

BS 8545:2014



BSI Standards Publication

Trees: from nursery to independence in the landscape – Recommendations

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 28 February 2014. It was prepared by Technical Committee B/213, *Trees and tree work*. A list of organizations represented on this committee can be obtained on request to its secretary.

Information about this document

BS 8545 is a new British Standard and is intended to assist people involved in planning, designing, resourcing, producing, planting and managing new trees in the landscape.

The purpose of this standard is to explain how new trees can be successfully grown and planted so that they flourish in the landscape without excessive maintenance. The standard promotes the principle that successful new tree planting relies on the integration of careful design, nursery production and planting site management, into one continuous process. All parts of the process are important and need careful consideration if new trees are to successfully achieve independence in the landscape.

The large amounts of research and anecdotal evidence on good practice throughout the breadth of preparing, planting and maintaining new trees, make it impossible to comprehensively list all that information within this standard. Instead, the standard seeks to distil the best of that information into discrete recommendations that summarize the process. It is structured so that users can access an overview of all parts of the process quickly and easily through the flowcharts and the body text. This is supplemented by more detailed discussion in the annexes, which is supported by technical referencing of relevant scientific research. The intention is for users to be able to easily identify the clauses that are relevant to their needs and, if necessary, then drill down into more detail in the annexes, and follow that up with accessible research references, if even more explanation is required.

The standard does not seek to be prescriptive or to provide a simple solution to cover all eventualities, recognizing that there is no single route to achieve its ends; but rather traces a series of good practice options, providing guidance and enabling an optimal route to be planned, defined by individual site constraints. It is for those involved in the process of achieving independence for young trees in the landscape to decide on which of the options outlined in the body of this standard are appropriate to their own requirements. These options will be conditioned by design and strategic intentions, individual site constraints and requirements, nursery availability and quality of tree stock, budget size and maintenance schedules.

This standard recognizes that each site is different, and its successful use depends on the depth and integrity of individual site assessment. Additionally, it recognizes that there is a wide range of experience, credentials and local knowledge of individual users, which could affect how recommendations are implemented. For example, local knowledge of, and familiarity with, the site conditions (as with the retrofitting of street trees) could dispense with the need for detailed site investigations. Conversely, designers working at a new location would clearly need detailed investigations to fill in the gaps in their knowledge and inform the decision-making process.

In most situations, a great diversity of information needs to be accumulated to inform the decision-making process, which requires skill, knowledge and experience to transform ideas on paper into successful results on the ground. This is an intellectual process that involves weighing the accumulated information to arrive at a balanced decision that has properly and fully accounted for all the relevant influencing factors. This process is technically difficult and intellectually challenging, but is absolutely necessary to consistently successfully deliver new trees that are independent in the landscape.

This standard recognizes that the word “establishment” can be taken as meaning the tree is present and alive, but those physical characteristics have very little bearing on whether the tree will survive and flourish. Indeed, trees can stay alive for decades, but remain moribund and make no significant contribution to the landscape. An obvious objective of all new planting is to reach the position as quickly as possible where a tree is healthy and has every prospect of achieving its full potential to deliver the benefits it was planted for, without any excessive or abnormal management input. It is for this reason that the phrase “independence in the landscape” is preferred in this standard to the word “establishment”.

Use of this document

This British Standard takes the form of guidance and recommendations. It should not be quoted as if it was a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

It has been a widely recognized fact that a significant proportion of newly planted trees fail to survive to maturity. The *Trees in towns II* report [1] commissioned by the Department of Communities and Local Government highlighted that as much as 25% of all planting undertaken in the public sector actually fails. Although there has not been any comparable survey undertaken in the private sector, anecdotal evidence indicates that the failure rates are similar.

It is difficult to pinpoint the reason why the failure rate of new planting is so high, but one contributory factor is the present disjointed approach to production and planting. This standard seeks to define all the parts of the process as a continuous and joined-up sequence, rather than isolated parts that have no tangible connections.

An important objective of this standard is to assist practitioners in making balanced and informed tree planting decisions. Ideally, all newly planted trees need to be able to grow with vigour appropriate to the species and situation, in good health, and with minimal nuisance to achieve the desired planting objectives.

The standard sets out good practice in strategic and policy formation and then follows the whole transplanting process through to independence in the landscape, under the following clause headings:

- policy and strategy;
- site evaluation and constraints assessment;
- species selection;
- nursery production and procurement;
- handling and storage;
- planting;
- post-planting management and maintenance.

These clause headings are intended to be considered consecutively as illustrated in the flowchart in Figure 1 (see Clause 4). This flowchart cascades down to a separate flowchart for each of the separate clause headings (see Clause 5 to Clause 11). Each of these individual flowcharts is immediately followed by a series of recommendations relating to that particular subject. Each clause is cross-referenced to a series of annexes which explores each subject in greater depth, with figures and tables to add further clarification.

Each clause in this standard can be read independently from the others, but the combined clauses outline a process which is continuous. The whole process is only as strong as its weakest link; every part of the process needs to be given equal weight.

1 Scope

This British Standard gives recommendations for transplanting young trees successfully from the nursery, through to achieving their eventual independence in the landscape, specifically covering the issues of planning, design, production, planting and management.

This British Standard applies to trees where a distinct crown has been prepared in the nursery. It does not apply to whips, transplants and seedlings, or to other woody material.

NOTE Although this standard does not give specific recommendations for other woody material, many of its provisions can be applied to such material, e.g. to shrubs.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 3998, *Tree work – Recommendations*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 backfill medium

material used for refilling an excavated planting hole

3.2 bare root tree

tree grown using bare root nursery production system (3.16.1)

3.3 bulk density

<of soil> ratio of dry soil mass to bulk soil volume, including pore spaces

NOTE Bulk density is also known as “soil density” or “dry density”.

3.4 cavitation

break in the continuity of water columns in the xylem and hence the water supply to transpiring leaves

NOTE Cavitation is usually caused by extreme soil/weather conditions, such as drought or freezing, when the tension of water within the xylem becomes so great that dissolved air within the water expands to fill either the vessel elements or the tracheids.

3.5 clonal selection

process of selecting an individual parent plant with required attributes to create a single genotype that, through vegetative propagation, can be used to create genetically identical progeny

3.6 containerized tree

tree grown using containerizing nursery production system (3.16.2)

3.7 container-grown tree

tree grown using container-growing nursery production system (3.16.3)

3.8 decurrent tree

tree exhibiting natural growth habit characterized by strong lateral or branch dominance that eventually produces a rounded or spreading tree crown

3.9 excurrent tree

tree exhibiting natural growth habit characterized by strong apical dominance that eventually produces an upright crown form dominated by one or a few central leading shoots

3.10 field capacity

maximum amount of water a soil can hold after free drainage has occurred

3.11 formative pruning

crown pruning when a tree is young or early mature with the objective of producing a tree which in maturity will be free from any major physical weaknesses and which will complement the management objectives for the site

3.12 independence in the landscape

point at which a newly planted tree is no longer reliant on excessive or abnormal management intervention in order to grow and flourish with realistic prospects of achieving its full potential to contribute to the landscape

3.13 landscape character

pattern of elements in a landscape that makes one landscape different from another

3.14 leaf fluorescence

measure of photosynthetic efficiency that indicates plant vitality

3.15 nursery pruning

pruning on the nursery to produce well-balanced crown formation, straight leader and subordinated lateral branches while retaining the photosynthetic integrity of the young tree during its development

3.16 nursery production systems**3.16.1 bare root production system**

nursery stock process whereby trees are planted and grown on in open land or fields and lifted with the root system free of soil

NOTE This is also known as "open ground".

