BRITISH STANDARD

BS 4428:1989

Incorporating Amendment No. 1

Code of practice for general landscape operations (excluding hard surfaces)

UDC 712.3/.7:(083.75)

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Committee (BDB/-) to Technical Committee BDB/5, upon which the following bodies were represented:

Arboricultural Association
Association of County Councils
Association of District Councils
Association of Metropolitan Authorities
Building Employers' Confederation
Construction Health and Safety Group
Department of the Environment, Property Services Agency
Engineering Equipment and Materials Users' Association
Federation of Civil Engineering Contractors
Federation of Manufacturers of Construction Equipment and Cranes
Federation of Piling Specialists
Health and Safety Executive
Incorporated Association of Architects and Surveyors
Institute of Building Control
Institute of Clerks of Works of Great Britain Inc.
Institution of Civil Engineers
Institution of Environmental Health Officers
Institution of Structural Engineers
Landscape Institute
National Council of Building Materials Producers
National Federation of Demolition Contractors
Royal Institute of British Architects
Royal Institution of Chartered Surveyors
Scottish Development Department
Trades Union Congress

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Association of Playing Fields Officers and Landscape Managers
British Aggregate Construction Materials Industries
British Association of Landscape Industries
British Railways Board
Electricity Supply Industry in England and Wales
Forestry Commission
Horticultural Trades Association
Institute of Groundsmanship
Institute of Leisure and Amenity Management
National Playing Fields Association
Royal Town Planning Institute
Sand and Gravel Association Limited

This British Standard, having been prepared under the direction of the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 August 1989

First published April 1969
First revision August 1989

The following BSI references relate to the work on this standard:
Committee reference BDB/5
Draft for comment 87/10155 DC

ISBN 0 580 17194 9

Amendments issued since publication

Amd. No.	Date of issue	Comments
6784	September 1991	Indicated by a sideline in the margin

Contents

Foreword

This British Standard has been prepared under the direction of the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Committee. It is a revision of BS 4428:1969, which is now withdrawn.

Attention is drawn to BS 3998, BS 4043 and BS 5837. A British Standard concerning recommendations for grounds maintenance, including the maintenance of grass areas is being prepared.

Attention is also drawn to Practice Note 3: Building near Trees, published by and available from the National House-Building Council, Chiltern Avenue, Amersham, Buckinghamshire.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 32, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

blank

Section 1. General

1.1 Scope

This British Standard code of practice gives recommendations for the following general landscape operations (excluding hard surfaces):

a) preliminary investigations;

b) drainage;

c) grading and cultivation;

d) seeding of grass areas;

e) turfing;

f) amenity tree planting;

g) woodland planting;

h) planting of shrubs, herbaceous plants and bulbs.

The recommendations of the code of practice take account of current techniques, equipment and materials; and are restricted to general landscape operations. Intensively used and specialized sports areas such as playing fields, bowling greens, cricket tables and golf greens are excluded from the revision, both because they are specialized and because they are covered by Sports Ground Construction/Specification: 1975 issued by the National Playing Fields Association and the Sports Turf Research Institute.

The code of practice does, however, include recommendations for the gradients of sports fields that are not covered by the National Playing Fields Association technical publication Gradients for Outdoor Sports Facilities: 1983 (see **4.2.3**).

The code does not cover the planting of alpine and aquatic plants.

NOTE The titles of the publications referred to in this standard are listed on page 32.

1.2 Definitions

For the purposes of this British Standard the definitions given in BS 2468 and BS 6100 apply, together with the following.

1.2.1
major grading

adjustment of contours when final levels can only be achieved by the removal of organic and partially organic surface soils (topsoil and subsoil) and by excavating and grading inert soils beneath the subsoil layer

1.2.2
minor grading

formation of true running contours by blade grading and movement of subsoil following the removal of topsoil

1.2.3
regulating

formation of true running contours by blade grading and movement of topsoil only

1.2.4
subsoil

layer immediately below topsoil and above inert parent material, which is less well structured and less biologically active than topsoil but which acts as a source of plant nutrients and moisture

1.2.5
topsoil

original surface layer of grassland or cultivated land; usually a darker shade of brown, grey or red than the subsoil that lies immediately beneath it because it contains organic matter intimately mixed with the mineral matter

Section 2. Preliminary investigations

2.1 Site investigations before operations

2.1.1 Consultation

A desk study of available information relating to a site should be undertaken prior to performing any physical investigations and the following should be consulted.

a) Geological and/or soil survey maps for a general indication of the drift and rock or soil type.

b) Statutory undertakings for the presence of underground apparatus and apparatus above ground, which might restrict the operation of construction plant (see also **2.3** and **2.6**); and local planning authorities for the existence of Sites of Special Scientific Interest (SSSI) and Tree Preservation Orders (TPO).

c) Appendices A and B of BS 5930:1981, which give guidance on methods of site investigation and sources of information.

When reclamation of made ground is to be undertaken, specialist advice should be obtained regarding the investigation of possible contaminants within the fill, and reference should be made to DD 175. See also **4.4.5**.

2.1.2 Topsoil

The following investigations should be performed depending upon the nature of grading or cultivation work to be carried out.

a) Ascertaining of depths over entire site, e.g. by setting out a grid at, say, 30 m centres and determining depths by methods given in **2.1.4**.

b) Investigation of the quality of topsoil to ascertain that it is suitable for the intended purpose (to sustain active or healthy growth), or that it can be rendered suitable (see also BS 3882). The facilities of the National Agricultural Development and Advisory Service, agricultural colleges, the Sports Turf Research Institute and independent consultants should be used to pin-point deficiencies if they appear to exist.

2.1.3 Subsoil and general excavations

Inspection should be carried out to a depth of at least 750 mm below the level of lowest excavation, to determine the nature of the subsoil and underlying soils, and to establish the presence or otherwise of underground water and rock deposits. One of the following methods should be used.

a) *Hand auger*: in moist clays and soils free from stones (depths below about 0.5 m are difficult).

b) *Hand excavation*: shallow trial pits can be excavated by hand to about 1.5 m depth but become relatively expensive, compared with mechanical excavations, with increasing depth.

c) *Tractor mounted digger*: tractor mounted diggers can excavate trial pits down to 5 m depth in most soils and weak rocks. When it is intended that pits are to be entered for examination of the soils in situ, the sides should be supported or battered back to stable slopes.

NOTE Safety measures and trench support systems in relation to trial pits are discussed in BS 5930 and BS 6031.

d) *Mounted mechanical auger*: mounted mechanical augers can be used for samples in excess of 30 m depth in soils free from rock and boulders, though with some difficulty in dry, sandy, soils; auger sizes range from 225 mm to 900 mm diameter.

e) *Light cable percussion boring rig*: light boring rigs are specially designed for ground investigation work in soils and weak rock to 60 m depth in suitable strata.

f) *Rotary drill*: rotary drilling to produce core samples is used for rock exploration.

NOTE It is generally unnecessary to examine the subsoil and deeper deposits at the same intervals as the topsoil, if conditions are expected to be uniform. Special techniques have to be used when undisturbed samples are needed (see BS 5930 for further details). Methods of testing are described in BS 1377.

2.1.4 Recording

Results of investigations should be logged and the results should be presented on a vertical diagram giving the following details:

a) weather conditions at the time;

b) ground level to Ordnance Datum;

c) depth and description of organic topsoil;

d) depth and description of subsoil;

e) depth and types of excavated material;

f) level of water-table or zone of saturation.

2.1.5 Drainage investigations

Reference should be made to **2.3** and **3.2**.

2.1.6 Other investigations

Areas of rock should be plotted as far as possible by additional trial boring or other methods.

An estimate should be made of the proportion of stone in the topsoil (see BS 3882).

Road access for heavy machinery and low loaders should be determined and temporary roads on the site should be defined on plans of the site.

NOTE Observation and tests may be necessary to determine the permeability of the ground for drainage purposes. Relevant instrumentation and methods of test are given in BS 5930 and BS 1377.

2.2 Site enclosures

The location of site boundaries should be established before work commences and fencing should be erected as necessary.

Temporary fencing for the protection of the public should be maintained in good and effective condition until work is completed. Temporary fencing should then be removed.

NOTE 1 The type of fencing used will depend upon a number of factors, e.g. the location of the site, the likelihood of trespass and pilfering, the degree of danger to persons accidentally trespassing, and the extent to which persons or plant could interfere with or cause damage to adjoining properties or protected vegetation and artefacts.
NOTE 2 Urban sites are more likely to need protection than rural ones. Particular site requirements will affect the type of fence selected. It may be possible to alter or adapt existing site fencing to suit the timing and pattern of works.

2.3 Existing services

The appropriate statutory undertakings and pipeline agencies should be contacted and as far as possible the location of all service runs, such as water supply, gas, electricity (overhead and underground), telephone and existing drainage systems (including land drainage, springs and watercourses) should be ascertained before work is started and should be marked upon a plan, giving their position, size and depth. If necessary, they should be exposed by hand excavations.

The position and depth of all underground apparatus on the site should be verified, marked and, if necessary, should be exposed by hand excavations.

When services could be affected by excavation or when machines may be working nearby, the services concerned should be carefully sealed off, protected or diverted. Any work of a temporary nature should be made good at completion. Any permanent adjustments should be part of the new works. In most cases it will be necessary to obtain the approval and assistance of the statutory undertakings and local authorities concerned. Adjoining landowners should be kept fully informed.

2.4 Existing vegetation

2.4.1 Protection

Existing vegetation that is to be retained should be protected from damage with 1.2 m cleft chestnut or similar fencing. This should be maintained in good and effective condition until work is completed. Fencing to protect trees should coincide, as far as is practicable, with the spread of the branches, or in the case of fastigiate trees with a radius of half the height of the tree.

NOTE Some tree species have a root spread of a greater radius than branch spread; in such cases, certain landscape operations should be excluded from within the area of the entire root spread. See BS 5837.

Materials should not be stacked within the root spread of trees. Normal maintenance should be carried out within fenced areas during the execution of the work.

2.4.2 Remedial work

Existing plants and grass that are to be retained should be restored and maintained in a healthy condition and shapely habit. Accidental damage which may occur during the execution of the work should be carefully repaired during, and at completion of, the works. Accidental damage repairs should be carefully monitored during the following growing season and if recovery is poor, replacement of damaged plants should take place.

NOTE Recommendations are given in BS 3998 for tree work, and will be included in BS XXXX-3[1)] for the renovation of turf.

2.4.3 Preparation for moving

Trees and large shrubs that are to be transplanted should normally be prepared some time in advance.

NOTE Recommendations on this subject are given in BS 4043.

2.4.4 Vegetation to be cleared

Long grass and weeds should be cut and removed from the site. Trees, hedges and other plants should be cleared and should be removed from the site if burning is not permitted. Large roots should be grubbed out. Reference should be made to BS 3998 for recommendations regarding the clearance of tree stumps.

Controlled burning should be carried out clear of existing trees and shrubs.

NOTE The ash from these fires can be spread on the site with the exception of areas designed for calcifuge (acid loving) plants, which will not succeed in these circumstances.

[1)] In preparation.

2.5 Stripping and storage of topsoil and subsoil

Topsoil should normally be stripped when an area is to be occupied by buildings, roads or other hard surfaces, when major changes of level are needed, or when topsoils and subsoils are likely to suffer damage from building or engineering activities.

Topsoils and subsoils should be carefully stripped and stockpiled in reasonably dry conditions to avoid unnecessary compaction and damage to soil structure. They should be stacked separately and strict precautions should be taken to prevent the mixing of subsoil and topsoil. Topsoil spoil heaps should not exceed 3 m in height, including topsoil existing on site, and should be used within 12 months. If a greater time is needed for stacking, special precautions and remedial procedures will be necessary (see **4.8.3**).

While soil is stacked, measures should be taken to control the spread of unwanted vegetation.

NOTE The appearance of the heap can be improved and weeds can be suppressed by sowing a short-term crop of grass or clover.

2.6 Existing artefacts

2.6.1 Fencing

Work to be undertaken close to existing buildings, paved areas and special structures to be retained should be protected from damage by fencing such as 1.2 m cleft chestnut fencing complying with BS 1722-4.

2.6.2 Archaeological finds

Prior to the carrying out of site works, investigations should be undertaken as regards areas of archaeological interest.

NOTE 1 Part 2 of the Ancient Monuments and Archaeological Areas Act 1979 gives to nominated archaeologists statutory rights to investigate areas designated as of archaeological interest. If the site is on the Scheduled Monuments list, consent will be needed from the local planning department before proceeding further.

NOTE 2 There is no obligation to report discoveries of monuments in England and Wales. However, it is recommended that they should be reported to the local planning authority and to interested parties. In Scotland and Northern Ireland all finds of archeological interest have to be reported.

Treasure trove finds of gold and silver should be reported to the local planning authority.

NOTE 3 Finds of gold and silver come under royal prerogative and common law. Any other finds are the property of the landowner.

2.6.3 Materials for re-use

Before starting demolitions, any stone, brick, clay tiles, paving slabs, granite setts or other materials suitable for re-use should be carefully taken up and stored until needed or removed. The same should apply should any material coming to light during excavations be suitable for re-use.

