2. Assessing the risk of forestry operations to GWDTE

While most forestry operations are unlikely to disrupt groundwater flow to and from GWDTE, deep excavation for tracks, borrow pits, quarries and drainage have the potential to disrupt such flow:

- deep excavation (>0.5m) associated with the creation, or significant modification, of forest roads, tracks and borrow pits could disrupt groundwater flow to or from a GWDTE;

- ground preparation and drainage methods close to groundwater sources or that drain groundwater away from GWDTE could disrupt groundwater flow to or from a GWDTE;
- ground preparation less than 0.5m deep is unlikely to disrupt groundwater flow to and from GWDTE.



This guide focuses on protecting botanically rich communities primarily fed by a groundwater body. When operations have the potential to disrupt the groundwater supply to GWDTE that support botanically rich ground-flora communities, appropriate mitigation measures (e.g. avoidance or buffer areas) must be considered and included in the planting proposal. Detailed descriptions of the habitats are in the glossary (Annex 4) and in summary:

- springs and flushes are always botanically rich and should be protected and maintained open;
- botanically-rich fens should be protected and maintained open;
- fens that are considered not to be botanically rich, can be planted;

- rush pasture and *Molinia*-dominated marshy grassland (M23, M25) are usually not botanically rich and can be planted. Where botanically rich communities are present (often linked with base-rich groundwater moving through the soil), these areas can be planted with low density native species, if this has the potential to enhance the wetland habitat;
- wet heath (M15, M16) is an Annex 1 Habitat and can be widespread (especially in the north and west of Scotland), it is usually not botanically rich and can be planted. Where wet heath occurs in an intimate mixture with springs and flushes, these areas are likely to be botanically rich and should be assessed further. If they are botanically rich they should not be planted, except with low density native species if this will enhance the wetland habitat;
- degraded, botanically poor GWDTE (for example compromised by previous drainage and/or other land practice) can be planted. Managers are however encouraged to consider restoration opportunities for these habitats.

The planting proposal should be informed by an early assessment of the risks that forestry operations could pose to GWDTE and the inclusion of suitable mitigation measures. The risks will be assessed and the mitigations measures will be refined during two stages:

- preliminary investigation (initial site suitability assessment) based on existing data sources and a site walkover- see Section 3;
- further investigation to inform detailed planting proposal – see Section 4.

Section 5 gives more information about the principles that should be considered when planning the relevant forestry operations (including excavation).

3. Initial site suitability assessment

This stage involves the use of existing data sources and a walkover survey to: i) determine the presence and likely extent of GWDTE; and ii) assess the potential risks that woodland creation operations could pose to these.