3.16.2 containerizing production system

nursery stock process whereby trees grown in open ground are lifted and potted up into containers

3.16.3 container-growing production system

nursery stock process whereby trees spend all or most of their time in the nursery in containers

3.16.4 rootball production system

nursery stock process whereby trees are undercut or transplanted and lifted with a soil ball wrapped in hessian or other breathable material and secured with non-galvanized wire netting

3.17 root circling

debilitating spiralling action of roots over time in a restricted root ball or container that, if not rectified by pruning, will lead to root girdling

NOTE Trees with circled roots are often referred to as "pot-bound" or "root-bound".

3.18 root girdling

spiralling of roots on planted trees at or below ground level

NOTE Girdling is caused by the failure to prune out root circling in the nursery or at the time of planting that might strangle the tree and ultimately result in instability or even failure.

3.19 root flare

thickened and expanded base of a tree stem at ground level from which buttress roots form

NOTE This is also referred to as “stem flare” or “trunk flare”.

3.20 root shank

portion of root tissue on a young tree's stem above the adventitious root flare

NOTE Adventitious root flare is the area in which adventitious roots occur out of sequence from the more usual root formation of branches of a primary root system, usually after primary root pruning and the loss of natural laterals has occurred in nursery production.

3.21 rootballed tree

tree grown using rootball nursery production system (3.16.4)

3.22 soil biota

all the organisms that spend a significant portion of their life cycle within a soil profile, or at the soil–litter interface

NOTE For example, earthworms, nematodes, protozoa, fungi, bacteria and different arthropods.

3.23 stem taper

decrease in diameter of a tree's stem from the base upwards

3.24 structural soil

medium that can be compacted to pavement design and installation requirements yet permits root growth

3.25 tree pit

excavated hole of adequate dimensions to accommodate the root system of a specified tree

3.26 tree population

group of individual trees growing in a defined area at the same time

3.27 underground cellular system

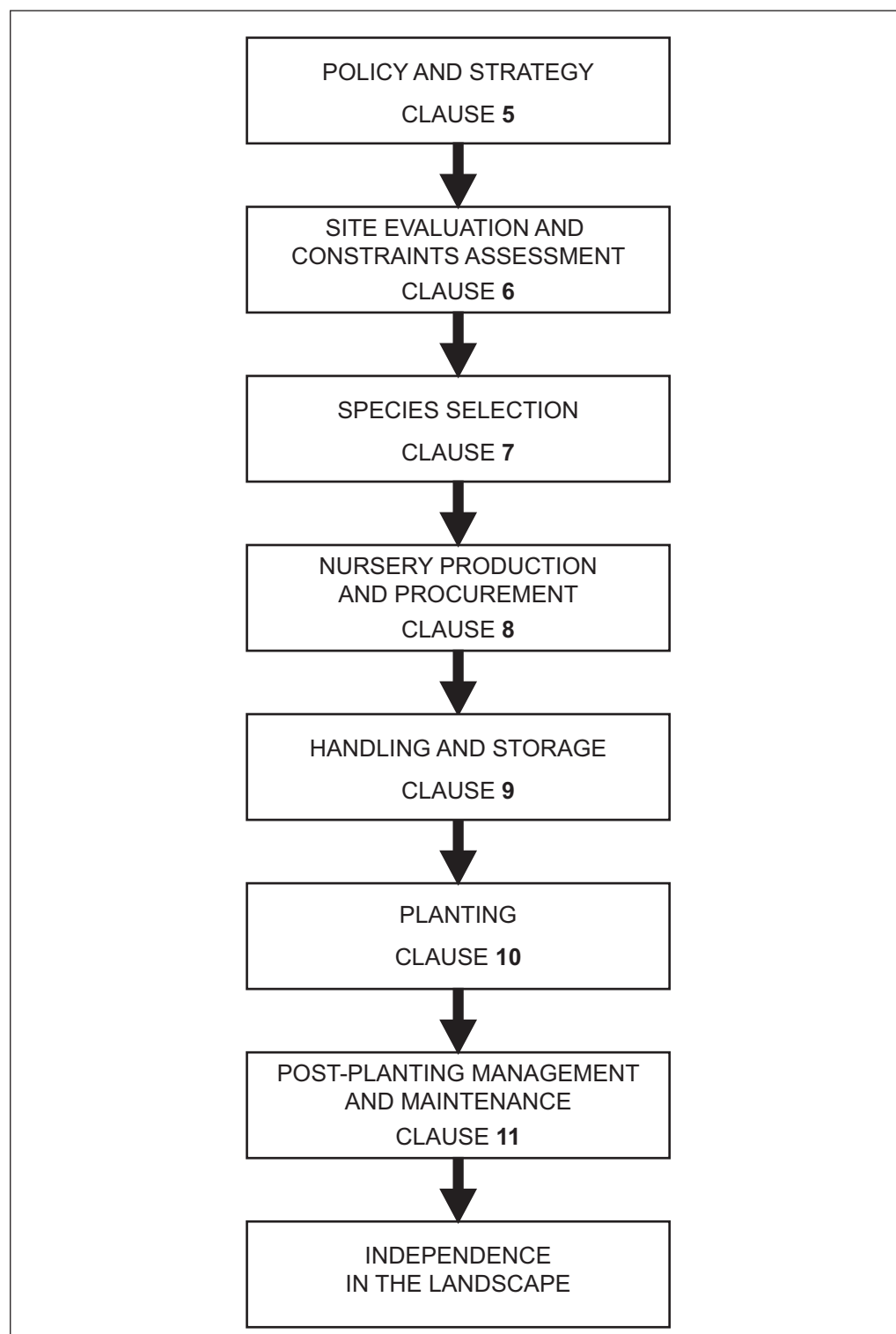
modular, suspended or load-bearing pavement system that incorporates uncompacted soil volumes to accommodate tree root growth

4 General process

For all planting projects, the process shown in Figure 1 should be followed.

NOTE Figure 1 and the flowcharts in the clauses that follow are conceptual diagrams that summarize the principles rather than the detail of each process. Although the flowcharts are presented in linear form, the practical application is likely to involve revisiting, cross-referencing or reviewing different stages of the process.