Areas of grass to be cut for turf should be kept mainly free from broad leaf weeds and should be treated during the growing season with "selective herbicide", if necessary, according to the manufacturer's instructions; and should be regularly and closely mown before being lifted.

NOTE See section 6 for recommendations concerning turf.

2.6.4 Demolitions

Buildings, walls, roads, foundations, disused drains, manholes and any other construction not needed should be demolished to minimum depths below finished levels, as follows:

a) grass areas:	450 mm
b) ground cover and perennial planting areas:	450 mm
c) shrub planting areas:	600 mm
d) tree planting (within 2 m of tree stations):	900 mm

All materials (see **4.4.5**) should be removed from the site or, by agreement, should be buried below the depths given in a) to d).

Below the depths given in a) to d), concrete slabs or other impervious layers should be assessed for size and depth so that a decision can be made as to whether the slabs or layers should be broken up to facilitate free drainage, or whether they should be removed from the site to obviate future drainage problems. When subsoiling and drainage operations are to be carried out involving depths below those mentioned in a) to d), consideration should be given to the need for demolition work to be carried out to lower levels, to ensure that effective drainage operations can be carried out.

Section 3. Drainage

3.1 General

In landscape work, consideration should be given to the need for drainage, either temporary or permanent, for the following conditions:

a) to make an area fit for its purpose;

b) to enable the public, and maintenance machinery, to use the area;

c) to improve plant growth and soil conditions;

d) to prevent plant death;

e) to prevent erosion and damage to new works, especially banks;

f) to prevent damage to adjoining property by discharge from site, especially during construction;

g) to lower a high water-table;

h) to prevent land slip;

i) to prevent water from higher ground flowing to the site over the surface or below ground;

j) to lead away surface water, especially when falls over the area are small;

k) to drain ponds and divert or pipe ditches and watercourses;

l) to carry away the outflow of springs.

3.2 Information needed for the design of drainage for general grass landscaped areas

Investigation into site conditions should determine the following:

a) the position, size and depths of useful surface water drains;

b) the availability of adjacent ponds, ditches and watercourses for outlets;

c) whether the ground is permeable enough (and if possible at what rate) to accommodate soakaways or boreholes;

d) the annual rainfall and intensity of rainfall, for use in calculations of run-off;

e) the proportion of clay in the subsoil, determined by mechanical analysis.

NOTE Methods of test are given in tests 7(A) and 7(C) of BS 1377:1975.

f) the history of previous field drainage and ditching. Lines of old drainage systems should be investigated by trial holes and the results should be plotted on a plan.

NOTE Information may be available from the Agricultural Development and Advisory Service, or the Department of Agriculture and Fisheries in Scotland. A visual inspection of the ground as well as an examination of aerial photographs often reveals the lines of old drainage systems under grass where the line of drain is a different colour from its surroundings, particularly during dry periods.

3.3 Design

NOTE 1 Detailed design of comprehensive land and field drainage is outside the scope of these recommendations, but short- and long-term general considerations are covered in **3.3.1** and **3.3.2**.

NOTE 2 General recommendations regarding workmanship and materials, ditching, bridges and culverts, subsoil drainage, together with diagrams of chambers, outfalls and pipe inlets, can be found in publications[2)] issued by the Ministry of Agriculture, Fisheries and Food.

NOTE 3 The types of drain commonly used for controlling surface water run-off and ground waters are described in BS 6031.

3.3.1 Construction period and 2 to 3 years after

Drainage problems may arise because of the vulnerable nature of the works, and because of the slow return to optimum permeable ground conditions after radical disturbance of the soil structure by compaction during earth moving and cultivations.

Particular care should therefore be taken with materials having high proportions of silt and clay to avoid creating an impervious surface. If such a surface does occur, its effects should be minimized by subsoiling (see **4.7.4**), taking care not to disturb any existing land drainage, until the natural drainage pattern is established.

It is necessary to prevent the formation of, or to break up, crusts that form on some soils and give rise to quick run-off. To guard against damage by swift sheet run-off, which may form gully erosion and cause damage to adjacent property, it is often necessary to install cut-off drains either in the form of ditches or French drains as follows:

a) at the top of cuttings when the higher land has low permeability;

b) at the foot of cuttings when seepage is likely through the cutting;

c) at the top edge of embankments, as these are the most vulnerable features in earth works;

d) at the lower edges to collect run-off and prevent damage to the toe of the filling.

[2)] Technical Note on Workmanship and Materials for Field Drainage Schemes: 1983. Published by and available from the Ministry of Agriculture, Fisheries and Food Publications Unit, Lion House, Willowburn Estate, Alnwick, Northumberland. Reference Book 345: The Design of Field Drainage Pipe Systems: 1983. Ministry of Agriculture, Fisheries and Food Agricultural Development and Advisory Service Land and Water Service. HMSO.

Drains should be carefully designed and constructed, with adequate falls to prevent local ponding leading to ingress of surface water into the subsoil. The performance of drains can have a major effect on stability. Losses from drains should be minimized and the drains should be inspected and maintained at frequent intervals.

NOTE The need for some of the work referred to in **3.3.1** often diminishes considerably with time, being greatly influenced by the growth to maturity of ground vegetation.

3.3.2 Long-term considerations

Consideration should be given to the means of lowering a water-table in zones of permanent or intermittent saturation; to the provision of drainage to tap the outflow of springs or permeable layers; and to the means of dealing with surplus water in the topsoil and subsoil arising from direct precipitation.

The type of sub-surface drainage scheme necessary will vary considerably. The appropriate design should have pipes selected to meet the site conditions, and permeable backfill should be used as a connector for mole drainage, subsoiling, or the interception of surface run-off. If the subsoil has a high fine sand silt content, a filter wrapped pipe may be necessary.

3.4 Outlets

3.4.1 Locations

It is essential to make adequate provision for the disposal of water from landscape operations. Such water should be channelled as follows.

a) Into public surface water drains, for which the approval of the local water authority is needed. This may be granted on terms that may include the provision of silt traps; calculations as to estimated flow may be needed.

b) To neighbouring ditches and watercourses. The consent of adjoining landowners may be required and legal easements may be necessary; drainage boards or local authorities may exercise jurisdiction over position and construction of outfall.

c) To soakaways (see BS 8301) or deep boreholes. Some knowledge as to the permeability of the underlying strata is essential; works in the gathering grounds of water authorities may need the authority's consent. Expert advice should be sought relating to the hydrogeological conditions existing at the site, to establish the merits and implications of any proposed scheme.

3.4.2 Size and capacity of outlet pipes

The size and capacity of outlet pipes and soakaways should enable them to cope with the maximum run-off during the heaviest period of rainfall that is likely to occur in a 5-year period (the 5-year storm). When there is a risk that neighbouring buildings or roads may be flooded, a design may need to cope with a 10- or even 20-year storm according to the circumstances (storms of intensity greater than 37 mm/h are not uncommon).

For any large sites, e.g. over 1 ha, the design of the drainage outlets should be based on the peak run-off, Q (in m^3/s), derived from the following formula:

$$Q = \frac{C/A}{350}$$

where

C is the run-off coefficient;

i is the rainfall intensity (in mm/h);

A is the site area (in ha).

Recommended coefficients for C are shown below and from these a suitable figure can be estimated to take account of partially developed sites with bare, surface crusted soils:

buildings and concreted areas	0.95 to 0.99
roads	0.75 to 0.90
pathways	0.50 to 0.75
established gardens, lawns and woodlands	0.10 to 0.15

The rainfall intensity, i, should be calculated from the local rainfall figures according to the size, slope and shape of the site and the design storm (e.g. 10-year) that is adopted.

3.5 Drainage systems

3.5.1 General

The drainage of topsoil and subsoil by the insertion of pipes, or the forming of channels, below ground in such positions that they will gather water at depths chosen on the basis of soil, structure, vegetation, climate and designed activity is necessary to:

a) lower an existing water-table to a depth that will enable optimum root penetration in zones of intermittent or permanent saturation; and/or

b) gather water, arriving by direct precipitation, from zones of non-saturation and so assist in drying the topsoil and upper layers of the ground.

Because of the variables in vegetation and climate (especially rainfall and evaporation) and the variability of soils, there is much controversy about the depth at which existing water-tables should be maintained (and consequently the depth and distance apart of subsoil drainage) to suit local conditions. There is some evidence that a depth of about 500 mm from the surface is the level at which the water-table should be controlled for grass, and that a depth of 1 m to 1.5 m would be more appropriate for shrubs and trees.

The design of subsoil drainage needs detailed knowledge and careful planning, with the provision of suitable outlets and silt traps. General guidance only can be given in this British Standard regarding the possible combinations of pipes, sand slits, mole drainage and the spacing and depths of these items taking account of the wide variety of soils and possible surface uses.

NOTE Systems of subsoil drainage are described in **3.5.2** to **3.5.6**.

3.5.2 Open ditches

The use of open ditches is of limited application in general landscape operations. They can be of use for the collection of large volumes of water collected by pipe/tile drains, but their physical disadvantages and inefficient functioning make the choice of open ditches for subsoil drainage unlikely in landscape work other than woodland planting.

3.5.3 French drains

French drains should be formed by excavating to a defined depth and backfilling with free draining granular material designed to meet filter criteria with or without geotextiles, as for pipe or tile systems (see **3.5.4**).

NOTE French drains are generally used in railway and motorway cuttings or embankments to control seepage.

3.5.4 Pipe or tile systems

Pipe or tile systems should employ clayware, plastics or concrete pipes surrounded with suitable filter material and/or geotextile or plastics membranes, in accordance with the recommendations of the manufacturer.

The design of the system should be based on a knowledge of the soil particle size distribution within the subsoil, the desired water-table level, precipitation and the proposed and designed use. The general arrangement of this system should be a 100 mm diameter main drain, fed by 60 mm diameter laterals having a minimum 350 mm cover, in either a fan or grid arrangement depending on the scale of the operation, and laid to the appropriate slope to prevent silting up. (See Figure 1.)

Drains should be designed to prevent silting up. When ingress of fine sediments into the drainage system is anticipated, falls should be designed to promote a minimum, self-cleansing velocity of 0.75 m/s. Velocities of flows depend on pipe grade, diameter and roughness as well as quantity of flow, and the appropriate manufacturers' publications should be consulted when determining minimum fall to achieve self-cleansing velocities. Silt traps that can be cleaned out should be provided at appropriate locations in the pipe systems and at outlets to collect sediments.

3.5.5 Slit drainage

NOTE Further improvement to drainage can be obtained by the use of sand/gravel "slits", using medium sand free of fine particles, if the designed activity permits. Sand slits are effective water collectors, which absorb water from their surfaces. Such a system can last indefinitely provided that measures are taken regularly to prevent capping. (See Figure 1.)

The slits should normally be 50 mm wide and 300 mm deep, filled with sand and gravel, and should be spaced at approximately 1 m to 3 m centres linking into the lateral trenches.

3.5.6 Mole drainage

NOTE Mole drainage (see Figure 2) is usually only of lasting value in cohesive soils. It is a method of draining heavy (clay) land by drawing an implement through the subsoil to form a channel at a predetermined depth, which receives water from a vertical slit made by the passage of the implement, as well as from cracks in the soil itself. This system has only a short life depending upon the nature of the subsoil, but can be repeated at intervals if the designed activity permits.

Construction of a mole system can disturb the soil structure, and fine particles washed away can lead to a loss of efficiency or blockages in associated pipe drainage.

Connections should be made to a skeleton pipe/tile system (see **3.5.4**) by the moles passing through the stone filter material.

3.5.7 Special features of drainage for landscape work

(See also Table 1.) In landscape operations the following points are of considerable importance.

a) In trenching operations topsoil should be separated from subsoil and the latter should be removed.

b) When removing water from the surface and from the topsoil, trenches should be kept as narrow as practicable and pipes should be backfilled with permeable filter material.

c) At least 150 mm of light topsoil should be placed at the top of all trenches where the removal of water from the surface is unnecessary.

d) Junctions between mains and laterals should be purpose-made and should be obtained from the same manufacturer as the pipes.

e) Inspection chambers should be incorporated at intervals and at points of junctions of mains to facilitate cleaning and so avoid excavations in established grounds.

