IMPORTED SOIL OR SOIL-FORMING MATERIALS PLACEMENT

BPG NOTE 5

Best Practice Guidance for Land Regeneration

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Introduction

Many sites in the UK have been left with little or no soil cover suitable for greenspace creation. This may be as a result of landfilling or mineral extraction or due to the presence of heavy industry. Soil material initially present on a site may have been removed or stored in bunds for long periods of time. Before successful vegetation establishment can take place, the soil cover will need to be replaced as part of the restoration of the site. This can involve either replacing the original soil that has been stored or importing a soil from elsewhere or using a soil-forming material. In all cases, the site developer must ensure that the soil cover placed on the site is suitable for plant growth. Often soil materials can hamper vegetation establishment because their chemical properties are not able to support plant growth (e.g. low nutrient or organic matter content) or because they have been stored or placed in such a way that their physical qualities are imperfect (e.g. shallow soil depth, compaction). To ensure that vegetation establishment will be successful, it is essential that soil materials are capable of supporting plant growth and that correct procedures for the placement of imported or stored soils and soil-forming materials are followed (Figure 1).

This BPG Note details advice and minimum standards acceptable by the Forestry Commission for the use and placement of imported soils or soil-forming materials on brownfield, landfill or otherwise disturbed sites. Forest Research is able to give advice and further guidance on all of the recommendations put forward here. ROOTS, the software package for greening brownfield land allows developers to input site information in order to produce bespoke specifications for all aspects of site restoration, including nutrient requirements, weed control and species selection. For more information go to: www.roots-software.co.uk

Figure 1 Appropriate use of soil materials is essential in any reclamation project.

Guidelines for maintaining stockpiles

When soils are removed from a site and stockpiled, i.e. subjected to storage prior to use, the following guidelines should be implemented:

- Soils should not be stored if possible, but should be placed immediately on other parts of the site undergoing restoration.
- Care should be taken to ensure that topsoil and subsoil materials are kept separate at all times.
- If soil is stockpiled then storage mounds should be no higher than 1.5 m for topsoils or 3 m for subsoils.
- Stockpiles of different soil materials should be located at least 20 m apart from each other to prevent any inadvertent mixing of the materials.
- Storage mounds must not be located on top of reinstated soils or on areas where natural undisturbed soils are present.
- If soils are to be stockpiled for more than 6 months then mounds must be seeded with grass to prevent erosion and to reduce or eliminate the possibility of weed infestation.

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Standards required for soil materials

Table 1 presents Forestry Commission and DETR guidance on the minimum standards acceptable for soil-forming materials which are to be placed as part of a restoration process. Best Practice Guidance Note 2: *Laboratory analysis of soils and spoils* gives a more detailed overview of sample analysis.

Table 1 Minimum standards for soil-forming materials acceptable for woodland establishment (updated from Moffat and Bending, 1992; Dobson and Moffat, 1993; Bending *et al.,* 1999)

Parameter		Standard	Comments on method
Texture		No limitations; however, the placement location of materials of different texture on site should be related to site factors e.g. topography	Texture (% sand, silt and clay) should be determined by pipette method. Preferred textures include materials with > 25% clay
Bulk density (after placement)		<1.5 g cm^{-3} to at least 50 cm depth <1.7 g cm^{-3} to below 1 m depth	
Stoniness	Clay or loam	<40 % by volume of material greater than 2 mm in diameter and <10 % by volume of material greater than 100 mm in diameter	Measure mass of stone >2 mm and >100 mm in a known mass / volume of soil; divide each value by 1.65 to calculate the volume
	Sand	<25 % by volume of material greater than 2 mm in diameter and <10 % by volume of material greater than 100 mm in diameter	
pH		Within the range 4.0 to 8.0	Based on a 1:2.5 soil: $CaCl_2$ (0.01 M) suspension
Electrical conductivity		<0.2 S m^{-1}	Based on a 1:1 soil:water suspension
Iron pyrite content		<0.05 %	British Standard 1016 method
Topsoil nutrient and organic content		N >200 kg N ha^{-1} P >16 mg l^{-1} (ADAS Index 2) K >121 mg l^{-1} (ADAS Index 2) Mg >51mg l^{-1} (ADAS Index 1) Organic matter content >10%	Standard ADAS methods
Specific metal and organic contaminants		These should fall between the Soil Guideline Values (DEFRA and EA, 2002) for residential without plant uptake and industrial / commercial, where no SGVs are available acceptable limits should be derived using a risk-based approach for human health. Levels of copper and zinc should not exceed 130 or 300 mg kg^{-1} respectively. [a]	Determination according to substance using a method comparable with the Soil Guideline Values being used. Approval should be sought from Forest Research on the guideline concentrations being used before soil placement begins.