Figure 1 General process for new planting projects



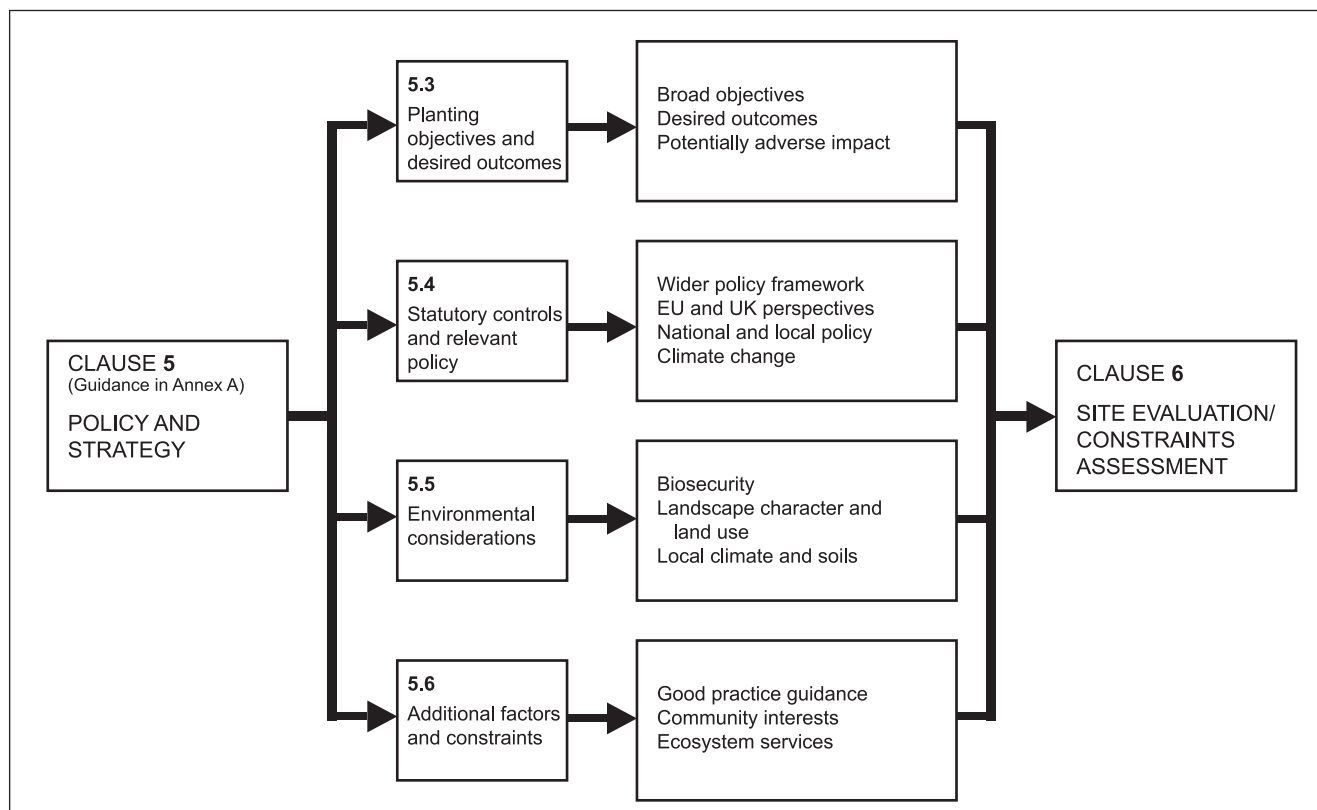
5 Policy and strategy

5.1 General

The policy and strategy part of the process should follow the order shown in Figure 2, and should meet the recommendations given in 5.2 to 5.6.

NOTE Further guidance on policy and strategy is given in Annex A.

Figure 2 Process flowchart for policy and strategy



5.2 General recommendations on policy and strategy

5.2.1 Individual trees form parts of the broader tree population, often referred to as the urban forest in built-up areas. The risks, benefits and characteristics of the urban forest should be taken into account when planning new planting.

5.2.2 Tree planting projects should identify and respond to relevant local planning and environmental policies and objectives.

NOTE Relevant policies might include those that relate to ecology, sustainability, landscape, climate change, biosecurity and the wider environment.

5.2.3 Tree planting projects can range from one tree in a residential setting to a large landscaping scheme involving thousands of individual trees. Irrespective of the scale of the project area, the same principles of design and integration of new tree planting into the existing planning and policy framework should be applied for all projects, whether in the public or the private realm.

NOTE Trees can be large, long-lived organisms. Their health, safety and life expectancy are influenced by various environmental factors and, conversely, their presence has effects on their surrounding environment.

5.3 Planting objectives and desired outcomes

5.3.1 An integral part of preparing a list of objectives is to consider the desired outcomes, and this process should be given significant weight in the design of the planting project.

NOTE Well-informed planting seeks to maximize the benefits of trees, whilst recognizing and minimizing or mitigating any adverse effects posed, e.g. by choice of species or location, taking the planting and future context fully into account.

5.3.2 In addition to benefits, trees can also have adverse impacts, which should be identified and taken into account in the design of the planting project.

5.4 Statutory controls and relevant policy

5.4.1 Trees grow within both rural and urban environments which are subject to diverse policy controls. These controls might be supportive, neutral or adverse in respect of tree planting and management but, where they are relevant to a proposed tree planting project, they should be taken fully into account.

NOTE 1 Attention is drawn to the legislative controls that affect tree planting, plant passports, quarantine controls, etc. Further guidance is given in Annex A.

NOTE 2 Local government authorities produce local plans and supporting documents, such as supplementary planning documents and area action plans, and these are likely to include policies on trees within defined areas. Such local policies can be informed and supplemented by technical studies, such as landscape character, open space, biodiversity, heritage and climate change adaptation assessments.

5.4.2 Land owners and managers other than local authorities might also apply policies that relate to trees, which should be taken into account in the planning and design of new planting projects.

NOTE Examples of such bodies include rail and utility service operators, housing associations, Ministry of Defence, the National Trust and other large land or estate owners.

5.4.3 All planting projects should be designed with the climate adaptation benefits of trees in mind and should specifically aim to contribute to the national climate adaptation initiative.

NOTE Attention is drawn to the Climate Change Act 2008 [2].

5.5 Environmental considerations

5.5.1 The design of a tree planting project should account for the vulnerability of new trees to pests and diseases.

NOTE This can be done by assessing existing tree populations, with the objective of reducing reliance upon a single or limited range of species and encouraging diversity within a given area.

5.5.2 Within the prevailing policy framework, in principle, tree populations should be managed to maintain, enhance or restore relationships with identified local landscape and heritage character, particularly at the rural urban interface. In urban areas, trees should relate to, improve or enhance the character of their surroundings, whilst simultaneously providing other identified benefits and services relevant to their context.

5.5.3 The design of tree planting projects should take account of local soil and climate conditions, which will have influenced landscape character.

NOTE Trees in significantly modified or disturbed environments, such as urban areas and reclamation sites, can be selected and managed to grow in such conditions. Alternatively or additionally, the local environment in which trees are to be planted or managed might need to be specially designed or modified to improve conditions for survival and growth.

5.5.4 The design of tree planting projects should make allowance for the anticipated effects of climate change and the local environmental changes that might result from it, as well as accommodating existing environmental conditions.

5.5.5 The design of tree planting projects should take account of existing and proposed land use and the activities associated with this, particularly in areas of proposed change where existing environmental conditions are likely to be modified or where the effects of tree planting would be beneficial.

5.6 Additional factors and constraints

5.6.1 The design of new planting projects should be informed by up to date, relevant and authoritative sources of technical and good practice guidance. It should draw on input from competent persons with appropriate and relevant expertise.