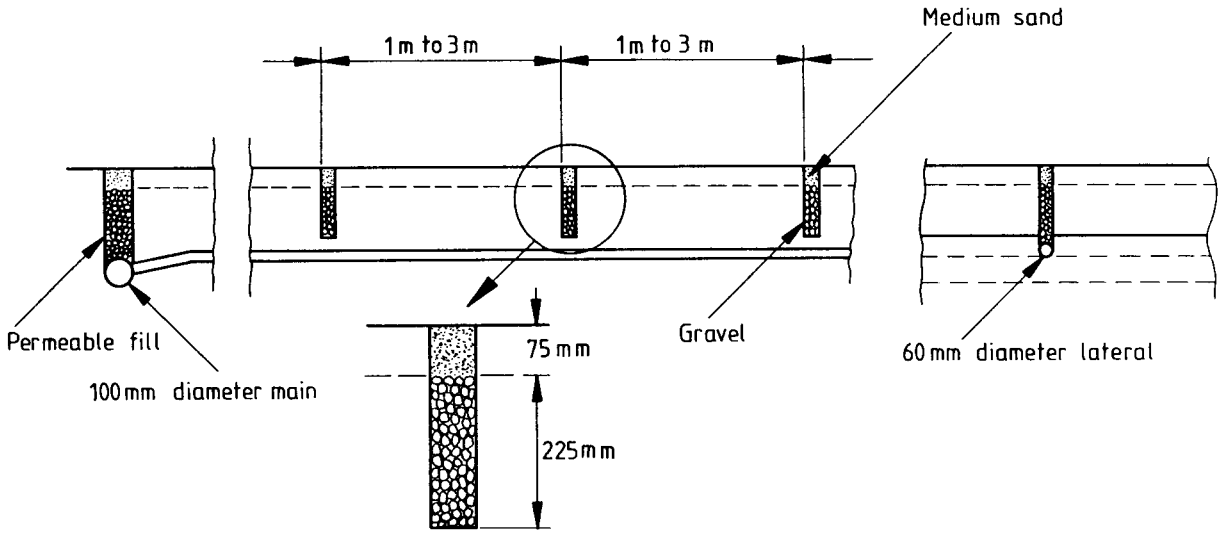
f) Pipes in drains adjacent to large trees should not be perforated and should have sealed joints so as to reduce the risk of ingress of tree roots; French drains to regulate groundwater levels in the area of trees should lead into pipes downslope of the roots. (See also BS 5837.)

g) Large-scale drainage operations are more economically carried out if specially constructed trench cutting and pipe laying machinery is used; diggers and machinery that have no means of maintaining an accurate level should be controlled by a system of levels and boning rods.

h) Arrangements for drainage should be as simple as possible to minimize multiplicity of junctions. Complicated short-run herringbone systems should be avoided and the placing of drainage lines should take account of optimum conditions for machine operations. A grid system is advantageous in this respect.

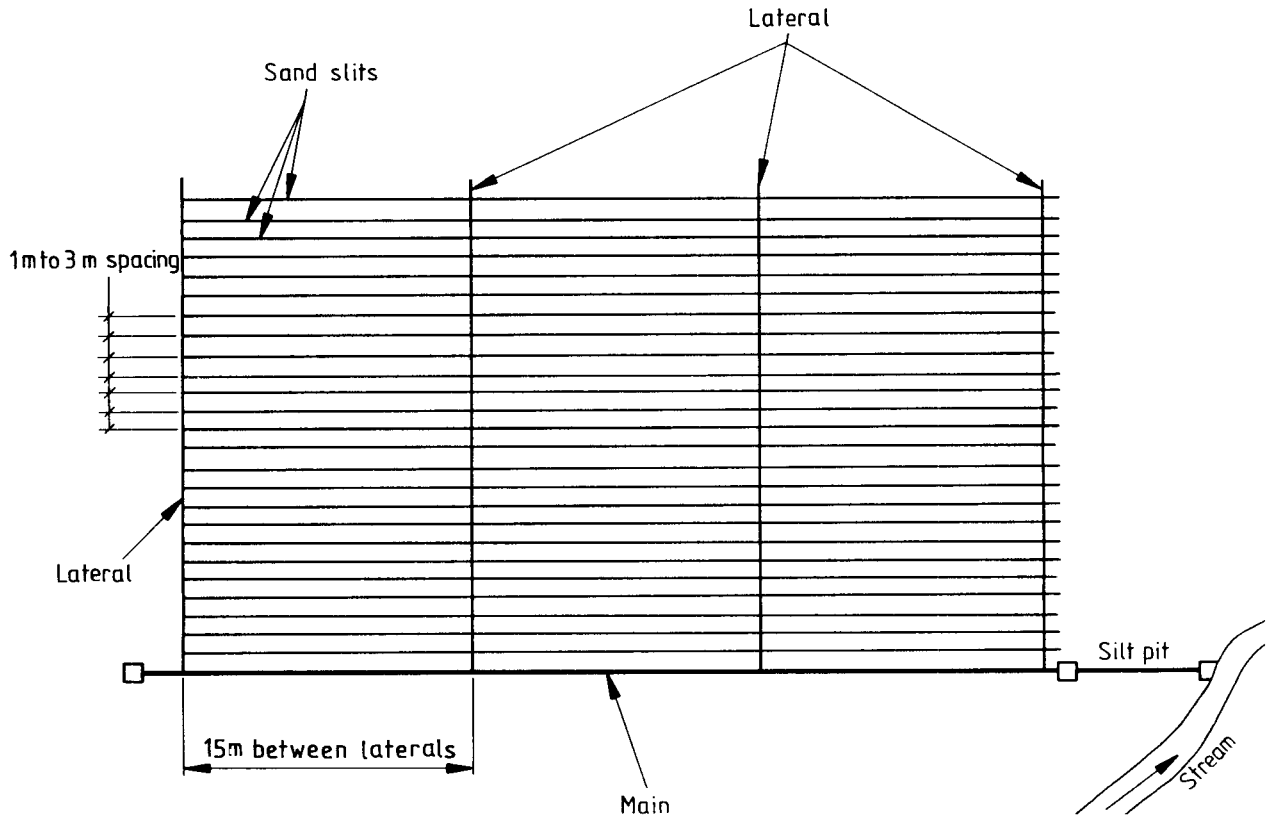
i) Topsoil over land drains should have good permeability.

NOTE For the subject of safety in trenches, reference should be made to CIRIA Report 97: Trenching practice: 1983, published by and available from the Construction Industry Research and Information Association, 6 Storey's Gate, London SW1P 3AU.



(1) (2)

(a) Typical detailed sections (not to scale).



(b) Plan

Figure 1 — Typical subsoil drainage for intensive use

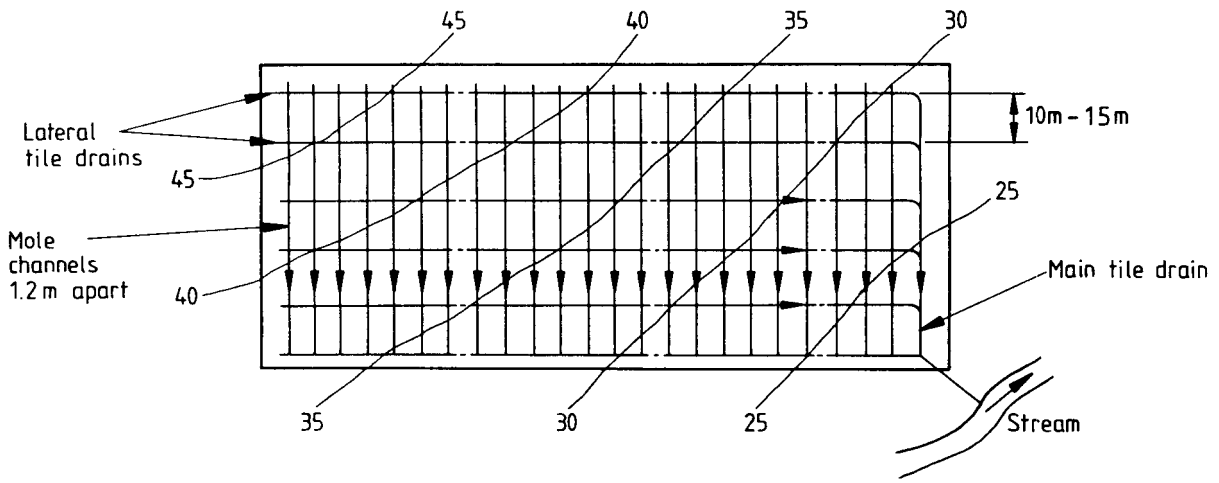


Figure 2 — Mole drains: plan

Table 1 — Relationship between soil permeability and subsoil drainage

Soil types	Soil permeability	Recommended lateral drainage	
		Distance apart of laterals m	Depth of laterals m
Clay	Nearly impervious: extremely slow	Sand slitting for topsoil drainage or mole drains may be appropriate 10 to 15	0.9 to 1.0
Silty clay/loam	Very slow	Mole drains may be appropriate 10 to 15	0.9 to 1.0
Sandy clay/clay loam	Adequate permeability	12 to 20	0.9 to 1.2
Medium loam		18 to 30	1.0 to 1.2
Fine sandy loam	Moderate	30 to 40	1.0 to 1.2
Medium sandy loam	Rapid	30 to 60	1.35 to 1.5
Chalk or large mineral particles	Rapid	Subsoil drains not needed	

NOTE 1 This table is not applicable to playing fields.
NOTE 2 For schemes that are to be supplemented by a slit drainage scheme drain spacing can be increased.
NOTE 3 Drains should only be omitted where both subsoil and topsoil are free-draining and where the water-table does not come close to the surface.
NOTE 4 Deeper drains may be needed if the water-table comes close to the surface.
NOTE 5 Drain spacings given are for guidance only and much will depend on the individual site, annual rainfall and level of use.

Section 4. Grading and cultivation

4.1 Synopsis of operations needed

Depending on circumstances, one or more of the following categories of groundworks may be necessary.

a) *Category A.* Major grading: by general excavation and filling after removal of all topsoil and subsoil (see **4.4**).

b) *Category B.* Minor grading: involving removal of topsoil and adjustments of local high and low spots within the subsoil depth (see **4.5**).

c) *Category C.* Surface cultivation, and regulating within the topsoil depth (see **4.6**).

d) Category D. Surface cultivation only (see **4.7**).

4.2 Recommended gradients

4.2.1 General

Account should be taken of the factors relating to soil and rock types and groundwater conditions when setting maximum gradients. Where there is no risk of instability and when there is freedom to design, the recommendations given in **4.2.2**, **4.2.3** and **4.2.4** should be considered.

4.2.2 Ground shaping and modelling

Sloping sides (batters) of excavation and fill areas should be formed to gradients not exceeding the following:

a) maximum gradients for hand maintenance: 1 in 1.5 (33°);

b) maximum gradients for special bank machines: 1 in 2 (27°);

c) maximum gradient for suitable tractor mounted mowers: 1 in 3 (18°).

(See also **4.2.5**.)

Plant to be used on steeply sloping ground should be designed to protect the operator in the event of overturning. Mechanical plant should only be operated parallel to the line of maximum gradient and all operators should be trained in the use of their equipment.

4.2.3 Sports fields

NOTE Subclause **4.2.3** relates to sports fields other than those for games covered by Gradients for Outdoor Sports Facilities: 1983, published by and available from the National Playing Fields Association, 25 Ovington Square SW3.

For general playing pitches a level area is not necessary, and may lead to drainage difficulties. Pitches should have falls of not less than 1 in 80 and gradients of up to 1 in 50 can be tolerated. In certain circumstances, gradients steeper than 1 in 50 may be inevitable. It should, however, be recognized that a reasonable standard of play without undue fatigue will not be possible when the gradient exceeds 1 in 40 across the pitch and 1 in 80 along the line of play.

4.2.4 General amenity areas

The setting of gradients for general amenity areas should take account of the use to which the areas will be put. Uses will include impromptu games and sedentary activities. Gentle variations in grade are recommended with adequate relatively flat areas and slopes of up to 1 in 5. Overall, amenity areas should have a natural and pleasing appearance relatively consistent with the surrounding landscape.

4.2.5 Formation of banks and slopes for ease of maintenance (see also **4.2.2**)

The top and toe of banks should be rounded. The curve to be followed should be described on a drawing and should be such that machine maintenance will be possible. (See Figure 3.)

When space does not permit slopes less than 1 in 2, consideration should be given to the following:

a) use of dwarf grasses on low nutrient topsoils;

b) whether woodland planting would be suitable;

c) whether deeper topsoil and evergreen ground cover planting would be suitable;

d) whether a vertical retaining structure would be appropriate.

A level verge should be provided between the bank edge and its boundary. The width of the verge should be related to the turning circle of maintenance equipment.