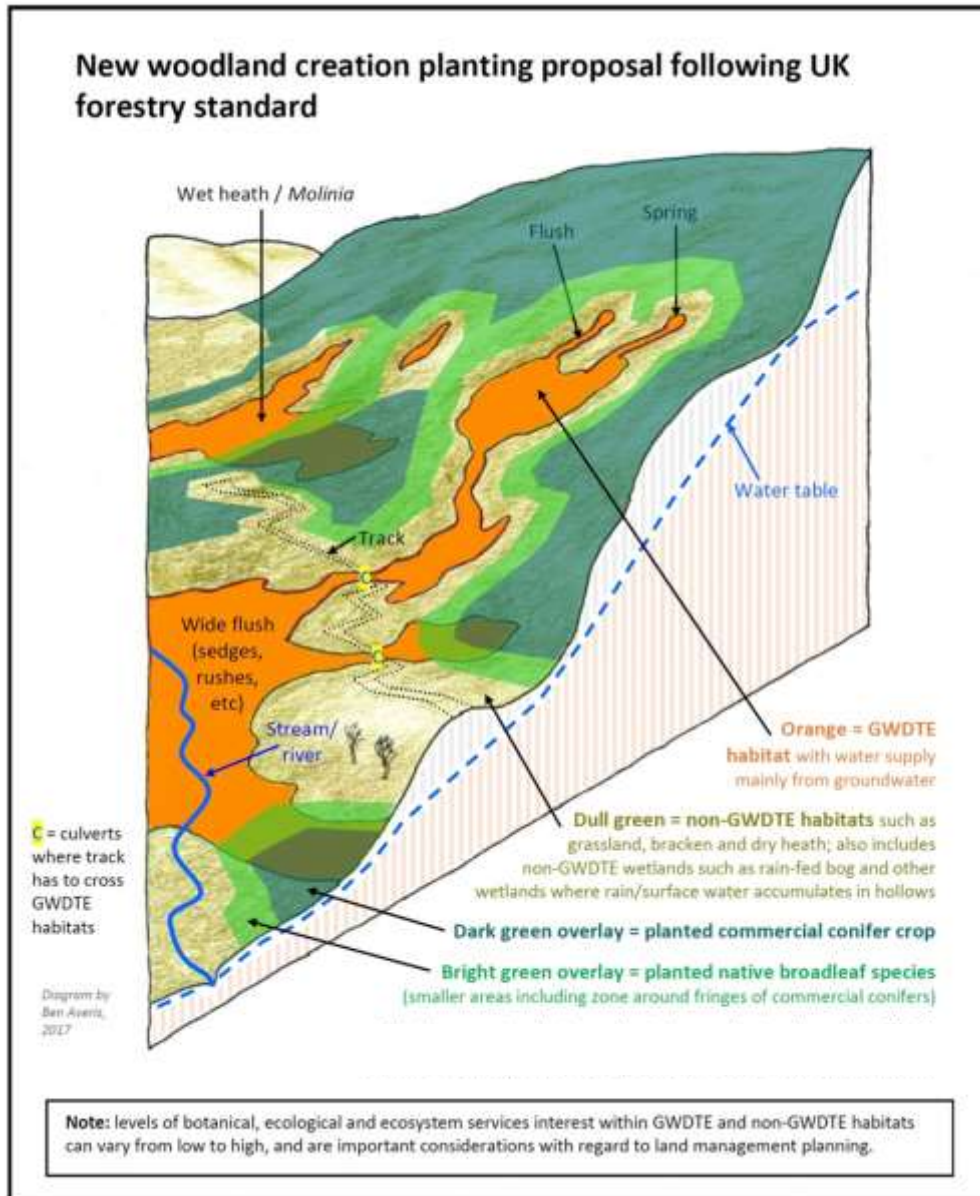
Data sources:

- assessing the location, extent and likely groundwater dependency of GWDTE can be based upon aerial photography and detailed topographic maps (accessible via FCS Mapviewer or Scotland's Environment Web [Land Information Search](#));
- the Habitat Map of Scotland brings together all the habitat information available for Scotland and is available at [HabMos](#);
- the OS MasterMap can help in identifying features such as 'issues', 'springs' or 'sinks' which indicate significant groundwater movement near the surface and thus the likelihood of groundwater dependency;
- geological maps may be useful as a drift or solid geology that is base-rich often indicates the likelihood of botanically rich GWDTE.

On the ground:

- a walk-over survey with a competent surveyor will help in identifying potential GWDTE ('risk areas') and in assessing the scale of the risk presented by woodland creation operations to them;

- the [Wetland Typology for Scotland](#) is a helpful guide to assist non-specialists to identify wetlands, their basic hydrological and ecological characteristics and their sensitivity to certain activities;
- potential GWDTE are usually found where there is a break in slope;
- potential GWDTE are often linked with base-rich groundwater discharge.