NOTE There is a substantial body of guidance available. Such sources inform all aspects of tree husbandry including selection, planting, handling and management, some of which are incorporated within this and other British Standards. There are also sources of expertise such as arboriculturists, horticulturists, landscape architects, ecologists, soil scientists, hydrologists and engineers whose inputs might also be of particular value.

5.6.2 Where appropriate, the design of new planting projects should be informed by the responses to community consultation and local interest groups.

5.6.3 Trees make a significant contribution to ecosystem services, which should be taken into account in the design of new tree planting projects.

6 Site evaluation and constraints assessment

6.1 Process flowchart

The site evaluation and constraints assessment part of the process should follow the order shown in Figure 3, and should meet the recommendations given in 6.2 to 6.5.

NOTE Further guidance on site evaluation and constraints assessment is given in Annex B.

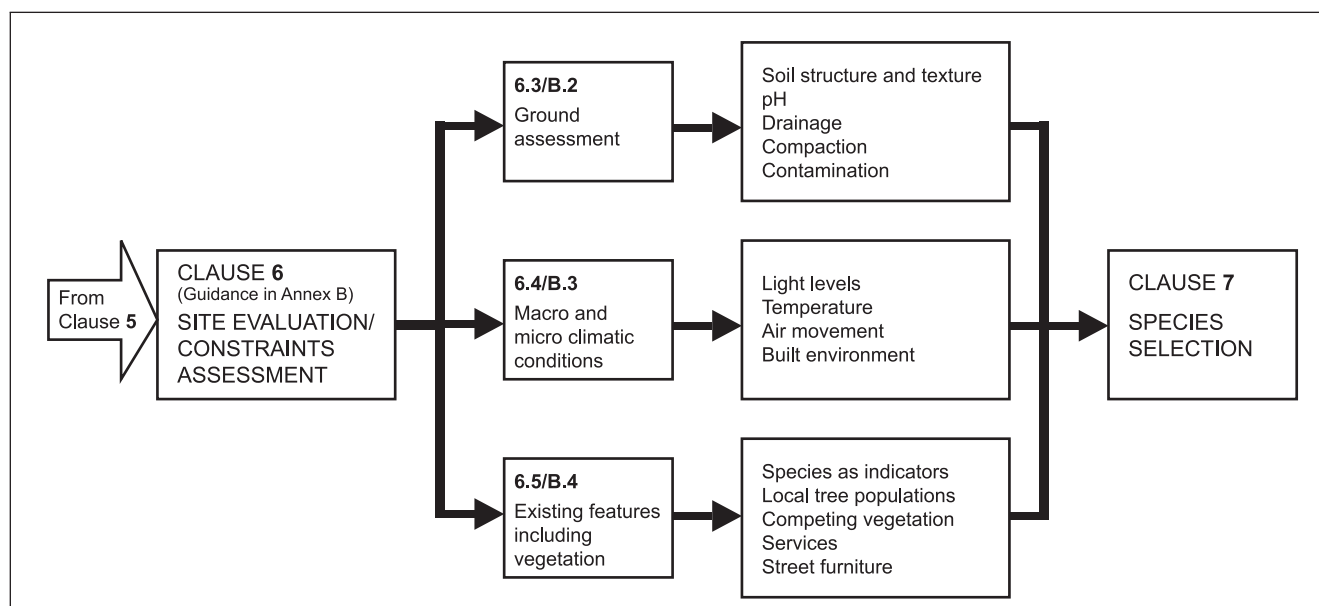
6.2 General recommendations for site evaluation and constraints assessment

NOTE See also B.1.

6.2.1 A full and comprehensive site evaluation and constraints assessment is essential to assist in the selection of the most appropriate species, nursery production method, site preparation and maintenance regime. Where familiarity with the site and experience do not allow sufficient interpretation of conditions, further investigations should be carried out to inform the decision-making process. Where appropriate, important information on site conditions should be recorded and made available to all involved in the decision-making process.

6.2.2 Vandalism can have a significant adverse impact on planting success, and the potential for vandalism should therefore be included in the assessment.

Figure 3 Process flowchart for site evaluation and constraints assessment



6.3 Ground assessment

NOTE 1 Planting sites are extremely variable, ranging from good quality undisturbed natural soil in existing soft landscaped areas, to highly disturbed and poor quality soils in urban environments. Similarly, the local knowledge and familiarity with site conditions of the person/team carrying out the assessment are also wide-ranging. These variables affect the depth of the assessment process necessary to achieve a sufficiently good understanding of the site conditions and to ensure that the planting proposals are properly informed and effective.

NOTE 2 See also B.2.

6.3.1 The characteristics, structure and texture of the soil should be assessed.

6.3.2 The soil profile should be taken into account, especially the depth of topsoil and subsoil.

NOTE This is important when assessing backfill depths.

6.3.3 If the soil pH is not known, it should be assessed.

NOTE pH is critical in species selection and the availability of nutrients in the soil.

6.3.4 If the drainage capacity of the soil is not known, it should be assessed using a percolation test or equivalent.

6.3.5 If excessive soil compaction is suspected, the levels of compaction should be assessed.

6.3.6 If soil contamination is suspected, the levels of contamination should be assessed.

6.4 Macro and micro climatic conditions

NOTE See also B.3.

6.4.1 Where light levels are considered to be low they should be assessed, taking particular account of shade patterns throughout the day, and the amount of daylight that any newly planted young tree can be expected to experience once planted.

6.4.2 There can be wide variations of air movement around trees planted in the built environment. These are often localized and extreme. An assessment of these extremes should be made and the potential impact on any new tree planting allowed for.

6.4.3 Air, soil and surface temperatures, drainage, gaseous exchange and the availability of water and nutrients are all affected by the type of surface surrounding newly planted trees. The potential impact on new tree planting of both existing and new surface types should be assessed.

6.4.4 The presence and use of buildings and other structures close to the planting site that could affect the new trees should be assessed.

NOTE Buildings affect shade, air movement and temperature. Their use determines the volume of pedestrian and other traffic which could adversely affect growing conditions and the potential for vandalism.

6.5 Existing features including vegetation

NOTE See also B.4.

6.5.1 Existing tree cover can provide a useful indicator as to which tree species will thrive on any site. The composition, condition and species mix adjacent to a site for new tree planting should therefore be assessed.

NOTE This can inform species choice with regard to monocultures, clonal selections, population imbalances, population resilience and landscape character.

6.5.2 Shade cast by other trees and the available space for crown development should be assessed.

6.5.3 Existing tree, shrub and grass cover can compete with new trees for available water, air and light. The amount of this cover and its potential impact should be assessed.

6.5.4 The position and location of all street furniture, including CCTV cameras, should be assessed as these can limit the suitability of any site for tree planting.

6.5.5 All sites, especially when planting street trees, should be fully assessed for the presence of underground services. The location of such services should be identified [e.g. using cable avoidance tools (CAT) scanners or ground-penetrating radar, or by referring to drawings], before any excavations commence.

7 Species selection

7.1 Process flowchart

The species selection part of the process should follow the order shown in Figure 4 and should meet the recommendations given in 7.2 to 7.5.

NOTE Further guidance on species selection is given in Annex C.