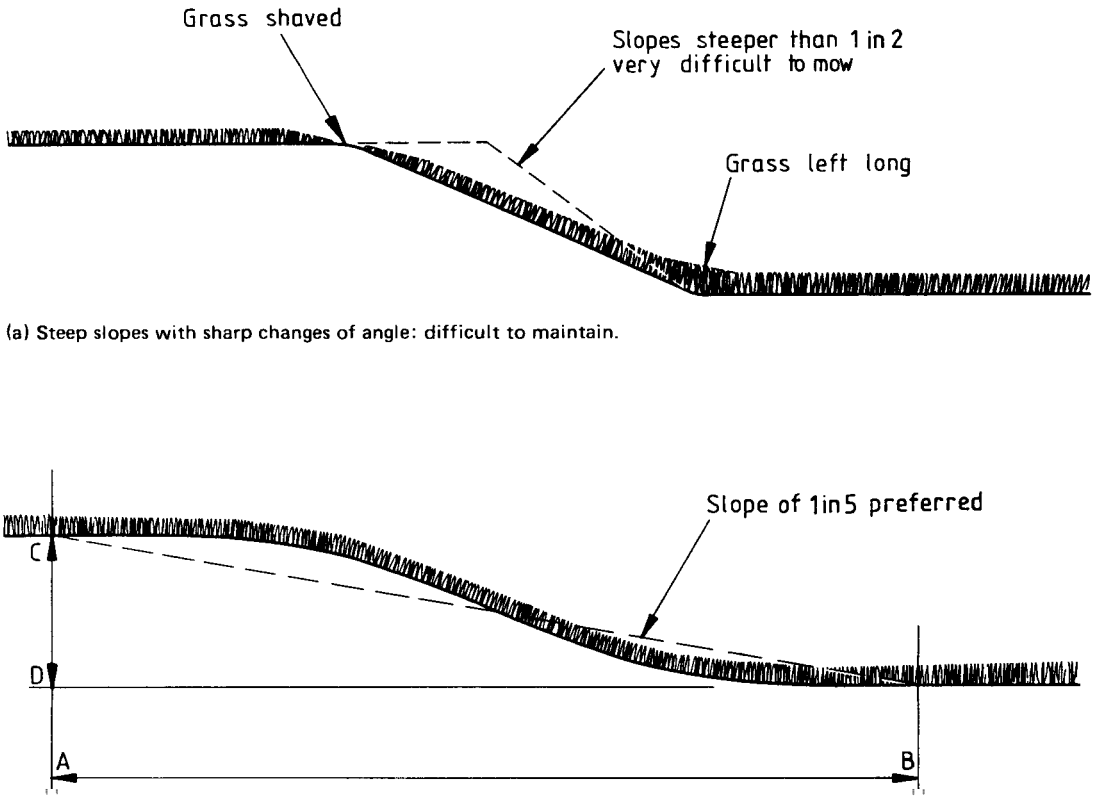
4.3 Work near trees

Reference should be made to BS 5837 if work near trees is to be carried out, in which case compaction and/or alteration of soil levels should be avoided. (See also **2.4.1**.)

4.4 Category A. Major grading

4.4.1 General

All operations carried out on steeply sloping hillsides and in areas where there are incidences of instability should be regarded as major grading.



NOTE For grades shallower than 1 in 2, AB should be less than or equal to 3.5 × CD.
b) Slack double curve: easily mown at all points.

Figure 3 — Maintenance of grass slopes

Major grading works on sloping ground may provoke instability, particularly where natural drainage characteristics are likely to be affected, and in such circumstances specialist advice should be obtained at an early stage in the design of the scheme.

NOTE For recommendations concerning major earthworks see BS 6031.

4.4.2 Spot levels and contours on drawings

Drawings for groundworks should show spot levels on a grid system as well as 500 mm contours (see also BS 1192-4); grids should be at 5 m, 10 m, 15 m, 25 m or 50 m.

4.4.3 Calculation of earthworks

In the interests of economy, quantities of earth to be moved should be calculated. This is necessary for:

a) arriving at accurate finished levels;

b) deciding, in the light of the amounts, the type of machinery to be used;

c) avoiding unnecessary removal or importation of bulk materials.

Measurements for groundworks should be calculated in the solid from the drawing; any excess or deficit of excavated material, due to bulking (see **4.4.4**), can usually be accommodated by raising or lowering the finished levels by an equal amount over the whole area, whilst maintaining the same gradients. If precise formation levels (closer than 75 mm) are needed, they should be specified accordingly.

NOTE Careful calculation in the balance of cut and fill should ensure that there is no surplus or deficit of material. It has generally been found possible to arrive at the finished levels to within 75 mm of the calculated level, but much depends upon the moisture content and consolidation of the fill.

4.4.4 Bulking

Calculations should generally be made on quantities measured in the solid excluding bulking, particularly if earth is to be moved and laid down by tractor drawn scrapers.

If earth is tipped and left to consolidate, the bulking factor could be considerable for cohesive soil dug dry, and subsequent sinkage should be taken into account. For material such as hard chalk and other rock, the volume increase should be investigated and allowed for.

4.4.5 Unsuitable materials

Specialist advice should be obtained with regard to the removal of unsuitable material and its incorporation into the scheme without resort to disposal off site.

NOTE Site investigations (see **2.1**) may have established the presence of unsuitable materials in excavation or fill areas. Specification for Highways: Department of Transport: 1986: HMSO, describes unsuitable material. Such material, if used as (or covered by) general fill, may give rise to instability.

4.4.6 Temporary drains

Temporary drains should be provided to collect excessive run-off and to prevent water entering from and into adjacent land during construction.

NOTE Recommendations for the control of ground and surface water are given in BS 6031.

4.4.7 Soil

Topsoil and subsoil should be specified by depth in situ and by volume as conserved and measured in stockpile. Where the naturally occurring volumes of topsoil and subsoil are insufficient to meet design requirements, the deficit should be made good by the separate conservation of selected soil types from general excavation.

Soil heaps should be formed (see **2.5**) in positions that facilitate eventual re-spreading, reduce travel to a minimum, and that will not result in interference with subsequent major levelling and/or grading operations.

4.4.8 Profiles for contours and finished levels

Profiles for contours and finished levels should be set out to control earthworks operations.

Before work is begun, profiles should be established showing the angles to be worked to, in order to avoid overfilling or overcutting; cuttings should be made from profiles, and banks should be formed by placing successive layers not more than 150 mm thick up to the profile line.

For bulk earthworks, profiles should normally be erected in a square pattern at 30 m intervals indicating a plane parallel to and 1.5 m above the proposed finished surface (subgrade) of general cut and fill. In areas of excavation and fill in excess of 1.5 m in depth, initial reduction or filling will be necessary before profiles can be set.

4.4.9 Earth moving equipment

The operation of earth moving machines should be governed by weather and ground conditions.

NOTE 1 In wet conditions the operation of earth moving equipment can have a deleterious effect upon soil structure and render the material unsuitable. Tracked equipment can operate on softer ground than that needed for rubber tyred plant. Earth moving equipment has been developed for use on soft soils. For the effect of compaction upon subsequent drainage, see section 3.

NOTE 2 Earth moving plant is continuously being developed and improved. Performance and output of different plant is given in the current CPA Year Book and UK Plant finder, published by and available from the Construction Plant Hire Association, 28 Eccleston Street, London SW1.

4.4.10 Compaction

Fill placed as part of major grading works, which will be more than 1 m below final ground surface, should be deposited in layers generally not exceeding 150 mm depth and should be compacted by the methodical routing of plant over each layer prior to deposition of the subsequent layer. When fill is to be placed in layers exceeding 150 mm depth, and when it is essential to minimize as far as possible the eventual settlement of fill areas, compactive effort should be applied additional to that provided by the spreading equipment.

NOTE 1 When it is intended, subsequently, to loosen the finished surfaces (subgrade) of general fill, additional compaction can be omitted from the final layers of fill to a depth equivalent to that of the proposed depth of ripping (see **4.4.15**).

NOTE 2 Information relating to compaction equipment is summarized in BS 6031. (See also Specification for Highways: Department of Transport: 1986. HMSO.)

4.4.11 Sloping sides of cuttings and embankments

The stability of banks and slopes depends on many factors and should be fully investigated following the recommendations given in BS 5930 and BS 6031. Where there is a risk of instability specialist advice should be gained before preparing the design.

It is important to consider, during the design stage, the effect of water on banks, both in cuttings and embankments; drainage is specifically referred to in section 3.

NOTE 1 Slopes at which banks should be cut or formed for ease of maintenance are recommended in **4.2.2**.

NOTE 2 The angles at which safe slopes can be cut and embankments can be formed in rock depend upon many factors relating to rock strength, structure and fracturing. Guidelines are given in BS 6031.

4.4.12 Disposal of rubbish with excavated material

The opportunity should be taken at the beginning of major grading to dispose of unwanted inorganic material at the bottom of tipping areas after the topsoil has been removed, so that a clear distance of 1 m is available on top of it after filling.

Material that will leave cavities after rotting, such as grass, leaves, roots and timber, should be excluded.

Metal containers should be flattened under the tracks of heavy machinery and large objects should be cut up.

Stones, slabs, rocks and hardcore should be placed so that voids are not formed.

The use of household refuse in tipped areas should be the subject of a separate study, and is not dealt with in this code of practice (see also **2.1.1**).

4.4.13 Rock

If the presence of rock is suspected from trial holes and/or from geological maps, it will be necessary to determine:

a) whether normal earth moving machinery can cut without rippers;

b) what type of additional rippers may be needed;

c) if explosives and/or compressors will be needed.

NOTE The need to place rock in fillings without creating voids is referred to in **4.4.12**.

When explosives are employed to loosen rock, they should be used only by competent personnel trained in their use and under the supervision of an authorized experienced engineer. All explosives should be stored and controlled in accordance with Home Office requirements and those of the Explosives Act 1875, the Factories Act 1961 and the Health and Safety at Work etc. Act 1974. The local authority and the crime prevention officer of the local police should also be notified.

4.4.14 Preparation of subgrade

After completion of general excavation and filling to subgrade levels, and prior to the replacement of subsoil and topsoil, areas should be graded with a rigid blade grader to true, flowing contours. The degree of acceptable accuracy at subgrade level (determined by boning rods or straight edge as applicable) will depend upon the intended use of the land, but in all cases the prepared surfaces should be free of localized depressions that might give rise to the ponding of water.

For general grassed areas, the maximum limit of deviation from planned gradient or given levels should be ± 150 mm. The maximum permitted deviation when tested by placing boning rods 30 m apart should be ± 100 mm. (Plus or minus indicates total permitted error up or down from a plane.)

These limits should not apply when final grass surfaces abut buildings, kerbs or any other hard surfaces; nor should they include for ruts, local hollows, trench sinkages, or for lumps, holes left after stone picking, and the grading of ridges. These items should be made good as appropriate by re-levelling, and rolling if necessary, prior to the spreading of subsoil.

Depending upon the soil texture and degree of compaction, the subgrade should be loosened with a ripper attachment equipped with a minimum of three tines spaced at intervals of not greater than 1.2 m. Straight tines may be used for light scarifying up to 150 mm in depth, but for greater depths and where thorough disturbance of the surface is required, tines should be fitted with heavy duty winged shanks. In order to minimize the possibility of waterlogging or erosion, and to ensure maximum shatter of the subgrade, ripping should be carried out in dry conditions and in at least two directions set obliquely across the slope of the ground.

Large stones brought to the surface by operations should be picked off and disposed of at a depth of at least 1 m below final levels. The depth of ripping and the size of stone to be removed will depend upon the eventual use of the land and subsequent operations such as the installation of drainage. Ripping depths and stone sizes should be specified, and it should also be stated whether all stones above the given dimension within the specified depth are to be removed, or whether removal of such stones is limited to a surface pick only. When constant supervision is not intended, the proposed method of testing should be given.

In circumstances where the subgrade consists mainly of chalk, deep ripping to bring up large blocks of materials and flints should be avoided, but the surface should be lightly scarified to avoid forming a pan, and to promote drainage. This should also apply in cases where the subgrade in areas of excavation is in rock and where the surface layers of fill have been constructed using material containing a high proportion of rock.

4.4.15 Preparation of formation

Following completion of operations at subgrade level, subsoil from designated stockpiles should be replaced in an even layer of specified depth and graded to even, running contours. In specifying the depth and, if necessary, the method of placing subsoil, drainage should be considered (see section 3).

The finished surface (formation) of subsoil so replaced should be prepared free of localized depressions and to a maximum permitted deviation of ± 100 mm from planned gradients or given levels. The maximum permitted deviation when tested by placing boning rods 30 m apart should be ± 50 mm. (See **4.4.14** for cases when these acceptable levels of deviation do not apply.)

Prior to the replacement of topsoil, subsoil should be ripped to full depth or as otherwise needed, and should be picked free of stones, as recommended in **4.4.14**.

NOTE 1 For light, non-cohesive subsoil placed over chalk or rock, or in cases where ripping of the subgrade has not been specified, ripping of subsoil may be adequate to 300 mm depth with spacings up to 600 mm centres.
NOTE 2 For well-compacted and cohesive subsoil material, ripping to full depth with heavy duty winged shanks may be necessary.

Additional penetration of between 50 mm and 100 mm into the underlying subgrade is recommended as a means of eradicating any panning of the subgrade caused by earth moving vehicles during subsoil replacement operations. In cases where the subgrade consists mainly of chalk or rock, penetration into the subgrade should be avoided.

4.5 Category B. Minor grading

4.5.1 Profiles

Profiles should be set up at selected points across the site, preferably to a grid pattern. Boning rods should then be used to establish the extent of high and low spots and to determine the volumes of each.

4.5.2 Topsoil

Topsoil to be set aside for future use should be cultivated as recommended in **4.7** until it is in a condition to be removed.

Topsoil should be stripped and stored (see **2.5**) from all areas that cannot be treated as described in **4.6** and **4.7**, and should be set aside for eventual respreading.

4.5.3 Subsoil

The depth of subsoil on high spots should be gauged by investigations, as the cover in such areas may be as little as 150 mm to 250 mm.

Following the removal of topsoil, the area should be regulated to true running contours by blade grading within the subsoil depth. High areas should be reduced and the resultant material should be used to fill the low areas. It may be necessary to remove subsoil completely from localized areas where the depth of excavation would result in only a minimal retained subsoil cover of less than 100 mm. Subsoil so removed should be set aside temporarily and should be respread over the area following regulation of levels within the general underlying material.