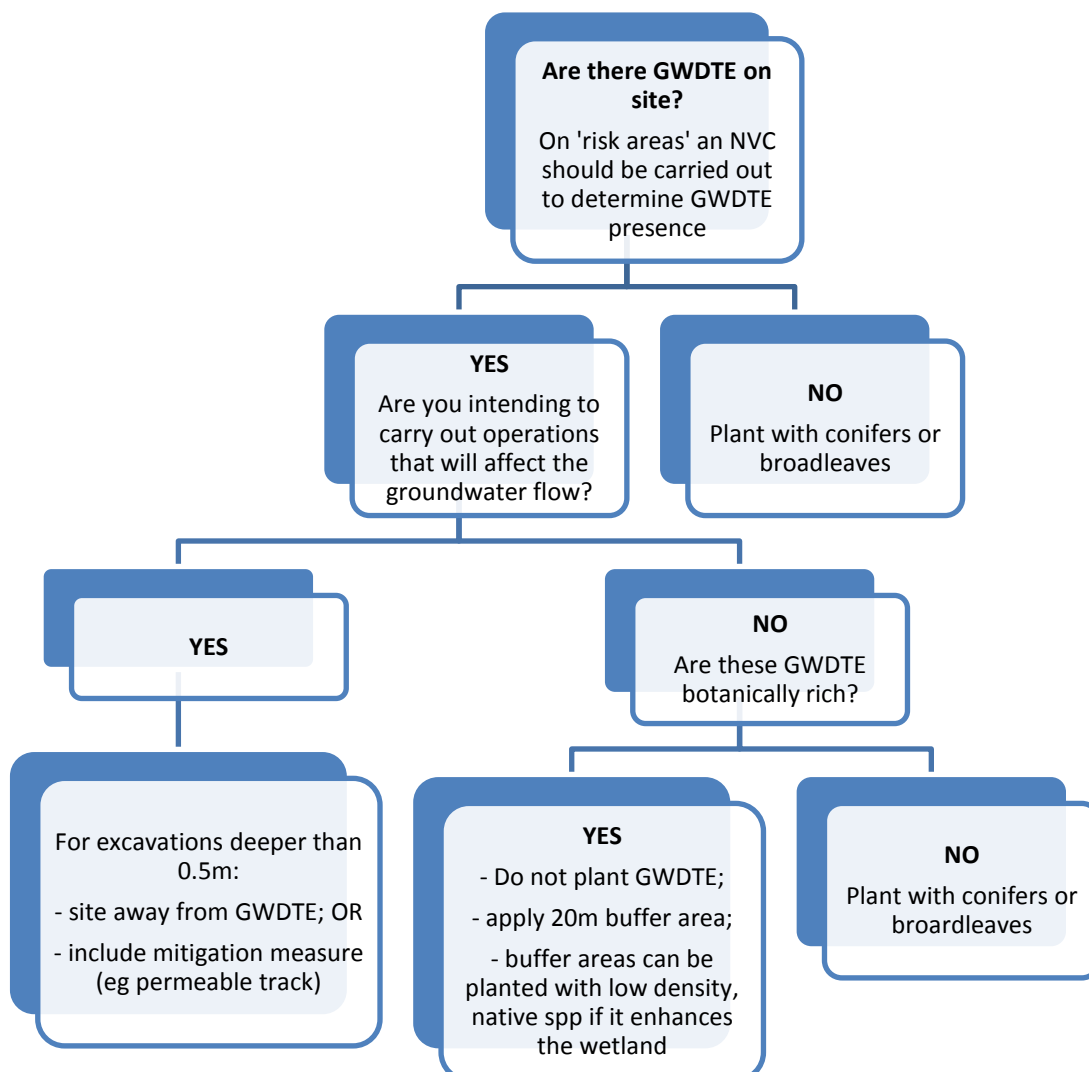
Examples of outline proposals based on the initial site suitability assessment are included at Annex 2.

4. Detailed planting proposal

While the initial site suitability assessment is largely based on aerial photographs, GIS information and a walk-over survey, the development of a detailed planting proposal requires further investigation on 'risk areas' to gather more detailed ecological information. Where the walk-over survey identified potential GWDTE, on these 'risk areas':

- a NVC (National Vegetation Classification) survey of wetlands should be carried out to assess their alkaline-related vegetation and their botanical richness;
- vegetation surveys should be carried out by a competent surveyor at times of the year when species can be identified (usually May to end September);
- if a survey is not carried out, these areas should be avoided or protected by buffer areas according to the UKFS;
- once GWDTE have been identified on the ground, their condition and extent should be recorded;
- the planting proposal must be designed in a way that these sensitive receptors are avoided or protected using buffer areas or where appropriate by choosing low-impact operations (see Annex 2);
- buffer areas are designed to protect water supply, water quality and to maintain adequate light conditions into these ecosystems- avoid undesired shading to wetland in these areas and buffer areas can be planted with low density, native species if it enhances the wetland;
- the vegetation survey map should be overlaid with a map that clearly details the extent of proposed operations and infrastructure (including excavations) and the proposed avoidance/mitigation measures (see Annex 3).