7.2 General recommendations for species selection

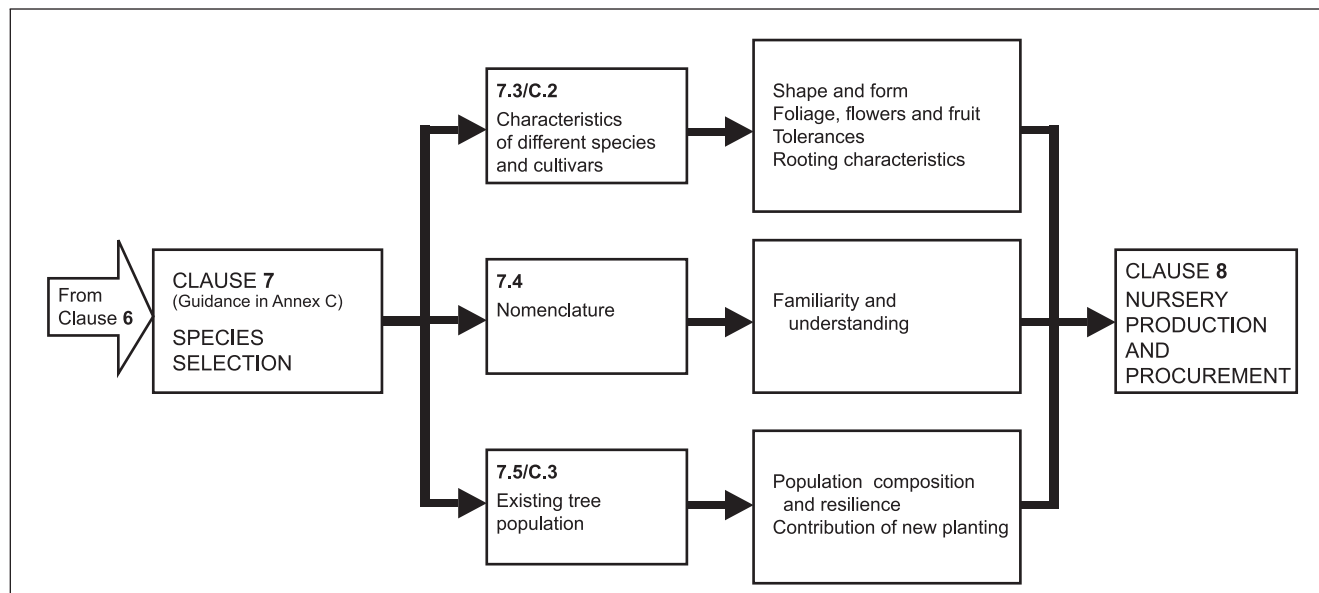
NOTE See also C.1.

7.2.1 It is essential for transplanting success that those specifying and/or procuring young trees have a detailed knowledge of tree species and their clones. This knowledge should include understanding the characteristics of tree performance under different environmental and climatic conditions. Specialist advice should be sought where necessary.

NOTE It is important to remember that characteristics indicating resilience, such as drought tolerance and frost hardiness, identified in a supplier's catalogue are not always immediately apparent, and a period of acclimatization might be necessary.

7.2.2 Nursery catalogues should not be used as authoritative references.

Figure 4 Process flowchart for species selection



7.3 Characteristics of different species and cultivars

NOTE See also C.2.

The following characteristics should be taken into account when making a species choice for any given site:

- the ultimate dimensions of the tree and whether there is space for those dimensions to be realized;
- the speed of growth and final form of the tree;
- the potential longevity of the tree;
- the foliage characteristics of the tree (size, shape, density, length of season, evergreen or deciduous);
- the floral characteristics of the tree (pollen, colour, flowering season and length, scent, prominence of flowers);
- the fruit and seed characteristics of the tree (size, toxicity, edibility, persistence);
- the bark and twig characteristics of the tree (colour, texture, peeling or not);
- resistance or susceptibility to pests and diseases and inherent structural defects such as weak branch attachments;
- other relevant characteristics including thorns, honeydew, autumnal leaf decomposition, attraction to insects, branch drop, allergies;
- the rooting characteristics of the tree (depth, spread, vigour, stability);
- tolerance of pruning, including formative pruning;
- tolerance of pollution (air, waterborne, salt, gas, chemical);
- tolerance of variable soil conditions (pH levels, presence of contaminated material, structure, texture, profile, clay content, moisture retention, nutrients);

- resistance or susceptibility to drought, solar heat scorch and flooding;
- tolerance of exposed positions and wind.

7.4 Nomenclature

All those involved in species selection should have an understanding of and should use the binomial system of nomenclature.

NOTE Guidance on nomenclature is given in the National plant specification [3].

7.5 Existing tree population of the landscape into which young trees are planted

NOTE See also C.3.

7.5.1 Most young trees are planted into an existing tree population that often extends beyond the boundaries of any particular planting site. The composition and resilience of that existing population, including species mix, age-class structure, and vulnerability to pest and disease, should be taken into account when selecting species, clones and genotypes.

7.5.2 The contribution that young trees will make to the benefits provided by the whole tree population of any geographic area should be taken into account when selecting species.

8 Nursery production and procurement

8.1 Process flowchart

The nursery production and procurement part of the process should follow the order shown in Figure 5 and should meet the recommendations given in 8.2 to 8.6.

NOTE Further guidance on nursery production and procurement is given in Annex D.

8.2 General recommendations for nursery production and procurement

NOTE See also D.1.

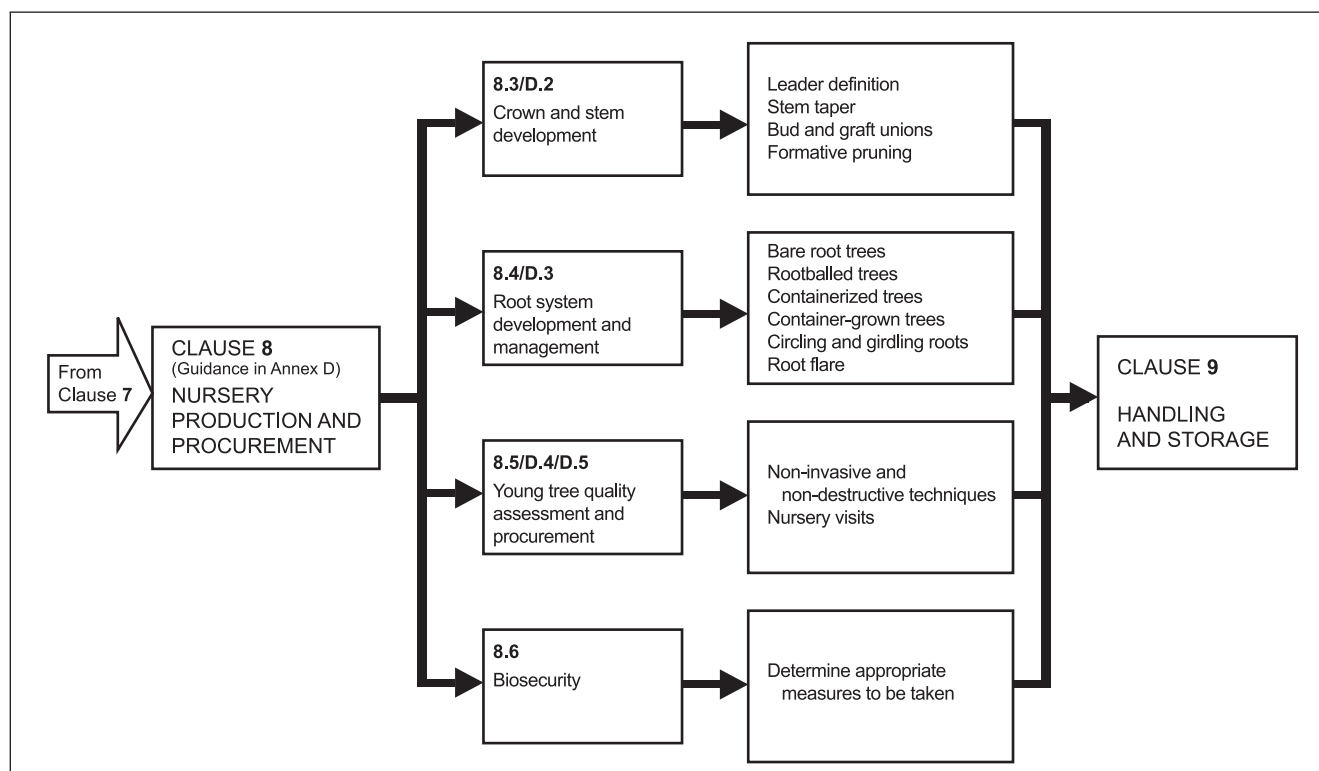
8.2.1 Everyone involved in design using young trees, in the selection and procurement of young trees, and in the planting and management of young trees, should have knowledge of nursery production and the attributes of different production systems used. Specialist advice should be sought where necessary.