4.5.4 Respreading of topsoil

Topsoil previously set aside should be respread evenly over stripped areas (see **4.8.2**).

4.5.5 Subsoiling

Subsoiling should be carried out, if necessary, as described in **4.7**.

4.5.6 Grading and cultivating

The area should be graded and cultivated as described in **4.6**.

4.6 Category C. Surface cultivation, and regulating within the topsoil depth

4.6.1 General

The depth of topsoil on high places should be gauged by investigations; cover can be as little as 75 mm to 100 mm and minor grading is not practicable unless 150 mm of topsoil or more is available. Hollows should preferably be filled with "imported" topsoil.

4.6.2 Methods of work

The topsoil should be cultivated as recommended in **4.7**. The resultant soil condition should be such that the particles are small and dry enough (from dust to about 10 mm) to run freely with a blade grader.

Areas in excess of 0.2 ha should be graded with one of the following types of rigid blade grader, adjustable for tilt, pitch and angle:

a) grader trailed or hydraulically controlled from wheeled or crawler tractors;

b) motor road grader[3)], fixed unit;

c) earth levelling blade to wheeled tractor, rear mounted.

4.7 Category D. Surface cultivation only

4.7.1 General

Land that is to be maintained by mowing machinery should be surface graded either by hand raking or by graders. When the surface is to be left rough and not mown the methods of work given in **4.7.2** to **4.7.7** should still be considered. Unwanted trees and scrub should be dug out.

4.7.2 Thick sward

Where land is covered with a thick sward the soil should be broken up to the full depth of the topsoil.

NOTE The use of total non-residual herbicides may be considered prior to cultivation.

4.7.3 Hard ground

Hard ground should be broken up with a ripper operated in transverse directions; the same implement will expose large roots and boulders, which should be removed from the site.

[3)] Information on motor graders is given in the CPA Year Book and UK Plant Finder.

4.7.4 Impeded drainage

When there is evidence of impeded drainage, subsoiling should be considered.

NOTE It is normally most economical to draw the subsoiler at centres equal to twice the depth of cultivation, e.g. at 1.2 m centres to a depth of 600 mm.

4.7.5 Disc ploughing or rotary or fixed tine cultivation

Land treated as in **4.7.2**, **4.7.3** and **4.7.4** should be treated by disc plough or rotary or fixed tine cultivator, provided that the implement is capable of reaching the full depth of topsoil.

4.7.6 Woody roots

Where trees and scrub have been cleared, woody roots within the cultivated depth should be brought to the surface and should be removed from the site.

4.7.7 Vegetable matter and large stones

Tufts of grass and other vegetable matter should be raked out and removed or burned. Large stones (75 mm and over) should be removed from the site.

4.8 Topsoil

4.8.1 General

Topsoil should comply with BS 3882.

4.8.2 Spreading

Topsoil should be handled carefully during spreading to avoid damage to structure by machine induced compaction. Replacement of topsoil should not be carried out in wet conditions.

Topsoil should be spread evenly in layers not exceeding 150 mm thick. Finished thicknesses should be as follows (see also Figure 4):

a) grass areas: 100 mm to 150 mm, according to use, after firming;

b) shrub areas: 400 mm minimum after firming;

c) tree areas: 600 mm minimum after firming.

4.8.3 Stored topsoil

Poor storage can lead to a loss of the “crumb” structure, usually as a result of compaction of wet topsoil when put into store, loss of aeration, water logging and anaerobic decay of organic matter. This state can be partly rectified by adding organic matter such as a manure, peat, compost, or proprietary soil ameliorants, and should be minimized by moving the material only in dry conditions and with appropriate machinery so as to avoid compaction.

If material to improve the soil structure and texture is used, it should be applied before the last cultivations prior to seeding.

Tests should be undertaken on samples of topsoil after respreading to assess the extent of any nutrient deficiencies and the need for any subsequent addition of fertilizers.

4.8.4 Cultivation of topsoil

After spreading, the topsoil should be cultivated to a condition suitable for blade grading. Large and unwanted material (75 mm and over) should be picked off and removed.

4.8.5 Shrub beds and tree pits

When shrub beds and tree pits occur in large grass areas, formation levels should be prepared at the specified depth for grass over the whole area. Further excavation should be subsequently carried out to the additional depth for shrub and tree planting.

In all cases, when excavation is necessary to obtain adequate depth for shrub beds and tree pits, existing topsoil that is suitable for re-use should be kept separate from subsoil and other excavated material.

4.9 Fallow period

If possible, and where the potential danger of erosion by wind and water is not a consideration, topsoil areas should be cleaned by allowing them to lie fallow for a period of several months, preferably in late spring or summer.

During this period weeds should not be allowed to seed, and growing weeds should be eliminated by cultivation or chemical control as appropriate.

NOTE Despite the difficulty of programming, the provision of a fallow period in landscape work is one of the simplest and most effective ways of increasing the success of establishment and the ease of economy of maintenance in subsequent planting. With the efficiency of modern broad spectrum non-residual herbicides, soil cleaning can be achieved at relatively low cost.

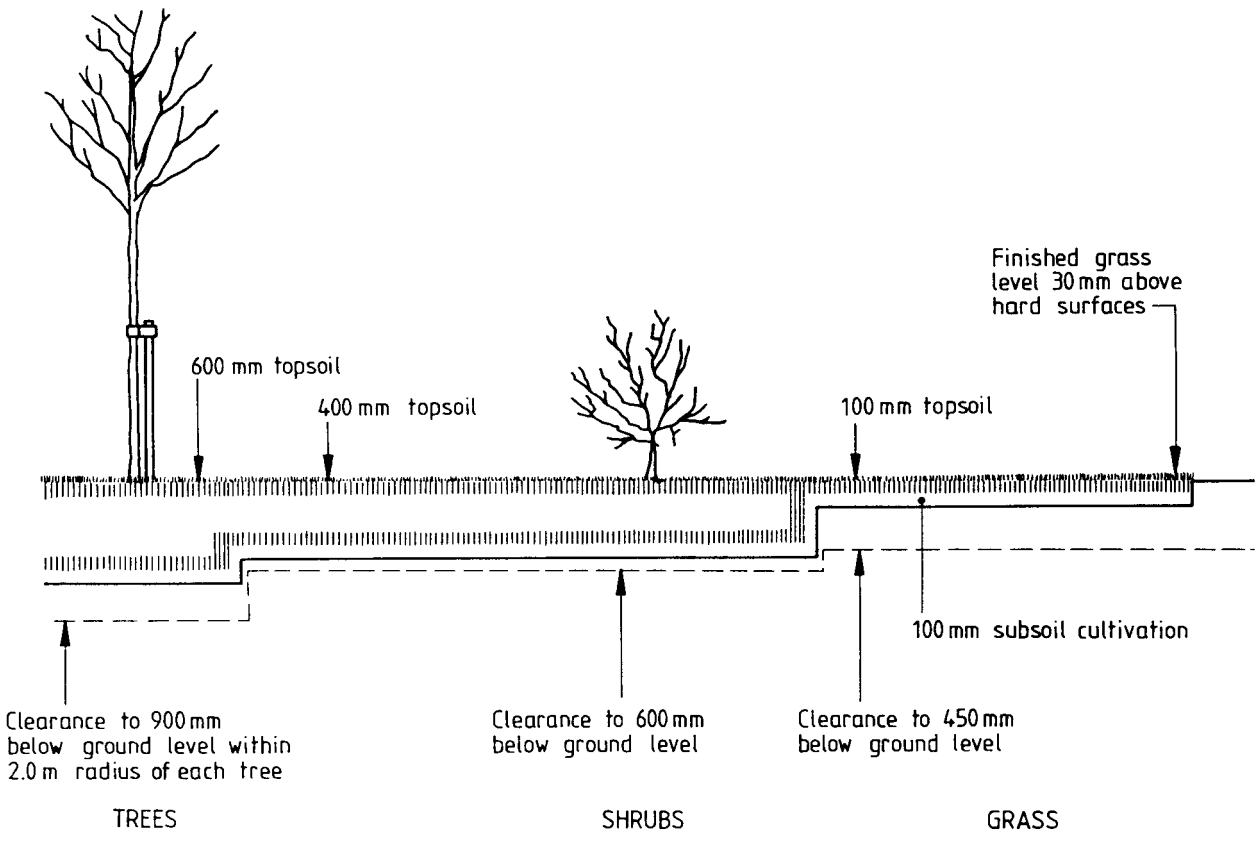


Figure 4 — Groundworks for planting and grassing

Section 5. Seeding of grass areas[4)]

5.1 Seed

Grass species and varieties should be selected according to the soil type, climate and the intended wear and mowing needs of the area[5)].

When a high quality sward is required, grass cultivars and varieties that are tolerant of regular mowing below 10 mm should be chosen.

NOTE Study of the varietal merit ratings last issued annually by the Sports Turf Research Institute will help to identify the cultivars most suitable for the intended use of the area.

Grass seed is sold in a variety of qualities: for landscape work "certified seed" should be used. When specifying such seed the word "certified" should be used in the description of each component of the seed mix, e.g. "Certified Kent Wild White Clover".

Certified seed and seed mixes are sold in containers having a blue label: "Certified" quality seed should reach prescribed standards of purity and germination as set out in the Fodder Plant Seed Regulations 1985 (SI 975) and the Seeds (National List of Varieties) Regulations 1982 (Sl 844).

5.2 Fertilizing

If found necessary after soil analysis, an appropriate preseeding fertilizer having a relatively high phosphate analysis should be applied to stimulate root growth.

NOTE Fertilizer formulae are defined by reference to EEC analysis, which is stated on the fertilizer container and is set out as a ratio of the nutrient content as a percentage of nitrogen (N): phosphate (P_2O_5): potash (K_2O). Phosphate is usually divided into the soluble form (quickly available to plants) and the insoluble form (slowly available to plants). High phosphate fertilizers for landscape work, available in 25 kg bags, are as follows:

N	P_2O_5	K_2O
6:	9:	6
17:	11:	7
8:	12:	8
10:	15:	10

Fertilizer should be applied at a rate of 300 kg to 600 kg per hectare, dependent upon local conditions.

5.3 Preparation of seed bed

In preparation for sowing, the surface should be cultivated to remove compaction and should be contoured to true running levels. The surface should be lightly and uniformly firmed and reduced to a friable tilth by raking or harrowing. All surface stones from 10 mm to 50 mm in any dimension, dependent on the mowing height required, should be removed from the surface.

5.4 Turf edging to seeded areas

In areas where initial appearance is important, turves should be laid to provide a neat edge to seeded lawns. After initial preparation of the seed bed a 750 mm margin should be raked back and one row of turves laid end to end. The level of the seed bed should be married into the turf and turves should be selected to match the mixture of the grasses being sown. Turves should not be allowed to dry out before they become established and supplementary watering may be necessary.

5.5 Sowing

NOTE The time for sowing varies according to area and soil conditions, but most satisfactory conditions are when temperature and rainfall are at their best levels for the majority of seed varieties. A specialized seed sowing machine will ensure higher establishment rates and will also ensure accurate and economical seed distribution.

Sowing should be carried out during suitable calm weather conditions at a rate of between 15 g/m^2 to 30 g/m^2 for small areas and fine lawns, depending upon the mixture selected and the period of establishment time, and at a rate of 100 kg/h to 200 kg/h for the machine seeding of large areas.

The operation should be carried out in equal sowings in transverse directions.

After sowing, the ground should be lightly raked or harrowed and should then be firmed with a lightweight roller.

5.6 Sowing on steep banks

NOTE On steep banks and other mechanically inaccessible areas, hydraulic mulched seeding techniques can be used where seed is applied in a solution by machine.

Erosion should be controlled by bitumen emulsion, latex, the use of geotextile sheets, reinforcement netting or grass reinforcement techniques using concrete or plastics hollow blocks.

[4)] The maintenance of grass areas is to be covered in a British Standard concerning recommendations for grounds maintenance, which is in course of preparation.

[5)] See Turfgrass Seed, published annually by and available from the Sports Turf Research Institute, Bingley, West Yorkshire BD16 1AU.

5.7 Herbicide in young swards

Annual weed should be eradicated by mowing, but more serious weed infestations should be treated with a recommended selective herbicide, following the manufacturer's recommendations.

5.8 Initial cut

Immediately before cutting, all stones above 25 mm in any dimension should be hand picked and the area should be crossed with a lightweight roller to firm the grass and consolidate the surface.

When the grass is established and from 40 mm to 75 mm high, according to the seed mixture, it should be topped with a rotary mower so as to leave from 25 mm to 50 mm of growth and to cut weeds, in order to control the growth of coarser grass and to encourage tillering.

A mowing programme should be organized that gradually reduces the height of the grass.

Grass cutting machinery should be very sharp and in good condition to avoid pulling out young seedlings.

When cutting takes place without a box all arisings should be spread evenly to prevent damage to the growing grass beneath. This applies particularly to grass cut during periods of dull or wet weather.

Section 6. Turfing

6.1 Turf

Turves should be in accordance with the recommendations given in BS 3969 and should be composed of grass varieties or cultivars suitable for the intended use of the area to be laid.