This flow chart summarises the development of the planting proposal:



5. Planning the appropriate forestry operations

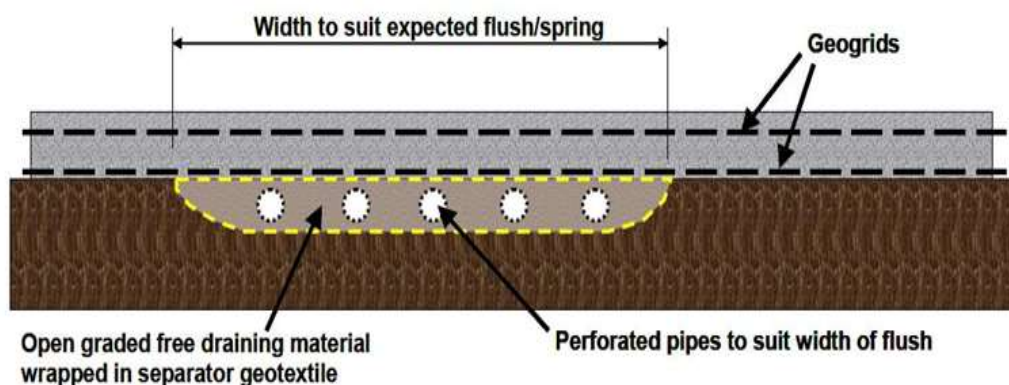
While most forestry operations are unlikely to disrupt groundwater flow to and from GWDTE, deep excavations have the potential to disrupt such flow. This guide is primarily intended for larger productive woodland creation proposals, however on small schemes both the applicant and FCS must be satisfied that GWDTE (both the habitats themselves and their source) have been appropriately protected.

Here is a summary of principles to secure the appropriate protection for GWDTE during forestry operations:

For track, borrow pits, quarries and drainage:

- tracks, borrow pits, quarries and drainage requiring excavation deeper than 0.5m should be sited away from GWDTE. Where this is not possible, it is best practice to include permeable track/culverts (e.g. coarse aggregate base, or culverts installed at regular intervals) where there is a spring, flush or botanically rich GWDTE within 100m downslope of the track (see below and Annex 3 for example);
- floating roads across large springs and flushes (>2m wide) might need a CAR licence ([CAR Practical Guide](#) table 5, page 42-44);

An example of good practice to achieve a road crossing using a wrapped, free draining drainage blanket is shown in [Floating roads on peat](#) (Page 41, Fig 8.7):



- always ensure that hydrological connectivity from the upstream groundwater supply to the downstream GWDTE is maintained;
- always ensure that GWDTE are not under-drained by the local impact of the excavation;
- during construction, do not track over, pile and store material on GWDTE;

For ground preparation and planting:

- where operations will not disrupt the groundwater flow, the area can be planted with appropriate tree species;
- do not plant on botanically rich GWDTE, such as springs, flushes and botanically rich fens;
- buffer areas identify a minimum buffer distance of 20m from the edge of the habitat- avoid undesired shading to wetland in these areas and buffer areas can be planted with low density, native species if it enhances the wetland;

- where the on the ground survey identifies botanical communities that are rare in Scotland, these should be avoided/ left open;
- consider how best to maintain ecological connectivity by linking open ground habitats;
- where operations have the potential to increase groundwater flow to botanically rich GWDTE (e.g. drainage that actively diverts groundwater flow into them), consider how this excess could be diverted to a less sensitive area/ waterbody. It is good practice not to increase the natural water supply to GWDTE, as these extra volumes or differing chemistry could damage them.

6. Review of this practice guide

The working group (FCS, SNH, SEPA and Confor) will review this practice guide in 2019, as we refine and improve knowledge and good practice on protecting wetlands that are critically dependent upon groundwater.

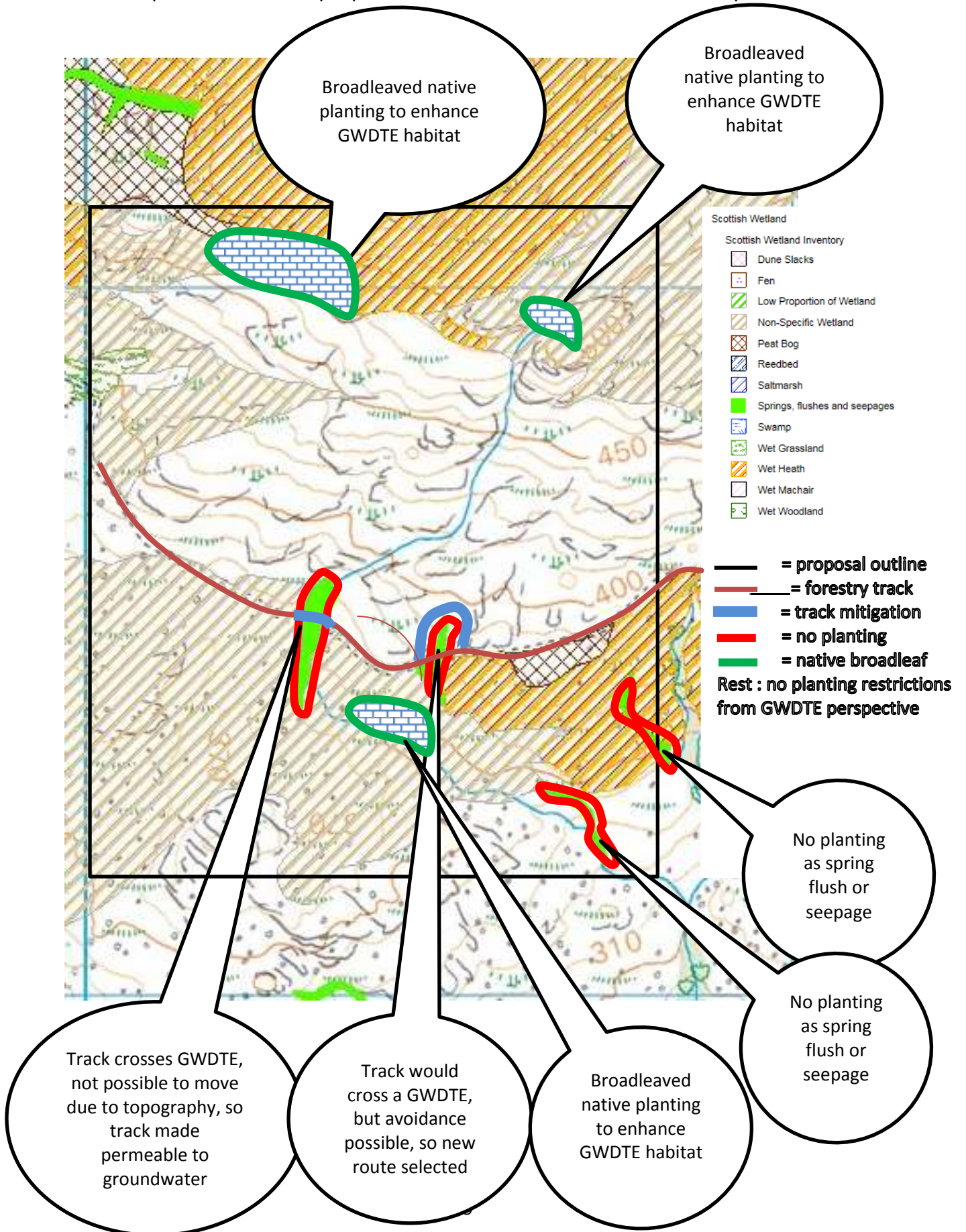
Legislative framework

Groundwater is important for public and private water supply, for its interactions with surface water, maintaining river flows in drier months and sustaining wetlands and their water-dependent flora and fauna.