8.2.2 As a minimum, nurseries should be able to supply the following information for each tree they produce:

- age of tree;
- method of propagation;
- method of production;
- formative pruning regimes;
- type of growing media if trees are containerized;
- country of origin;
- date of import;

- complete audit trail from supply to sale;
- pest and disease control programme.

Figure 5 Process flowchart for nursery production and procurement



8.3 Crown and stem development

NOTE 1 See also D.2.

NOTE 2 Some or all of the recommendations in this subclause might not be applicable if there are specific design considerations or specific external requirements to be met on or by the nursery.

8.3.1 All bud and graft unions should be checked to ensure full compatibility between stock and scion and that there are no weak unions or disproportionate growth at the grafting/budding joint. Evidence should be sought as to the type of stock and scion wood used in budding and grafting in the context of their long-term compatibility.

8.3.2 A young tree should not be accepted from a nursery if the bud union has been set below the soil surface.

8.3.3 All young tree stock should have a straight leader (see Note), irrespective of whether excurrent or decurrent in natural habit, and an even, well-balanced branching system. Decurrent trees should retain a leader until they have reached two-thirds of their mature height.

NOTE This does not apply to weeping trees, trees produced as multi-stemmed specimens or other trees where a straight leader is not a natural characteristic.

8.3.4 All young trees should exhibit a clearly defined stem taper, evident from crown through to root flare, appropriate to the species.

8.3.5 All young trees should have a proportionate, balanced height/stem girth ratio appropriate to the species.

8.3.6 All young trees should be self-supporting and able to stand upright without the use of cane, stake or other form of support at the point of dispatch.

8.3.7 All young trees should be formatively pruned at the nursery to give well-balanced crown formation, a well-formed straight central leader and lateral branches subordinated to that leader. Co-dominant branches and stems should be removed or subordinated.

8.3.8 Poorly attached branches with included bark, and inward-growing branches, should be removed or formatively pruned. Where branches cross or rub, the most significant branch should be retained and any others removed.

8.4 Root system development and management

NOTE See also D.3. A description of the principal nursery production systems in the UK is given in D.3.1.

8.4.1 All bare root trees should have a well-balanced radial root system comprising at least four obvious and substantial lateral roots.

NOTE A guide to root spread is given in Annex D, Table D.3.

8.4.2 All rootballed (balled and burlapped) trees of 12 cm to 14 cm girth and above should be transplanted at least three times on the nursery.

NOTE 1 Trees are sometimes lifted with a loose soil ball for root protection during dispatch. These are not true rootballs and the supplying nursery needs to make this clear.

NOTE 2 The principles of undercutting and transplanting rootballed trees, and the effects of not carrying out the process correctly, are illustrated in Annex D, Figure D.9 and Figure D.10.

8.4.3 All rootballs should contain a fully fibrous root system with obvious evidence of root pruning or transplanting.

8.4.4 The rootball should be a proportionate size to the stem diameter.

NOTE Guidance on the relationship between tree size and size of rootball is given in Annex D, Table D.5.

8.4.5 Containerized or container-grown trees should be free from circling or girdled roots. All nurseries should be able to supply evidence of the length of time for which young containerized trees have been in a container, giving potting dates. Purchasers of containerized trees should request these details.

NOTE All containerizing and container-growing production systems produce girdled roots if the tree is left in the container too long.

8.4.6 The natural root flare should be visible at all times.

NOTE Rootball, containerizing, and container-growing production systems can all result in the natural root flare of the young tree being too deep and buried. Additionally, root flare development varies with age and from species to species.

8.4.7 Since the root systems of rootballed, containerized or container-grown trees are not visible until the time of planting, a sample of the actual root system should be checked where practicable by breaking open a small percentage of rootballs or containers.

NOTE This is to check that good practice has been followed as detailed in 8.4.1 to 8.4.5.

8.4.8 All wire used for rootballing should be non-galvanized.

8.5 Young tree quality assessment and procurement

NOTE See also D.4 and D.5.

8.5.1 Non-destructive, non-invasive techniques should be used, as appropriate, to evaluate the physiological condition of young trees.

8.5.2 An effective way to evaluate the condition of young trees is to visit the nursery growing them. Any purchase of young trees should be accompanied by a nursery visit, wherever practicable, to check that production good practice is being followed. Nursery visits should ideally take place when trees have full foliage and stress indicators are more likely to be apparent (see Annex D, Figure D.13).

8.5.3 Adequate time should be allowed for procurement, particularly where planting involves special requirements (e.g. unusual species, exceptional sizes or large quantities).

8.5.4 Selected tree stock should be marked or tagged on the nursery.

8.6 Biosecurity

Biosecurity is an important consideration, and appropriate measures should be taken to minimize the introduction and spread of harmful organisms.

NOTE Advice on biosecurity is available from the Forestry Commission (www.forestry.gov.uk/biosecurity¹⁾) and the Food and Environment Research Agency (<http://www.fera.defra.gov.uk/>¹⁾).

9 Handling and storage

9.1 Process flowchart

The handling and storage part of the process should follow the order shown in Figure 6 and should meet the recommendations given in 9.2 to 9.5.

NOTE Further guidance on handling and storage is given in Annex E.

9.2 Lifting on the nursery

NOTE See also E.1.

9.2.1 The lifting of bare root and rootballed trees should take place only in the dormant season.

NOTE This season is usually identified as the period when deciduous trees have lost their foliage. It is normally between early November and March, although it varies from year to year.

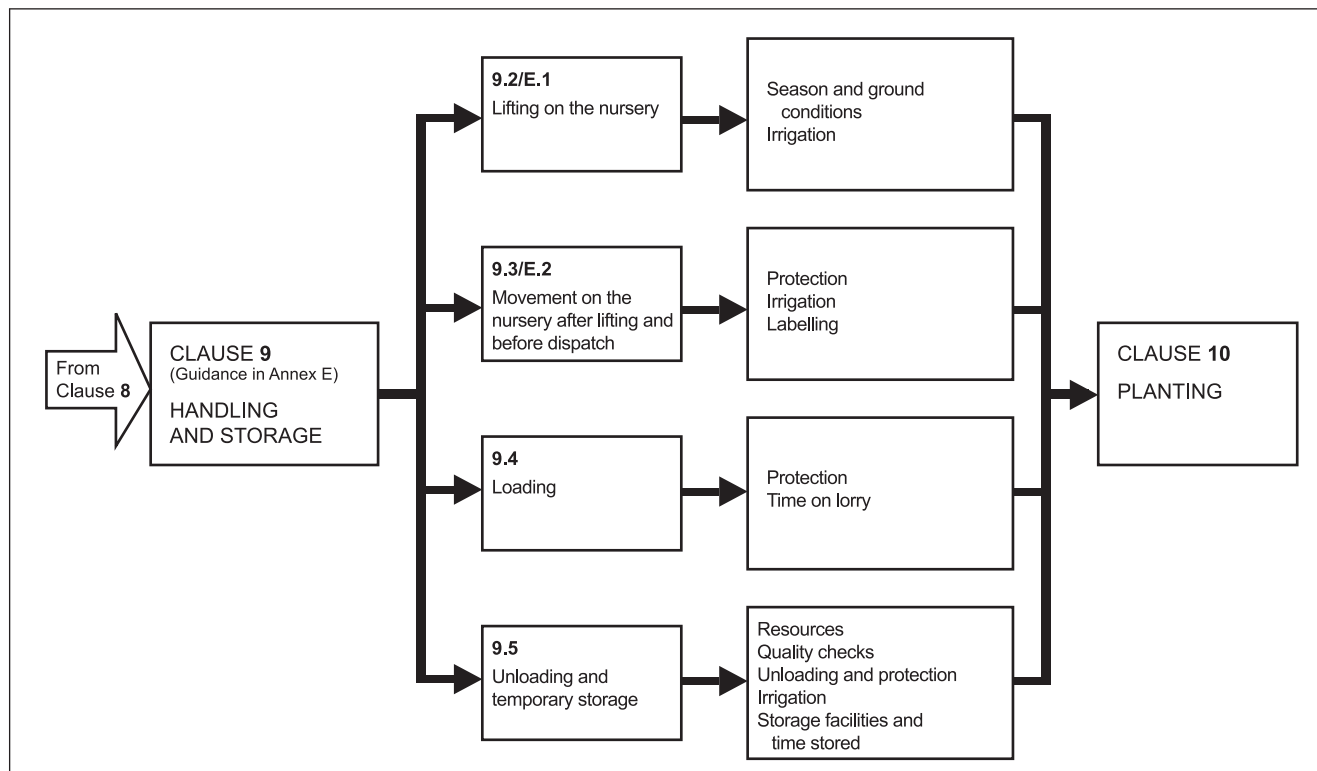
9.2.2 Ground conditions at the time of lifting should be favourable; the ground should not be waterlogged, excessively dry or frozen. Particular attention should be paid to the protection of root systems in drying winds and from direct sunlight.

9.2.3 Container-grown and containerized trees can be dispatched at any time of the year. Irrespective of the time of year when such trees are dispatched, the fibrous roots in the container should hold the compost ball together once the container is removed. If the compost ball falls apart, the tree should be rejected as there has been inadequate root development.

¹⁾ Last accessed 24 February 2014.

9.2.4 Not all containerized or container-grown trees are dispatched in the containers they were grown in. Some production systems require that the container is removed at the time of dispatch and the root system wrapped in hessian, which makes the roots vulnerable to drying out. At all times following wrapping, the wrapped root system should be kept fully irrigated. The length of time between removal of the container and wrapping in hessian should be kept to a minimum.

Figure 6 Process flowchart for handling and storage



9.3 Movement on the nursery after lifting and before dispatch

NOTE See also E.2.

9.3.1 All bare root trees should have their root systems covered and fully protected during this period to prevent desiccation. Co-extruded bags, which are black inside and white outside, should be used for bare root trees.

NOTE The white outer covering prevents roots from overheating and drying out while the black inner covering prevents light penetration.

9.3.2 Rootballed trees are often lifted in the dormant season and stored for dispatch in the late spring. These trees should be stored in an upright position, supported and irrigated during the time of storage.

9.3.3 Containerized or container-grown trees should be irrigated regularly once off the nursery production line, and fully irrigated immediately before loading and dispatch.

9.3.4 The movement of lifted trees of all production systems should be kept to a minimum on the nursery before loading for dispatch, to minimize the possibility of accidental damage occurring.

9.3.5 All trees should be individually clearly labelled, indicating the supplier's name, species, variety, cultivar and size. Labels should also indicate the customer's name, any batch numbers used on the nursery and, in the case of containerized trees, the date of containerization.

9.4 Loading

9.4.1 All trees should be loaded and stacked in such a way as to minimize the possibility of breakage or crushing by the weight of the plants above or from the security ropes.

9.4.2 The method of loading rootballed and containerized trees can result in the main stem of trees being unsupported and therefore subjected to movement during transport and pressure when unloading. Such movement and pressure can result in damage to the main stem. All main stems should be fully supported on loading by straw bales or suitable pressure-absorbing materials.

9.4.3 On open lorries, the trees should be completely covered with opaque sheeting which has been firmly secured. In closed lorries or containers, provision should be made to ensure that the trees remain cool and moist at all times during transit.

9.4.4 The time that young trees are kept on any lorry during the loading, transit and unloading process should be kept to a minimum.

9.4.5 Delivery times should be agreed between the nursery and the recipient. Additional information such as access arrangements, height restrictions and parking restrictions should be supplied by the recipient at the same time.

9.5 Unloading and temporary storage

9.5.1 Recipients of young trees from the nursery should ensure that they have the resources, both human and mechanical, necessary to unload the lorry in a speedy and efficient manner.

9.5.2 A full quality check should take place at the time of unloading.

9.5.3 Any defects or breakages should be reported to the dispatching nursery immediately. Trees that do not meet the specification or are otherwise unsatisfactory or damaged should be rejected and returned.

9.5.4 Rootballed or containerized trees should be lowered intact from the lorry by hand or machinery. They should not be dropped onto the ground, as this can cause damage to the root system.

9.5.5 All bare root trees should also be unloaded carefully and should have their root systems protected immediately after unloading, either by heeling in on site in a temporary trench, or by covering with a moisture-retentive, breathable material.

NOTE Bare root trees delivered in co-extruded bags can be left in those bags until planting but need to be protected from sun, wind and severe frost.

9.5.6 Any non-porous protective material should be removed at this stage. Heeled-in root systems should be kept moist at all times.

9.5.7 The length of time that trees are held in temporary storage should be kept to a minimum. There are occasions when rootballed trees are lifted during the dormant season and stored for supply at a later date. Such trees should be stored in an upright position and irrigated until dispatched.

9.5.8 All sites of temporary storage should be specific for that purpose. Such sites should be isolated from areas where there is the potential for contamination from other stored materials on neighbouring sites or damage from vehicles.

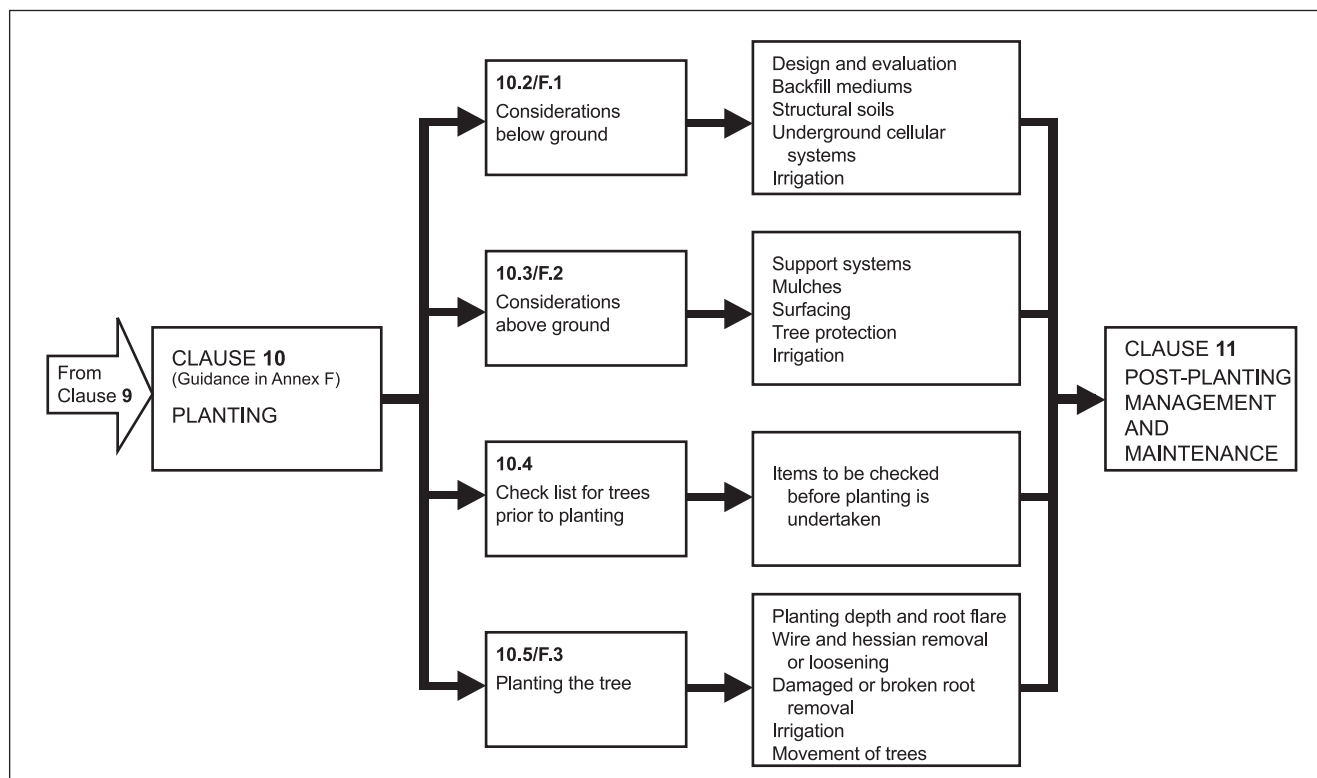
10 Planting

10.1 Process flowchart

The planting part of the process should follow the order shown in Figure 7 and should meet the recommendations given in 10.2 to 10.5.

NOTE Further guidance on planting is given in Annex F.

Figure 7 Process flowchart for planting



10.2 Considerations below ground

NOTE See also F.1.

10.2.1 Design of the planting pit and site preparation should be based on the comprehensive evaluation of site conditions and constraints as outlined in Clause 6, and modified as necessary to ameliorate any limiting conditions.

10.2.2 The high variability of soils, particularly in the urban environment, requires that all professionals involved in specifying the planting of young trees should have a high level of knowledge relating to tree development under prevailing soil conditions. Where such knowledge is unavailable or where site conditions are complex, specialist advice should be sought.

10.2.3 During the preparation of the tree pit, the soil is disturbed, but the base of the tree pit should remain undisturbed unless there are specific problems such as poor drainage, soil smearing or pans resulting from pit construction which need to be rectified.

10.2.4 The use of geotextiles or any other barrier to root growth, either at the base of or along the sides of tree pits, can limit root development into surrounding soils. Unless there is a specific requirement to inhibit root growth, such barriers should not be used as a tree pit lining.

10.2.5 The backfill medium used should be as close as possible in texture and structure to the soil excavated from the tree pit. Ideally the soil dug from the excavated pit should be used as the backfill medium.

NOTE If modifications to the soil are necessary, soil ameliorants may be used sparingly.

10.2.6 All backfill applied should, as far as is practicable, replicate the horizons within the original soil profile.

NOTE In urban areas, such horizons might not be visible.

10.2.7 Topsoil should not be used below the depth of the original topsoil layer.

10.2.8 Imported topsoil can be extremely variable, and there are different grades and mixes available. These should be fully evaluated, and the most appropriate mix chosen for the relevant site. Any imported soil that does not meet project specifications for structure, texture, quality or chemistry should be rejected.

10.2.9 Structural soils and underground cellular systems are a solution where the planting area requires a load-bearing capacity and where adequate soil volume is unavailable. The use of structural soils and underground cellular systems is a specialism, and specialist experience and advice should be sought as to their suitability before their use is recommended.

NOTE Structural soils are usually a mixture of washed, often rounded, aggregates or gravels, clay loam, and a stabilizing agent to keep the mixture from separating. They can provide an integrated, root penetrable, high strength pavement system that shifts design away from individual tree pits.

10.2.10 There are several below-ground irrigation aids commercially available. Site constraints should be taken into account when determining which, if any, irrigation aids to use.

10.2.11 The use of various soil ameliorants, which include auxins, mycorrhizae, biostimulants, sugars and hydrogels, have been advocated as means of reducing transplant loss. Data from several independent trials demonstrate widely conflicting opinions as to their efficacy and therefore they should not be used as a matter of routine.

10.3 Considerations above ground

NOTE See also F.2.

10.3.1 There are many methods of securing newly planted trees, where external support is necessary. Each has its place and the choice should relate to stock size and type, specific site constraints or other requirements.

10.3.2 All systems should allow for canopy and stem movement as low down a tree as practically possible, whilst supporting the structural function of the root system.

10.3.3 Before a young tree is planted, all tree stakes used should be driven into the ground to a sufficient depth to provide full support for the tree.

NOTE It might be necessary to orientate the tree for the staking system selected.

10.3.4 The choice of materials used to attach a stake support system to a tree should allow for the radial expansion of the stem.

10.3.5 The tensioning wires or straps used with underground guying systems should be placed as shallowly as possible and should have only a light covering of soil or mulch applied.