6.2 Final preparation

The surface of the ground to receive turves should be lightly and uniformly firmed and contoured to true running levels. The area should be raked to a fine tilth 25 mm in depth and all stones above 25 mm in any dimension should be removed. A dressing of fertilizer as recommended in **5.2** should be incorporated.

6.3 Turf laying

6.3.1 General

Turf should be laid when the weather is suitable and soil conditions are moist. When possible preference should be given to autumn and spring operations. Turf should not be laid during periods of drought or when frost is in the ground.

6.3.2 Delivery and stacking

Supplies of turves should be delivered at appropriate intervals throughout the work in order to avoid as far as possible stacking turves for long periods.

Turves should be stacked to a maximum height of 1.4 m on cleared ground and should be inspected daily; they should be moved regularly to prevent knitting and deterioration, and should be watered if and when necessary. Turves that show signs of deterioration should be used without delay or should be laid out.

6.3.3 Laying

Turves from the stack should be wheeled to the laying area over planks butted together. Adequate timber planks should be used to support persons and loaded barrows.

The turves should be laid on the prepared soil bed, working from planks set over previously laid turves, and should be firmed into position in consecutive rows with broken joints (as in stretcher bond brickwork) closely butted and to correct levels; turf edges and margins should be laid with whole turves (see Figure 5). The use of half bond is not essential. As work progresses a dressing of finely sifted top soil or fine peat may need to be worked into any gaps in the joints, still working from the planks. Any inequalities in finished levels should be adjusted as work progresses by raking out and/or packing fine soil under the turf.

The finished level of the turf should conform to the needed levels, allowing for final settlement.

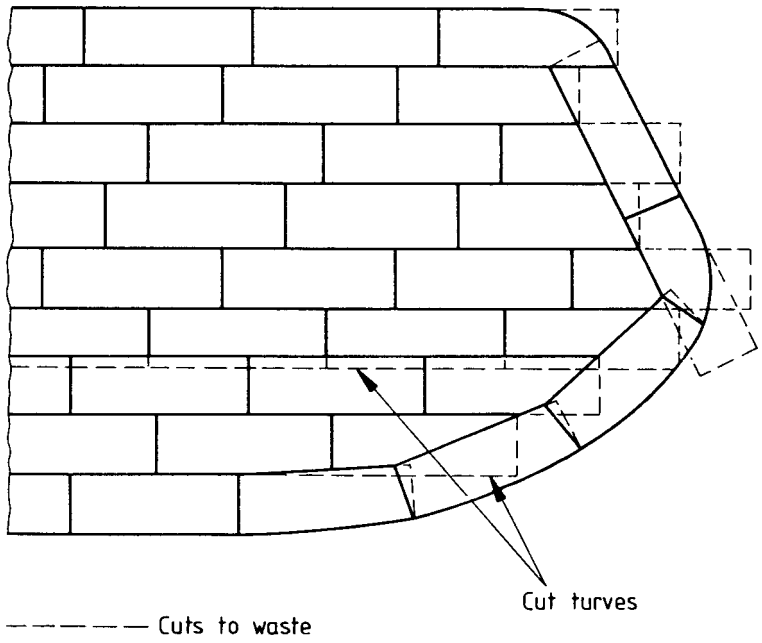


Figure 5 — Turf laying: flexible use of stretcher bond, whilst maintaining whole turves around perimeter

6.4 Turfing to banks exceeding 30°

6.4.1 General

Soil stability may be a problem when turfing banks with a gradient exceeding 30° (1 in 1.75). Information concerning drainage, the construction of such banks and grading, is given in sections 3 and 4. Topsoiling or turfing should not be undertaken until the bank has been satisfactorily graded and any necessary cut-off drains have been completed.

6.4.2 Turf

Turves should comply with BS 3969. It is particularly important that turves to be used on banks should be sufficiently fibrous to withstand difficult handling conditions.

6.4.3 Season

Turfing to banks should preferably be carried out during the autumn or early winter. The spring should normally be avoided because of the harmful effects of prolonged dry weather and drying winds at that time of year.

6.4.4 Formation level

Normal preparation of the formation level should be omitted if it is likely to result in subsoil slipping down the slope. However, to assist in retaining topsoil on the slope, prevent water running down the impervious surface and encourage the penetration of stabilizing root growth, it is essential that the smooth, polished surfaces produced by excavation in certain soils should be loosened.

6.4.5 Topsoiling

A 75 mm to 100 mm layer of topsoil should be sufficient. On slopes where there are practical difficulties in retaining topsoil because of the gradient, topsoil should be spread in narrow strips across the bank, starting from the bottom, and laying two or three rows of turves before proceeding with the next strip.

6.4.6 Turf laying

Sufficient timber planks and ladders should be used to ensure safe and efficient working. The turves can be laid diagonally or horizontally. They should be laid to stretcher bond pattern, butt jointed, firmed and secured by stout wooden pegs 200 mm in length or by 4 mm galvanized wire pins, bent or hairpin pattern, at least 200 mm long. When necessary the turves should be lightly and evenly firmed with wooden beaters. The top of the beaters should be frequently scraped to clean off accumulated soil or mud. Finely sifted topsoil should be worked well into the joints.

On very steep banks or where stability is a major problem, netting should be laid over the turf and should be pegged down. Where necessary, the wire netting should be reinforced at the top and bottom, and intermediately, with stout wire cable threaded through the mesh.

6.5 Watering

Watering should be carried out with sprinklers, perforated hose pipes or oscillating sprays to avoid washing soil out of the joints. It is essential that turves should not be allowed to dry out, and that water penetrates into the underlying topsoil. If shrinkage occurs any open joints should be filled with fine topsoil or compost brushed in and subsequently well watered. Special care is needed on banks.

Section 7. Amenity tree planting

7.1 Planting stock

All plant material should comply with the minimum requirements of BS 3936-1 and BS 3936-4; also with BS 5236 and BS 4043.

7.2 Trees in relation to construction

Reference should be made to BS 5837 for recommendations concerning trees in relation to construction.

7.3 Site preparation

The subsoil and topsoil should have a good physical structure, be friable, retentive of moisture, and well drained. On sites where this is lacking, or the ground is heavily compacted, cultivation over the whole area should be undertaken.

NOTE Cultivation may include deep soil cultivation and draining, followed by short-term grassing or the establishment of herbaceous cover, and the delay of tree planting for at least one growing season.

A 1 m minimum diameter weed free spot should be provided around the tree planting area.

7.4 Planting season

Deciduous tree planting should normally be carried out in the dormant season. Evergreen trees, which should be planted when the ground is warm enough to encourage rapid root activity — in early autumn or late spring, may need wind protection.

NOTE 1 Planting may be carried out at other periods, of specially prepared subjects; either container grown material or material that has been lifted in season and has been balled and wrapped and kept on the surface plunged in wood shavings, sand, peat or other suitable material.

All subjects moved in warm weather should be subjected to overhead spraying with water and should be mulched and shaded.

NOTE 2 See **9.4** for recommendations concerning ground and weather conditions.

NOTE 3 For root balled trees see BS 4043.

7.5 Plant handling[6)]

Trees should be supplied packaged in accordance with the recommendations of BS 3936. If planting is not carried out immediately after delivery, balled and container plants should be placed close together and the ball or container should be covered with sand or moist peat to prevent drying out and freezing. Bare rooted plants should have any wrapping removed and should be firmly heeled in by placing and spreading the roots in a prepared trench and by covering them with peat or topsoil.

7.6 Tree pits

Excavations for tree pits should be at least twice the diameter of the root spread, and 1.5 times the depth of the roots of the stock to be planted. The bottom and sides of the hole should be forked to break up the subsoil.

Excavated subsoil should be removed from the site and should be replaced with topsoil, planting compost or other suitable growing medium.

7.7 Staking[7)]

7.7.1 General

Newly planted trees over 1.5 m high should be held so that movement at the root collar is minimized until new roots have developed to anchor the tree. In some instances smaller trees may also need staking. The size of tree and the conditions on site will determine the design and strength of the artificial anchorage needed. However, as trees supported along the length of their stem may develop an imbalance in the crown weight and stem strength, stakes and ties generally should be designed to have a useful life of only two years, after which they should be removed.

7.7.2 Methods

For most trees and locations a single stake and one tie should provide adequate anchorage (see Figure 6 and Figure 7). "Tall Standard" trees (see BS 3936-1), and root-balled trees (see BS 4043), may need two stakes and a tie from each stake to the tree; or two stakes, a crossbar and a tie; in order to hold the root collar steady (see Figure 8).

Single stakes, which should generally be on the windward side of a tree, should be driven into the ground vertically, although on hillsides a slanting stake may need to be installed on the higher side (see Figure 9).

6) See also Plant Handling: 1985, published by the Committee of Plant Supply and Establishment and available from the Horticultural Trades Association, 19 High Street, Theale, Reading Berkshire.

7) See also Tree Staking: Research Note 40/87/ARB: published by and available from the Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey.