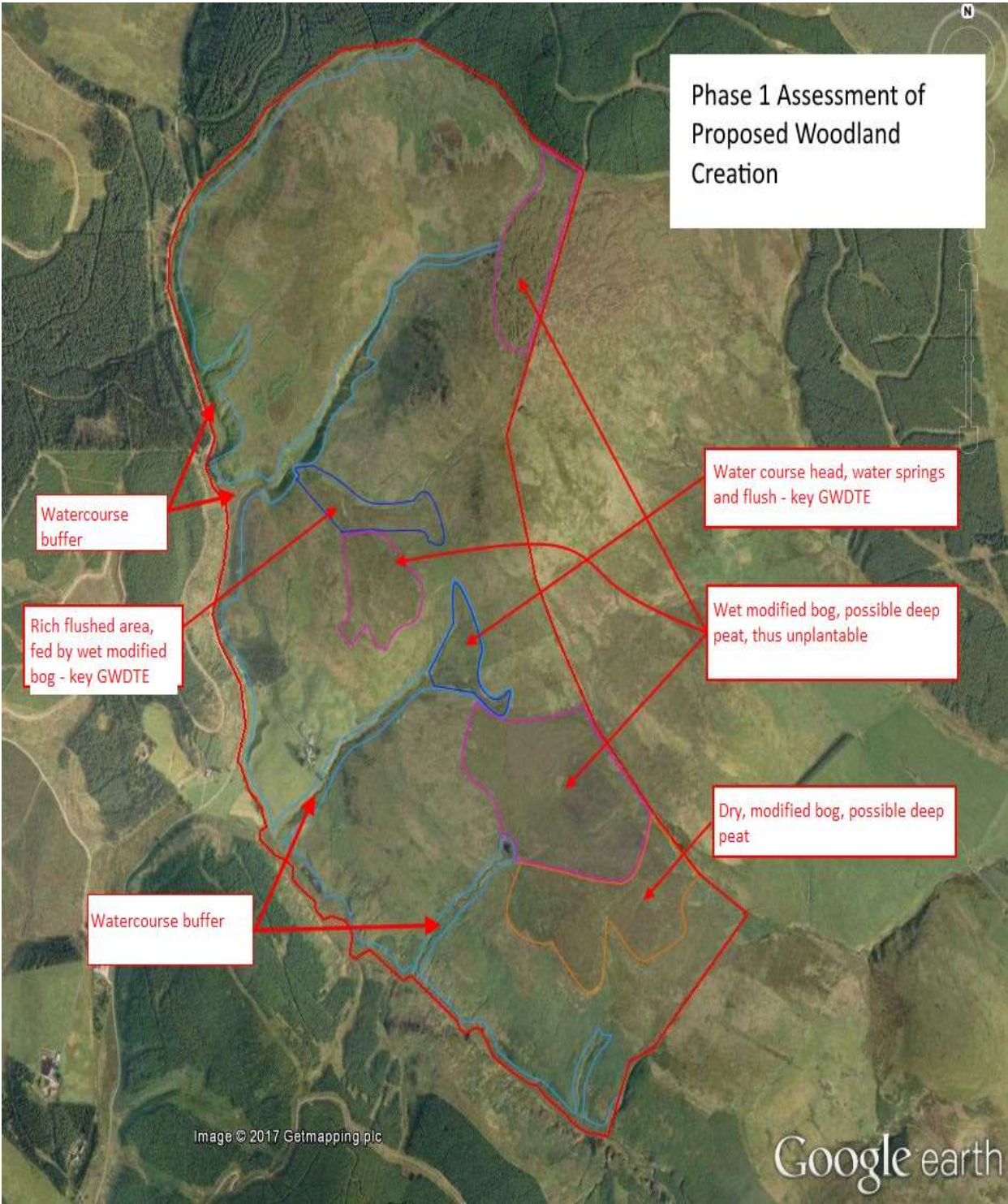
The EU Water Framework Directive and the associated Water Environment and Water Services (Scotland) Act drive long-term sustainable water management and aim for good ecological status of surface and groundwater bodies. The long-term sustainability of groundwater resources is assessed and protected through River Basin Management frameworks that focus on receptors such as drinking water.

Ecosystems (wetlands) that critically depend upon groundwater are part of this assessment as they represent the ecological quality of the invisible groundwater bodies. The hydrological linkage between groundwater and the wetland ecosystems that depend upon that is thus crucial and can be impacted upon from forestry activities. By mitigating the risks that forestry activities pose to groundwater, forest managers can improve protection of the wider water environment.

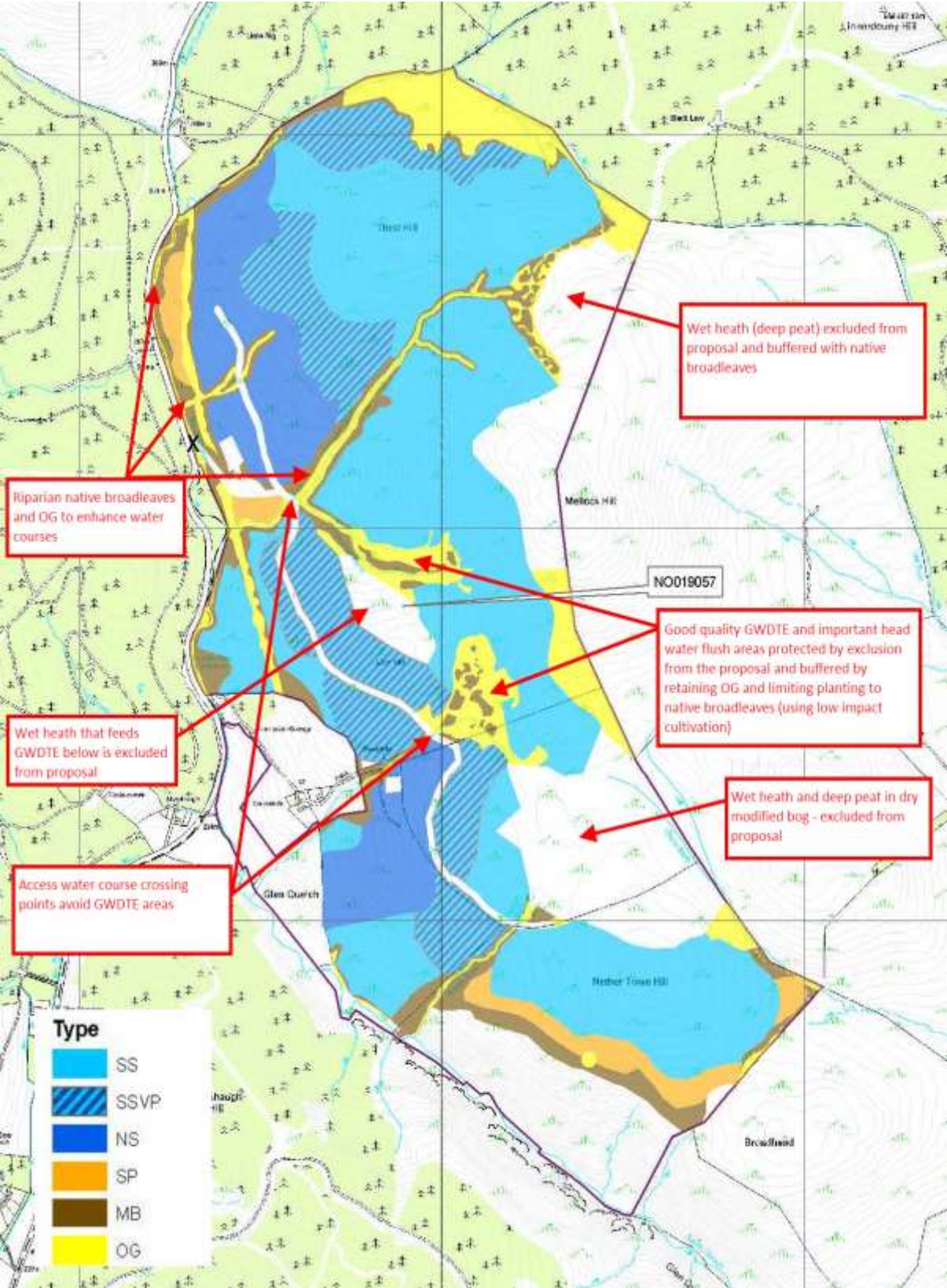
An example of an outline proposal based on the initial site suitability assessment



An example map on the development of a planting proposal with identification of 'risk areas'



An example map of proposed mitigation measures around 'risk areas'



Glossary

- **Base-richness** in ecology is the level in water or soil of chemical bases, such as calcium or magnesium ions. Base-rich environments (calcareous grassland, fen) are neutral or alkaline, while base-poor environments (bog, heath, moorland) are dominated by acidic conditions. Base-rich terrestrial environments are characteristic of areas where the underlying rocks are limestone. Base-poor environments are characteristic of areas where the underlying rocks are sandstone or granite, or where the water is derived directly from rainfall (ombrotrophic).
- **Biodiversity value:** The conservation value of a GWDTE is linked to the [Scottish Biodiversity List](#) and how important the habitat is in a local, national or international context. Springs, flushes and fens are generally of high conservation value, while rush pasture and *Molinia*-dominated marshy grassland may or may not be, depending on their botanical richness. Botanical richness and thus conservation value is often high where neutral or base-rich groundwater moves through the soil.
- **Botanical richness:** or 'plant species richness' is defined as the total number of species in an area and is one indicator of biodiversity. The biodiversity value is directly related to the botanical richness and it is described for each type of GWDTE in this glossary. Plant species richness is defined as the total number of species and is one indicator of botanical richness. Species and habitat rarity is another indicator.
- **Buffer areas:** (in the context of GWDTE and wetland) areas that protect the hydrological integrity of specific features from any proposed activity and to maintain light into these communities through the full forest rotation-allowing for mature height and width of tree canopy. These buffer areas can be incorporated into the design of the future forest and form part of the open ground component. It is good practice that the location of buffer areas is advised by a competent ecologist.
- **Detailed planting proposal:** a plan that details the operations and how work will be planned and implemented at site level.
- **Diffuse pollution:** pollution arising from land-use activities (urban and rural) that are dispersed across a catchment. These are distinct from 'point' sources of pollution associated with discharges of industrial wastes, municipal sewage, and deep mine or farm effluent.
- **Fen:** one of the main types of wetland (along with bogs, fens are a kind of mire) that are usually fed by mineral-rich surface water or groundwater. They are characterised by their distinct water chemistry, which is pH neutral or alkaline, with relatively high dissolved mineral levels but few other plant nutrients. They are usually dominated by grasses and sedges, typically have brown mosses including *Scorpidium* or *Drepanocladus* and frequently have a high diversity of other plant species. Botanically rich fens include M5, M9, M10, M13 and S24.
- **Groundwater:** all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.
- **Groundwater Dependent Terrestrial Ecosystems (GWDTE):** these are a category of wetlands whose vegetation is critically dependent on groundwater. Examples are springs, flushes and calcareous fens.

- **Hydrological connectivity:** the maintenance of continued flow pathways from groundwater source to the GWDTE. These flows can be interrupted by roads, track and drainage and mitigation measures need to be part of the woodland creation proposal.
- **Initial site suitability assessment:** an initial or concept planting plan that provides a starting point for discussion with interested parties.
- **Mitigation measures:** measures put in place to avoid, reduce or remedy the impact on a feature.
- **Priority habitats:** those identified as threatened and requiring conservation action under the UK Biodiversity Action Plan.
- **Scottish Biodiversity List:** a list of animals, plants and habitats that identifies those that are of the highest priority for biodiversity conservation in Scotland.
- **Sensitive areas:** areas that deserve protection because it contains a natural feature, such as the habitat of a rare species.
- **Springs and flushes:** 'Spring' and 'flush' are terms used to describe the vegetation or assemblages of plants on wet irrigated ground. A spring is the source of a stream, where the actual upwelling of water is usually covered with a cushion of mosses, and the rill or streamlet emerges at the downslope edge of the patch of mosses. Flushes mark out places where water flows over of the ground more diffusely. Flushes vary from expanses of soil, gravel and stones with a sparse array of mosses, sedges, rushes and small flowering plants to dense green swards of sedges or rushes or both interleaved with small herbs and underlaid with a carpet of mosses and liverworts. NVC communities associated with these wetlands include M5-M8, M10-M12, M31-M35, M37-M38).
- **Surface water:** water that collects on the surface of the ground such as a river, pond, wetland.
- **Waterlogged:** an area saturated with water.
- **Wet heath:** [Habitats Directive Annex I](#) habitat type, it can be widespread ((M15, M16) especially in the north and west of Scotland) and it is usually not botanically rich, however it may be of value even when it is not species-rich or in a mosaic with GWDTE. It usually occurs on acidic, nutrient-poor substrates, such as shallow peats or sandy soils with impeded drainage. The vegetation is typically dominated by mixtures of cross-leaved heath *Erica tetralix*, heather *Calluna vulgaris*, grasses, sedges and *Sphagnum* bog-mosses. Where wet heath occurs in mosaic with springs and flushes (and it is therefore fed by groundwater), or it is present on deep peat, these areas are likely to be botanically rich. These wetlands support communities that are rare in Scotland and they include M13, M22, M24 and S24.