[a] Information on Soil Guideline Values can be sourced from the following link: http://www.environment-agency.gov.uk/subjects/landquality/ and then navigate to the CLEA home page and then to publications relevant to CLEA.

Soil materials that are suitable for woodland use can be readily identified by the following procedure:

1. Avoid the use of materials from sites known to contain contaminants, e.g. former heavy industrial or chemical engineering sites, old landfill sites etc.
2. Visually inspect the materials at source and identify that they meet the initial specification for stoniness: avoid any with a high content of small stones or a total stone content in excess of 40% by volume. It is extremely difficult to remove small stones or improve excessively stony soils by mixing or de-stoning and stone content is often the key factor causing the material to be rejected by the Forestry Commission.
3. Samples of soils for analysis should be representative of the bulk of the material. The soils must be tested for *all* of the chemical parameters listed in Table 1. A preliminary single set of analyses should be taken to indicate if the soil meets most or all of the standards listed in Table 1. If the material is suitable or borderline then at least two and preferably three sets of further analyses (conducted on different replicate samples) should be produced for each individual soil material, to give greater certainty about the nature of the material. When sending samples to the laboratory the type of source material should be stated (if known); this makes it easier to identify suitable products for mixing.

Sampling frequency

A minimum of six samples of material per stockpile or a minimum of three samples of soil from each horizon (topsoil, upper subsoil, lower subsoil) of placed material per hectare should be tested. If these samples show highly variable results, then further sampling may be required.

It is always preferred if samples of material are taken before stockpiling or placement (if imported materials are used) to ensure that they meet the guidelines in Table 1. This will ensure that inappropriate materials are not imported onto a site which may hinder their use or adversely affect 'clean' materials which may be placed adjacent to them.

It should be made clear from the outset that any material which fails to meet these guidelines will not be accepted by the Forestry Commission for use on sites destined for a woodland end-use. Some flexibility is offered, however, in the ability to mix different soils of similar type in order to derive a material which will meet the standards listed above. The Forestry Commission works with the contractor in order to procure or produce good quality materials, and the following section gives guidelines on ways to achieve this.

Guidelines for mixing soil materials

Different types of soil may be mixed together in order to produce a suitable end-material. For example a lime-rich or high pH soil may be mixed in moderate quantities with a more neutral one (pH 6 or 7) to obtain a suitable end-material. Mixing is feasible if the textural classes of the two soils are adjacent on the textural triangle shown in Figure 2. However, soil has many different constituents with different properties that may interact in different ways. It is therefore important that advice is sought before mixing products, in order to make the best of the materials available. Advice on soil mixing should be sought following receipt of laboratory analyses for any materials identified as possible for use.

Soils which might possibly be mixed will include materials which:

- meet at least 90% of the standards listed above but are borderline on one or two standards;
- fall just outside the pH ranges indicated.

However, the composite properties of the final mixed materials must meet the standards listed in Table 1. If the samples are not suitable for mixing with other available materials then they should not be used. Sample mixing tests can be undertaken by a qualified authority to check that the final product is suitable for use on site. Advice on types of organic amendments which can be mixed in with the soil materials to produce a more suitable end-product should also be sought. The decision support software ROOTS includes a series of ready reckoners including a Supplementary Nitrogen Requirement Calculator with an ability to select from a wide range of amendments depending on local availability. An automated version of the soil textural classification triangle shown in Figure 1 is also available within the ROOTS software. By entering the percentage of clay and sand within any given sample a pointer will indicate the nature of the soil.

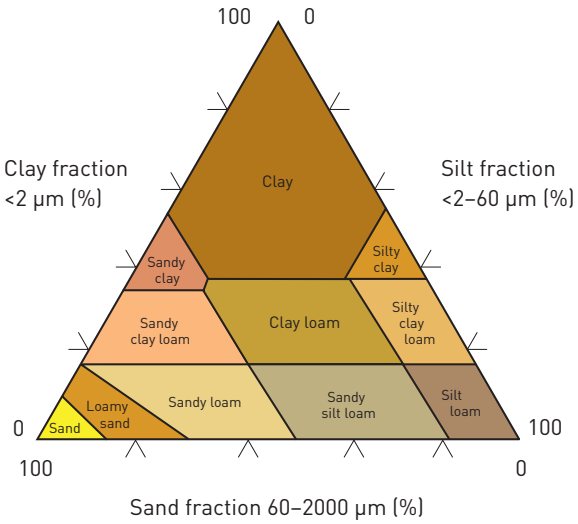

Figure 2 Soil textural triangle.

Guidelines for placing soil materials

- It is easiest to design a tree planting scheme if materials of similar type are constrained to particular locations on site. For example, try to avoid tipping soils of markedly different textures next to each other in a random mix (it is particularly important not to mix sands with clays).
- Materials containing a high proportion of fine sand or silt should be placed only on flat areas, to ensure that the risk of surface erosion is minimised. Clays are more suitable for slopes. Advice on the placement location that is best for the different materials should also be sought.
- Soils should be placed in the correct sequence, subsoils first and then topsoils.
- The locations of different types of placed materials from each source or mix should be drawn onto a site map so that the extent and boundaries are well defined for both topsoil and subsoil materials. The placed depth of each soil layer should also be recorded. This ensures that the planted tree species are suited to the different soil conditions present and that any further drainage or cultivation needs can be easily identified.
- Extreme care should be taken if placing soils near to watercourses or open ditches to prevent soil or sediment entering the watercourse. It is normally recommended that a buffer strip of at least 5 to 10 m should be maintained between an open ditch and the first tipped soil mound, but approval should be sought from the Environment Agency or SEPA before proceeding with such works. The land contour alongside the ditch should be graded using the backactor to a shallow slope of no more than 5% to reduce the risk of surface erosion or slumping of the placed materials. Where main watercourses are present or where arterial ditches are present which flow directly into a main watercourse, runoff from the reinstated soil must be collected and passed into settlement lagoons to prevent the pollution of watercourses by eroded material.
- Care must be taken to avoid soil losses or contamination with other materials at all times.
- Care should also be taken to minimise nuisance from dust at all times.
- Further information on appropriate soil placement can be found in BPG Note 4: *Loose tipping*.

Depth of placed final soil cover

The depth of soil required for woodland on landfill sites is determined by the need to:

- To prevent penetration (and/or desiccation) of any mineral cap present (e.g. on landfill sites) by tree roots.
- To provide sufficient available soil moisture and nutrition to support and sustain healthy, mature trees.
- To provide anchorage for roots and to avoid windthrow.

The general minimum guideline depth for soil cover over landfill sites where the end-use is woodland is 1.5 m of *rootable* placed soil cover (Dobson and Moffat, 1993). This value should reflect the final rootable depth following any settlement of the soil. Rootable implies that the soil must be free from compaction. This depth requirement must be reviewed in areas of low rainfall and according to the nature of the soil cover.

A greater depth of placed final cover is required for soils of sandy or chalky texture and of moderate stone content due to their reduced water holding capacity. Soils with stone content above 40% by volume should not be used.

The guidelines for soil depth assume that the soil profile is composed predominantly of subsoil with a topsoil cover of 0.3 m depth. Topsoil cover is recommended for all soils but is not essential for those with a moderate to high clay content. Topsoil will, however, be required over nutrient-poor or unstable / erodible subsoil materials. The recommended soil depths are based upon the assumption that the material to be used as placed soil cover is 'clean' and free from contamination and meets the specification given in Table 1.

References and further reading

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