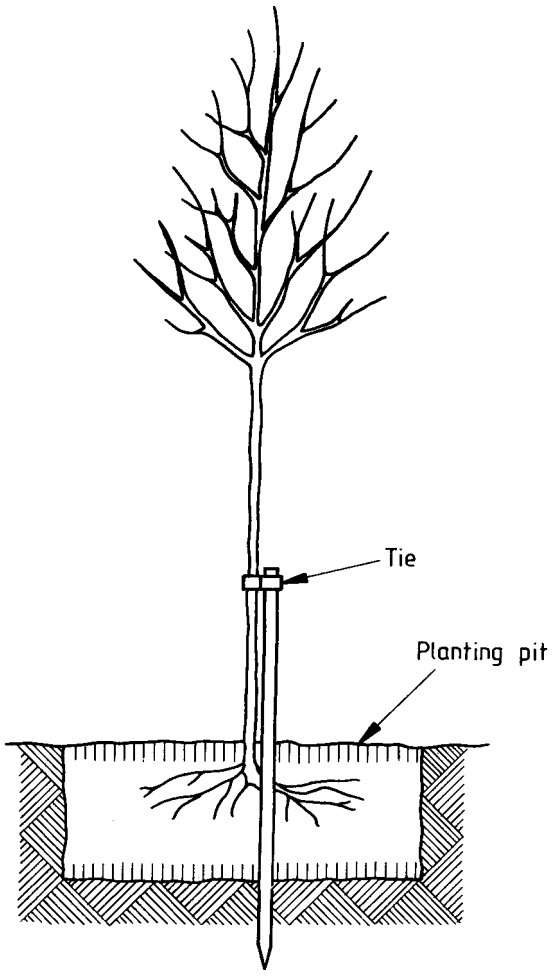


Figure 6 — Tree staking and tying

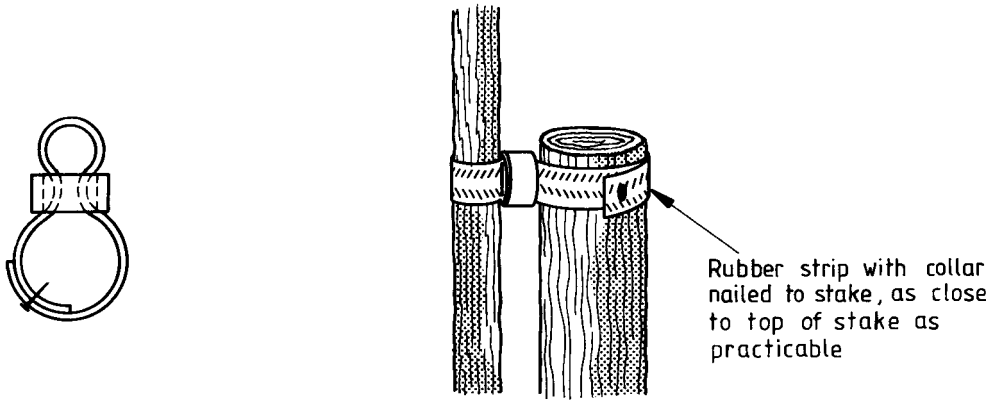


Figure 7 — Example of tree tie

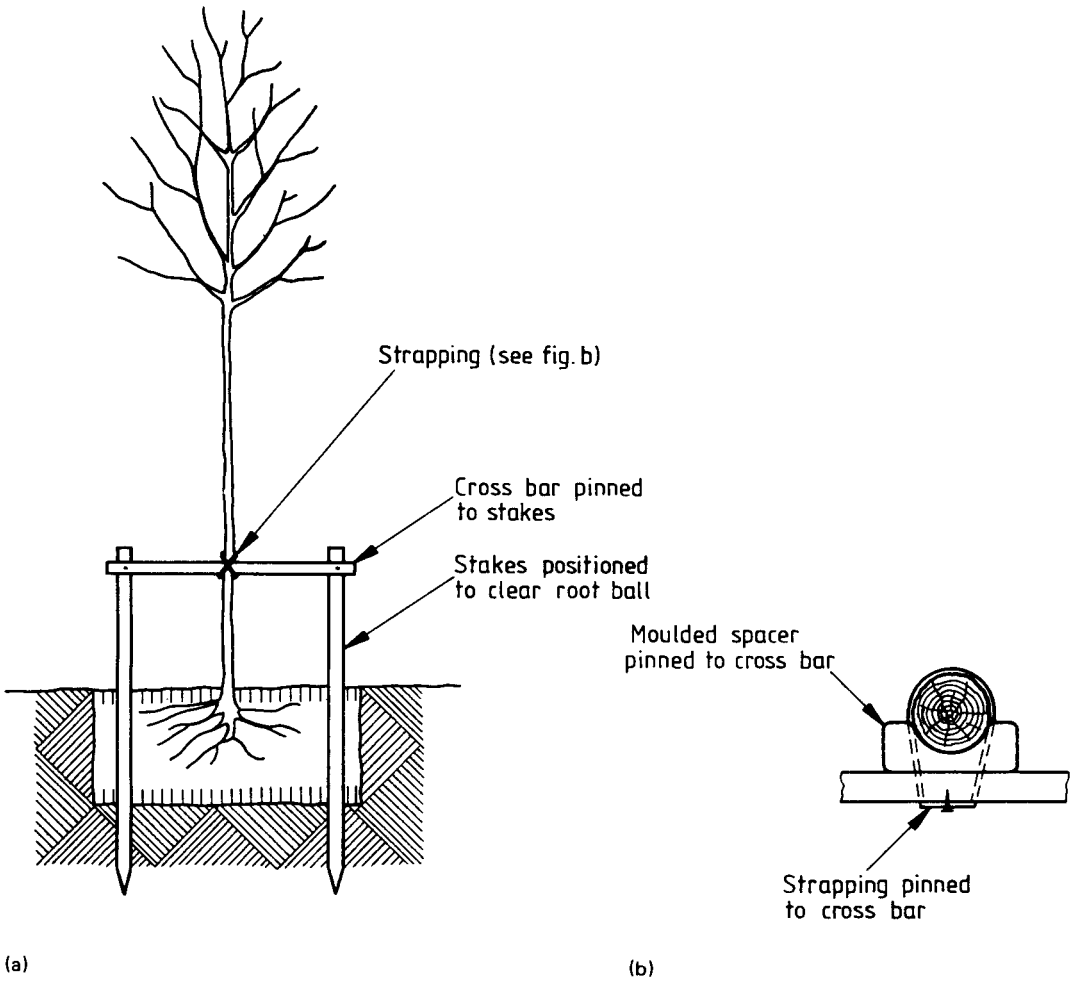


Figure 8 — Double staking suitable for trees for advanced nursery stock

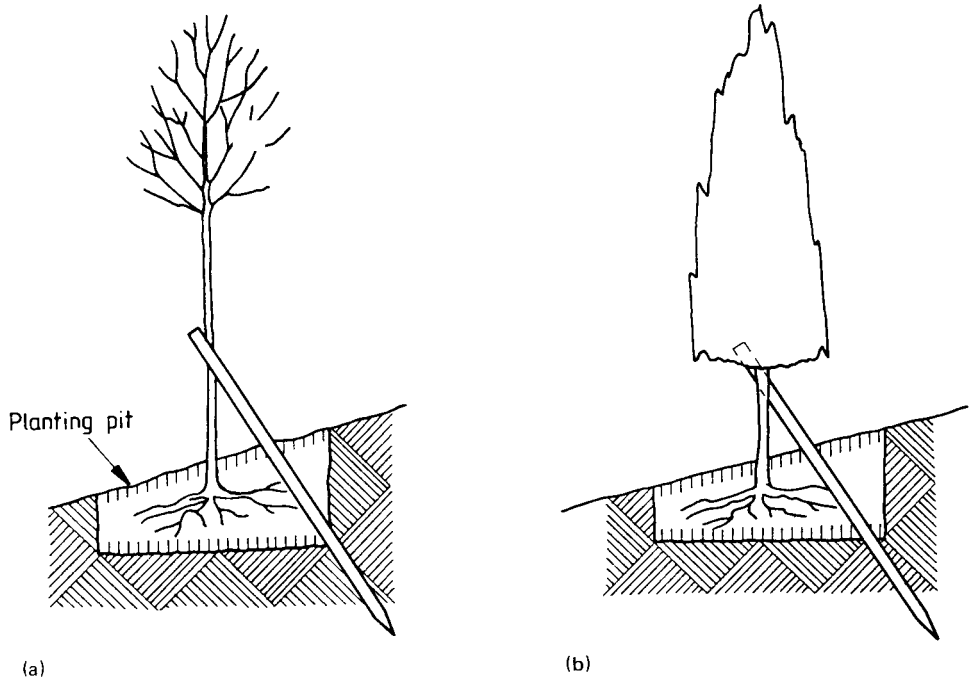


Figure 9 — Slanting stakes for hillsides or exposed situations

7.8 Planting

It is most important to plant trees at the original root collar soil depth. The soil mark on the stem is an indication of this and it should be maintained on the finished level, allowing for settling of the soil after planting.

Compost in containers should be moist before planting and before containers are removed. Any broken or damaged roots should be cut back to sound growth; heavily coiled roots on container grown plants should be eased from the root ball or cut. Bare roots should be spread evenly in the planting pit; a small mound in the centre of the pit on which the roots are placed will aid an even spread.

During back filling around the tree the soil should be lightly firmed to ensure close contact with the roots; with large material successive layers of soil need to be firmed as back filling proceeds. Firming should be such as to ensure that the roots will be held secure in the soil and that the penetration of moisture will not be restricted.

7.9 Tying

Each tree should be secured to the stake so as to prevent excessive movement. Abrasion should be avoided by using a buffer of rubber or plastics between the tree and the stake. The tree should be secured at the top of the stake; normally one tie should be used but this will depend on the size of the tree. Ties should be checked after severe gales and at least twice a year, and should be adjusted or replaced to allow for growth. They should be removed as soon as anchorage has been achieved.

7.10 Aftercare

7.10.1 Firming after frost or wind

If the roots of newly planted trees are loosened the soil should be refirmed as soon as possible to exclude air pockets from around the roots.

7.10.2 Weed control

Weeds and grass compete for moisture and nutrients and should be eliminated until the plants are well established, usually at least 2 years. A minimum space of 1 m diameter around each tree should be weed free.

7.10.3 Mulching

Mulcher, used to conserve soil moisture and to minimize weed growth, should consist of either sheet or granular materials such as ultra-violet stabilized polythene sheeting or bitumen felt, or 75 mm minimum of pea gravel or ground bark. Mulches should only be applied when the soil is moist.

7.10.4 Watering

During the growing season newly planted trees and shrubs should be watered to ensure that the soil is kept constantly moist, although this will vary with local climates and soil types.

7.10.5 Protection

For new tree planting, protection against damage from browsing, bark stripping and trampling is essential to secure satisfactory establishment.

NOTE 1 Transplants can be protected with a tree shelter, a translucent tube usually 1.2 m tall, that provides protection against browsing, together with increased growth rates due to the improved micro-climate within the tube.

NOTE 2 For small groups of trees or individual trees, individual protecting methods[8)] can be introduced. Trees 900 mm in height and above can be protected against damage by rabbits by the use of a spiral guard.

NOTE 3 See **8.6** for recommendations concerning the aftercare of trees.

[8)] See Arboricultural Leaflet No. 10: Individual Tree Protection: 1985, published by and available from the Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey.

Section 8. Woodland planting[9)]

8.1 Planting stock

8.1.1 General

Trees for woodland planting should comply with BS 3936-4, which should be regarded as a minimum standard.

NOTE Plants with stem diameter larger than the standard given in BS 3936-4 may be suitable for use on reclamation sites. Plants 150 mm to 250 mm tall are likely to be suitable on exposed sites or on ploughed ground, and plants up to 900 mm tall may be successful on sheltered fertile sites.

8.1.2 Replant disease

Some difficulty may be experienced if replanting with the same or related species in old planted areas and professional advice should be sought.

8.2 Preparation for planting on existing or former woodland sites

8.2.1 Weeds

Herbaceous and grassy weeds form strong competition to newly planted trees and although complete clearance is not necessary or desirable, a 1 m minimum diameter weed free area should be provided around the tree planting station.

8.2.2 Unwanted woody growth

NOTE Coppice growth and natural regeneration are frequently important features that, with careful management, provide a continuity and succession within a woodland.

There are occasions when coppice growth and natural regeneration are unwanted because of competition with new plantings, or for other reasons, and they should then be controlled by manual or chemical means. It is unnecessary to grub out their roots, except when plantations are susceptible to honey fungus *(Armillaria)*.

8.2.3 Retention of trees

Trees retained to provide overhead or side cover should have good form and balanced crowns.

NOTE Single trees that are thriving, shapely but immature can be retained to silvicultural and visual advantage. Groups of trees, saplings or shrub cover, whilst sometimes composed of plants of little individual merit, frequently provide amenity, screening and wildlife cover.

8.2.4 Cultivation

Freely drained soils with adequate humus will not normally need cultivation on underplanted or clear felled sites. Some ripping, subsoiling or scarifying should be carried out, if necessary, on iron pan or podsolized topsoil and subsoil.

8.2.5 Drainage

Existing open drains should be repaired and new ones should be provided in waterlogged areas, when necessary. The contents of drains should be discharged close to, but not directly into, watercourses in order to allow filtration of silt and prevent acid build-up.

8.3 Site preparation on new planting sites

8.3.1 Vegetation

Grassy and herbaceous vegetation should be treated as recommended in **8.2.1** unless the site is to be cultivated; heather may need to be burnt off.

8.3.2 Cultivation

Afforestation sites should normally be ploughed and cultivated, to achieve successful establishment.

Ploughing should be carried out, usually in summer for planting during the following winter, using equipment and techniques recommended by the Forestry Commission[10)]. Alternatively, scraping by hand should be undertaken for smaller areas on mineral soils, or for turfing on peat soils. Forestry plough furrows should be kept 10 m to 20 m short of watercourses.

NOTE Subsoil ripping is usually desirable to remove machine induced compaction when planting on reclaimed land.

8.3.3 Drainage

Drainage is necessary if ploughing has taken place or if there is standing water; it is also necessary in peaty soils, soils of poor permeability (gleys), and on reclamation sites. Cut off drains should be provided to intercept water flowing on to the site. The depth, spacing and gradient of the drains should be in accordance with the recommendations of the Forestry Commission[11)]. Drains can be cut by hand, plough or excavator, but should not be allowed to discharge water directly into a watercourse.

[9)] See also Bulletin No. 14: Forestry Practice: 1986, published by and available from the Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey.

[10)] See Forest Record No. 73: Ploughing Practice in the Forestry Commission: 1970, published by and available from the Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey.

[11)] See Forest Record No. 72, Forest Drainage Schemes: 1979, published by and available from the Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey.

8.4 Planting

8.4.1 Plant handling

Plant handling should be carried out following the recommendations of "Plant Handling", 1985[12)].

8.4.2 Time of planting

Planting should be carried out when the trees are dormant.

Bare rooted stock should not be planted in the late spring, even if flushing has been delayed by cold storage, unless the weather is very wet and the plants are still dormant.

NOTE The best time to plant broadleaved trees is in the autumn during mild, damp weather. Spring planting can be successful and is more usual for conifers on exposed sites, but if it becomes delayed or coincides with a prolonged dry spell losses can be very high.

8.4.3 Spacing

The choice of spacing adopted should depend on the objective to be achieved, the cost of establishment and the methods of controlling weed growth in the establishment phase.

NOTE Normal forestry planting is currently carried out at 2.1 m × 2.1 m or 2 000 plants/ha (a range between 1.8 m to 2.4 m spacing is acceptable). Some species, e.g. poplar, prefer a wider spacing. When an understory is being planted with trees, the trees may be at a wider spacing, with the understory at very close spacing. When tree shelters are being used very wide spacing may be appropriate.

8.4.4 Planting direct into uncultivated ground

When planting direct into uncultivated ground, L-, T-, H- shaped or straight notches should be used and special spades are available for this purpose. Mattocks should be used on hard, stony soil, while special spades are available for deep peat soils. The notch should be vertical and deep enough for the roots to hang freely, the tree being planted so that the root collar is exactly level with the ground surface. The notch should then be closed and the soil should be well firmed round the roots.

The soil should be checked and firmed again in the spring if frost lift has occurred.

8.4.5 Planting on ploughed or turfed ground

Notch planting should normally be employed on ploughed or turfed ground. In the case of ploughed ground, the trees should be planted on the side of the plough ridge away from the furrow.

8.5 Protection

For large blocks of new planting, fencing (see Table 6 of BS 1722-2:1973) against rabbits, stock and deer is, if well maintained, the most cost effective and satisfactory form of protection, as an alternative to individual tree protection. (See also **7.10.5**.)

8.6 Aftercare

8.6.1 Regular maintenance

Regular maintenance during the first five years after planting is essential, to help the survival of the plants and to increase growth and vigour. Aftercare should include annual weed control, attention to protection from animals, pruning and replacement of failures.

8.6.2 Weed control

Weeding should be carried out to help newly planted trees to survive and to grow well.

An area of 1 m diameter should be kept weed free around each tree. Weeding may be carried out by manual or chemical means (see **8.6.4**) or by mulching (see **7.10.3**).

The basis of good weed control should be achieved before planting, as a good weed kill at this time will reduce the problems later when the plants have become established. Usually, weeding should be undertaken at least once in the spring when weed growth is at its most vigorous.

NOTE Site inspections are the only reliable indicator of when weeding is needed.

8.6.3 Hook weeding and mechanical cutting

Hook weeding or mechanical cutting should be carried out to prevent trees being over-topped or heavily shaded by weed growth.

8.6.4 Herbicides

Herbicides, which are the most cost effective method of weed control, should be applied strictly in accordance with the manufacturer's instructions and the Food and Environment Protection Act 1985. Great care should be taken since chemicals lethal to broadleaved weeds are equally lethal to trees. Using herbicide, strip weeding along a line or spot weeding around a tree should be undertaken.

8.7 Fertilizers

Fertilizers are not necessary on most soils as nutrient deficiencies are unlikely. When planting on peaty moorlands or on heaths, a phosphate fertilizer will benefit growth.

[12)] See Plant Handling: 1985, published by the Committee for Plant Supply and Establishment, and available from The Horticultural Trades Association, 19 High Street, Theale, Reading, Berkshire.

Section 9. Planting of shrubs, herbaceous plants and bulbs

9.1 Nursery stock[13)]

All shrubs, hedging plants, climbers, herbaceous plants and bulbs should comply with BS 3936 where applicable, should be of reasonable size and shape and in healthy conditions, and should follow the general quality and packaging requirements of BS 3936.

Arrangements should be made with the supplier to prevent delivery of unprotected plants to site at a time when nobody is present to receive them.

Planting should be carried out as soon as possible after reaching site. When planting has of necessity been delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be heeled-in as soon as received or otherwise protected from drying out, and others should be set closely together and protected from the wind. The "laying out" of bare root stock to check spacing is deprecated.

If planting is to be delayed, packaged plants should be unpacked, the bundles should be opened up and each group of plants should be heeled-in separately, kept moist and should be clearly labelled.

9.2 Site preparation

Site preparation should be carried out following the recommendations of **4.7**.

9.3 Planting season

Most deciduous shrubs grown in open ground should only be moved in the dormant period. Evergreens and herbaceous plants should be planted in early autumn or late spring.

NOTE 1 Herbaceous plants can be moved throughout the winter provided that the soil is in a workable condition.
NOTE 2 Container grown plants can be planted during the growing season; however, they will then need regular watering and maintenance.

9.4 Ground and weather conditions

9.4.1 Frost

Planting is best avoided in frozen ground conditions, but such conditions need not necessarily prevent planting if the roots are not actually frozen, and if frozen ground or snow is not dug in. Frozen soil and snow should be set aside and replaced on top after planting.

9.4.2 Water

Planting should not be carried out in waterlogged soil.

9.4.3 Wind

Special care should be taken to protect roots of plants from drying out when planted in windy conditions.

When planting of conifers and evergreen shrubs is to be carried out in periods of persistent wind, especially north or east winds, consideration should be given to the provision of temporary protection as a wind break, to prevent the foliage drying out before the roots have time to make new growth.

NOTE Wind can be more dangerous to newly planted subjects than frost.

9.4.4 Dry weather

All plants should be firmed and watered if they are planted in dry weather.

9.5 Containers and wrappings

Containers and wrappings should be removed.

9.6 Roots

Badly damaged roots should be carefully pruned. Special care should be taken to ensure that the roots of container grown plants are loosened and spread out.

9.7 Planting of shrubs (except climbers and wall shrubs)

9.7.1 Topsoil

Shrubs should be planted in a minimum depth of 400 mm of topsoil (see **4.8**).

9.7.2 Planting

Planting holes should be about 150 mm wider than the root spread. The shrubs should be set in the holes so that the soil level, after settlement, will be at the original root collar level on the stem of the shrub.

The holes should be backfilled to half their depth and should be firmed by treading. The remainder of the topsoil should then be returned and again firmed by treading.

9.7.3 Grass areas

When planting shrubs in grass the turf should be destroyed by manual, mechanical or chemical means over a diameter of 1 m, or over an area 150 mm wider than the root spread.

9.7.4 Ground cover

Plants for ground cover should have canes and ties carefully removed, and the stems should be pegged out.

[13)] See also Plant Handling: 1985, published by the Committee for Plant Supply and Establishment, and available from the Horticultural Trades Association, 19 High Street, Theale, Reading, Berkshire.

9.7.5 Cutting back and pruning

Cutting back or pruning may be necessary for some shrubs on planting.

9.8 Planting of climbers and wall shrubs

9.8.1 Construction of supports

Unless climbers and wall shrubs are of a self-clinging variety needing only temporary support, some form of permanent support should be constructed before planting is attempted. For example, a wall should be wired or have trellis fixed to it.

Walls should be covered by fixing plastics coated steel wires of at least 18 s.w.g., set horizontally not less than 12 mm clear of the wall, 0.6 m from the ground and 0.3 m apart to a height and width as needed, and at 2 m centres set vertically.

Trellis should be fixed to timber battens or spacing pieces screwed into plugs set in the wall, and should be set so that it will be not less than 12 mm clear of the wall.

9.8.2 Planting

Pits should be excavated at least 300 mm wider than the root spread, and should be 500 mm deep.

When the plants are to be grown against a wall, the pit should be backfilled with good quality humus-rich topsoil, to assist water retention.

The plants should be planted so that the old root collars will be level with the top of the soil after firming, and should be well watered after planting. Plants should be at least 300 mm out from the wall, with the roots spread away from the wall.

9.8.3 Fixing to supports

Branches should be secured firmly with flexible ties to wire or trellis; any superfluous branches can be removed. When plants on canes are too young to reach the wire or trellis when planted, or when the plants are of a self-clinging variety, the canes should be retained. In the case of larger plants, the canes should be removed and the branches should be fanned out and secured separately to the supporting wires or trellis.

9.9 Herbaceous plants

It is essential that herbaceous plants should be planted in a clean and well cultivated topsoil (see **4.8**).

9.10 Bulbs

Bulbs and corms should be treated with carbendazim before storage and should be planted in the appropriate season with a trowel or planting tool of appropriate pattern and at a depth approximately 3 × the bulb diameter. The holes formed should be slightly larger than the bulbs or corms, which should have their bases in contact with the topsoil at the bottom of the holes. In fine turf a plug of turf should be neatly removed and replaced after planting.

9.11 Hedges and screens

9.11.1 Preparation

Shrubs for hedges and screens should be notch planted (see **8.4.4**) or trench planted. Hedge trenches should be a minimum of 400 mm deep, a minimum of 400 mm wide for single rows, and from 600 mm to 750 mm wide for double rows, depending on factors such as shrub size and species, and soil conditions.

The ground should be well prepared incorporating organic material according to soil needs.

9.11.2 Supports

Softer plants should be supported when young, e.g. by a low post and wire fence. Staggered rows should be planted on either side of the fence.

9.11.3 Cutting back and pruning

After planting, certain quick growing species such as privet or thorn should be cut back hard to within 150 mm to 200 mm of the ground to encourage bushy growth from the base. Some other plants, however, such as beech, hornbeam, most evergreens and conifers, should not have the leading shoot cut until it reaches the desired height.

9.12 Completion

On completion, the ground should be forked over and should be left tidy.

9.13 Protection

Protection from prevailing winds on exposed sites, for example by plastics wind breaks or low hessian screens, should be provided to assist hedges and screens to become established. This is particularly necessary for conifers and evergreens.

Protection by more substantial fencing should be provided as necessary to prevent damage from browsing, bark stripping and trampling, and to secure satisfactory establishment of shrubs, which may also need individual rabbit guards.

NOTE Fencing of large blocks (see Table 6 of BS 1722-2:1973) against rabbits, stock and deer is the most cost effective and satisfactory form of protection, if well maintained, as an alternative to individual tree protection.

9.14 Aftercare

9.14.1 Regular maintenance

Regular maintenance during the first five years after planting is essential to help the survival of the plants and to increase growth and vigour. After care should include annual weed control, attention to protection from animals, pruning, and replacement of failures.

If the roots of newly planted shrubs are loosened after frost or wind, the soil should be refirmed as soon as possible to exclude air pockets from around the roots.

9.14.2 Weed control

Weeds and grass compete for moisture and nutrients and should be eliminated, to permit newly planted shrubs to survive and to become well established, for a period of at least 2 years. A minimum space of 1 m diameter around each plant should be kept weed free.

Weeding should be carried out by manual or chemical means (see **8.6.4**) or by mulching (see **9.14.3**).

The basis of good weed control should be achieved before planting, as a good weed killer at this time will reduce the problems later when the plants have become established. Usually, weeding should be undertaken at least once in the spring when weed growth is at its most vigorous.

NOTE Site inspections are the only reliable indicator of when weeding is needed.

Herbicides, which are the most cost effective method of weed control, should be applied strictly in accordance with the manufacturer's instructions and the Food and Environment Protection Act 1985. Great care should be taken since chemicals lethal to broadleaved weeds are equally lethal to trees. Using herbicide, strip weeding along a line or spot weeding around a shrub should be undertaken.

9.14.3 Mulching

Mulching can be used to conserve soil moisture and to minimize weed growth. Mulches should consist of either sheet material such as ultra-violet stabilized polythene sheeting, ground bark, or organic material. Mulches should only be applied when the soil is moist.

9.14.4 Watering

During the growing season newly planted shrubs should be watered to ensure that the soil is kept constantly moist, although this will vary with local climates and soil types.

9.14.5 Fertilizers

Fertilizers are not necessary on most soils as nutrient deficiencies are unlikely. When planting on peaty moorlands or on heaths, a phosphate fertilizer will benefit growth.

Publications referred to

BS 1192, *Construction drawing practice.*

BS 1192-4, *Recommendations for landscape drawings.*

BS 1377, *Methods of test for soils for civil engineering purposes.*

BS 1722, *Fences.*

BS 1722-2, *Woven wire fences.*

BS 1722-4, *Specification for cleft chestnut pale fences.*

BS 2468, *Glossary of terms relating to agricultural machinery and implements.*

BS 3882, *Recommendations and classification for topsoil.*

BS 3936, *Nursery stock.*

BS 3936-1, *Specification for trees and shrubs.*

BS 3936-4, *Specification for forest trees.*

BS 3969, *Recommendations for turf for general landscape purposes.*

BS 3998, *Recommendations for tree work.*

BS 4043, *Recommendations for transplanting semi-mature trees.*

BS 5236, *Recommendations for cultivation and planting of trees in the advanced nursery stock category.*

BS 5837, *Code of practice for trees in relation to construction.*

BS 5930, *Code of practice for site investigations.*

BS 6031, *Code of practice for earthworks.*

BS 6100, *Glossary of building and civil engineering terms.*

BS 8301, *Code of practice for building drainage.*

BS XXXX, *Recommendations for grounds maintenance*[14)].

BS XXXX-3, *Maintenance of amenity and functional turf (other than sports turf).*

DD 175, *Code of practice for the identification of potentially contaminated land and its investigation.*

Ancient Monument and Archaeological Areas Act 1979: HMSO.

CPA Year Book and UK Plant Finder, published by and available from the Construction Plant Hire Association, 28 Eccleston Street, London SW1.

Fodder Plant Seed Regulations 1985: S.I. 975. HMSO.

Food and Environment Protection Act: 1986. HMSO.

Forestry Commission publications, available from the Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey, as follows:

Arboricultural Leaflet No. 10: Individual Tree Protection: 1985.

Bulletin No. 14: Forestry Practice: 1986.

Forest Record No. 72: Forest Drainage Schemes: 1979.

Forest Record No. 73: Ploughing Practice in the Forestry Commission: 1970.

Research Note 40/87/ARB: Tree Staking.

Gradients for Outdoor Sports Facilities: 1983. Published by and available from the National Playing Fields Association, 25 Ovington Square, London SW3.

Plant Handling: 1985. Published by the Committee for Plant Supply and Establishment, and available from the Horticultural Trades Association, 19 High Street, Theale, Reading, Berkshire.

Practice Note 3: Building near Trees: 1985. Published by and available from the National House-Building Council, Chilton Avenue, Amersham, Bucks HP6 5AP.

Reference Book 345: The Design of Field Drainage Pipe Systems: 1983. Published by and available from the Ministry of Agriculture, Fisheries and Food Agricultural Development and Advisory Service Land and Water Service. HMSO.

Seeds (National List of Varieties) Regulations 1982: S.I. 844. HMSO.

[14)] In preparation.

Specification for Highways: Department of Transport: 1986. HMSO.

Sports Ground Construction/Specification: 1975. Published by and available from the National Playing Fields Association, 25 Ovington Square, London SW3, and the Sports Turf Research Institute, Bingley, West Yorkshire, BD16 1AU.

Technical Note on Workmanship and Materials for Field Drainage Schemes: 1983. Published by and available from the Ministry of Agriculture, Fisheries and Food Publications Unit, Lion House, Willowburn Estate, Alnwick, Northumberland.

Trenching Practice: CIRIA Report No. 97: 1983. Published by and available from the Construction Industry Research and Information Association, 6 Storey's Gate, London SW1P 3AU.

Turfgrass Seed. Published annually by and available from the Sports Turf Research Institute, Bingley, West Yorkshire BD16 1AU.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL