BRITISH STANDARD

BS 5837:2005
Incorporating Corrigendum No. 1

Trees in relation to construction — Recommendations

ICS 65.020.40; 91.020

BSI British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/213, Trees, upon which the following bodies were represented:

Arboricultural Association
Institute of Leisure and Amenity Management
Institution of Civil Engineers
Institution of Structural Engineers
Landscape Institute
National House-building Council
ODPM — Wildlife and Countryside Directorate
Royal Institute of British Architects (RIBA)
Co-opted members

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15988 Corrigendum No. 1	September 2005	To correct second equation in Table 2, and minor errors in 5.2.4, 11.3.1 and 15.1.5

The following BSI references relate to the work on this standard:
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Contents

Foreword

This British Standard has been prepared by Technical Committee B/213. It supersedes BS 5837:1991 which is withdrawn.

This revision has been found to be necessary to take account of current practice regarding planning for the management, protection and planting of trees in the vicinity of structures, and for the protection of structures near trees.

This standard provides recommendations and guidance for arboriculturists, architects, builders, engineers, land managers, landscape architects and contractors, planners, statutory undertakers, surveyors, and all others interested in harmony between trees and construction.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to competent people (see Clause **2**).

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 does not of itself confer immunity from legal obligations.

Attention is drawn to the following statutory regulations: the Town and Country Planning Act 1990 (as amended) [1], the Forestry Act 1967 (as amended) [2], the Wildlife and Countryside Act 1981 (as amended) [3], the Conservation (Natural Habitats etc.) Regulations 1994 [4], the Countryside and Rights of Way Act 2000 [5], the Hedgerows Regulations 1997 [6], the Construction (Design and Management) Regulations (CDM) [7] and the Environment Act 1994 (as amended) [8].

Annex A provides guidance on aspects of trees and the law.

Summary of pages

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

1 Scope

This British Standard gives recommendations and guidance on the principles to be applied to achieve a satisfactory juxtaposition of trees, including shrubs, hedges and hedgerows, with structures. It follows, in sequence, the stages of planning and implementing the provisions which are essential to allow development to be integrated with trees.

This standard recognizes that there can be problems of development close to existing trees which are to be retained, and of planting trees close to existing structures. This standard sets out to assist those concerned with trees in relation to construction to form balanced judgements. It does not set out to put arguments for or against development, or for the removal or retention of trees. Where development, including demolition, is to occur, the standard provides guidance on how to decide which trees are appropriate for retention, on the means of protecting these trees during development, including demolition and construction work, and on the means of incorporating trees into the developed landscape.

NOTE A list of organizations from whom additional advice can be obtained is given in Annex B. The Bibliography contains details of publications referred to throughout this document. Other relevant publicly available documents are also listed.

2 Terms and definitions

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

2.1
arboriculturist
person who has, through relevant education, training and experience, gained recognized qualifications and expertise in the field of trees in relation to construction (see Annex B and the Foreword)

2.2
competent person
person who has training and experience relevant to the matter being addressed and an understanding of the requirements of the particular task being approached (see Foreword)

NOTE 1 A competent person understands the hazards and the methods to be implemented to eliminate or reduce the risks that can arise. For example, when on site, a competent person is able to recognize at all times whether it is safe to proceed.

NOTE 2 A competent person is able to advise on the best means by which the recommendations of this British Standard may be implemented.

2.3
structure
man-made object, such as a building, carriageway, path, wall, services, and built and excavated earthworks

2.4
veteran tree
tree that, by recognized criteria, shows features of biological, cultural or aesthetic value that are characteristic of, but not exclusive to, individuals surviving beyond the typical age range for the species concerned

2.5
root protection area (RPA)
layout design tool indicating the area surrounding a tree that contains sufficient rooting volume to ensure the survival of the tree, shown in plan form in m^2

2.6
tree constraints plan (TCP)
plan prepared by an arboriculturist for the purposes of layout design showing the RPA and representing the effect that the mature height and spread of retained trees will have on layouts through shade, dominance, etc.

2.7
construction exclusion zone
area based on the RPA (in m^2), identified by an arboriculturist, to be protected during development, including demolition and construction work, by the use of barriers and/or ground protection fit for purpose to ensure the successful long-term retention of a tree

2.8
tree protection plan (TPP)
scale drawing prepared by an arboriculturist showing the finalized layout proposals, tree retention and tree and landscape protection measures detailed within the arboricultural method statement (AMS), which can be shown graphically

2.9
arboricultural implications assessment (AIA)
study, undertaken by an arboriculturist, to identify, evaluate and possibly mitigate the extent of direct and indirect impacts on existing trees that may arise as a result of the implementation of any site layout proposal

2.10
arboricultural method statement (AMS)
methodology for the implementation of any aspect of development that has the potential to result in loss of or damage to a tree

NOTE The AMS is likely to include details of an on-site tree protection monitoring regime.

2.11
services
any above ground and piped and/or ducted underground infrastructure including water main, electricity supply, gas supply, fibre-optic utilities, telecommunications cabling, storm and foul water drainage, including temporary storage for run-off, pumping stations, interceptors and other allied buried structures

2.12
special engineering
design of a structure with the physiological requirements of trees as the priority

3 Strategy

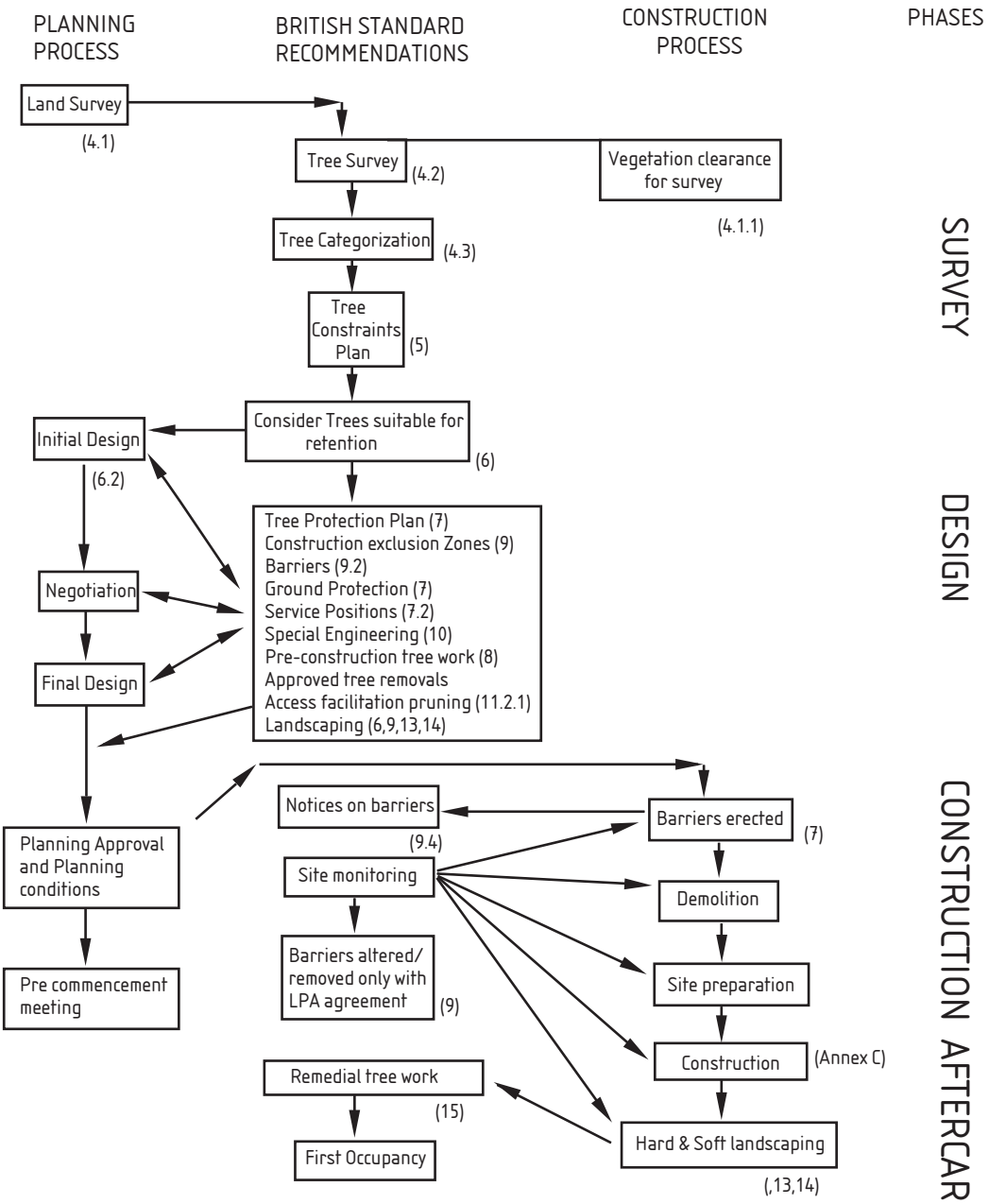
3.1 General

3.1.1 Trees can occupy a substantial part of a development site and because of their potential size can have a major influence on the planning and use of the site. Existing trees of good quality and value can greatly enhance new development, such as by providing an immediate appearance of maturity. However, trees can also be a constraint. Layouts sited poorly in relation to retained trees, or the retention of trees of an inappropriate size or species may be resented by future occupiers and no amount of legal protection will ensure their retention and survival. To avoid such problems and to ensure a harmonious relationship between trees and structures, careful planning and expert advice is needed on their juxtaposition.

3.1.2 A tree may take a century to reach maturity but it can be damaged or felled in a few minutes. Such damage is frequently caused unwittingly because of failure to appreciate the vulnerability of trees, particularly the root system (see Annex C), and how easily and often insidiously they can be damaged. Irreparable damage is frequently done to existing trees in the first few days of a contractor's occupation of a site. The early erection of tree protection to form the construction exclusion zone before works commence on site is essential as the only way to prevent damage being caused to retained trees by operations in their vicinity.

3.2 Implementation

3.2.1 This British Standard provides guidance for a balanced approach on deciding which trees are appropriate for retention, on the effect of trees on design considerations and on the means of protecting these trees during development. This involves a logical sequence of events summarized as a flow diagram (see Figure 1) that has tree care at the centre of the process. Pre planning site discussions involving all parties are recommended.



Figures in brackets refer to Clause numbers.

Figure 1 — Flow diagram, summarizing planning for trees on development sites

3.2.2 The layout of this standard follows the sequence of the flow diagram in Figure 1. Following the land survey (see **4.1**) the existing trees on and adjacent to the site should be surveyed (see **4.2**) and categorized (see **4.3**). The constraints these trees pose should be plotted on a tree constraints plan (see Clause **5**) and those selected for retention should be plotted on a tree protection plan as a result of the negotiations within the design process (see Clause **7**). Areas for new landscaping should be identified at this time (see **6.2.2**). The position of all excavations and any special engineering required can be specified in the form of arboricultural method statements. Once work is due to begin on site the arboriculturist should meet the site agent at a pre start meeting to ensure the correct erection of barriers and ground protection forming the construction exclusion zone (see Clause **9**).

3.2.3 The sequence of events outlined in **3.2.2** may not be necessary for all planning applications. For example, planning applications for a single conservatory may not require the level of detail that needs to accompany a planning application for the development of a site with one or more dwellings.

3.2.4 The success of the process outlined in **3.2.2** depends on the co-operation of all involved in the design and development team which should include an arboriculturist. In particular, it is essential for those involved in the development site works to appreciate the need for maintaining the construction exclusion zone. Any incursion into this area can quickly destroy all of the time, effort and expense which has gone into the retention of the trees.

3.2.5 Local authorities have an important role to play in encouraging and enforcing the processes outlined in **3.2.2**. The means for this are contained in existing regulations (see Annex A), which include provision for local authorities to enforce planning requirements. An arboriculturist appointed by the developer can help monitor site activity but enforcement is the responsibility of the local authority (e.g. active supervision of sites within their areas).

4 Surveys

4.1 Land survey

4.1.1 An accurately measured land survey (also known as a topographical survey) should be undertaken showing all relevant existing site features. Where trees are present, clearance of vegetation to facilitate the survey process should be undertaken only if strictly necessary and with care using hand held machinery. Mechanized flails may be used in more open areas, although bulldozing or soil stripping should be avoided.

4.1.2 This survey should be made available as scale drawings and in a commonly agreed digital format, if available, before any application for planning permission is submitted. Computer-based drawing software should be used where possible.

4.1.3 Prior to commencing the topographical survey, it may be appropriate to seek the advice of an arboriculturist to identify all trees that are relevant for inclusion in the survey. Alternatively, the topographical survey should include all trees present, and certainly all those over 75 mm stem diameter, measured at 1.5 m above adjacent (higher) ground level. Trees over this size growing on land adjacent to the site, which are at or within a distance equal to 12 times their stem diameter from the boundary (or 10 times their base diameter, in the case of multi-stemmed trees), or where their crowns overhang the site boundary, should also be included. For trees with more than one stem below 1.5 m above ground level, the stem diameter should be measured immediately above the root flare.

4.1.4 Other arboricultural or landscape features such as shrub masses or hedges should also be identified. The position of stumps should be included.

4.1.5 To summarize, the land survey should include:

a) the location of all trees, shrub masses, hedges etc., as identified in **4.1.3** and **4.1.4**;

b) other relevant features, such as streams, buildings and other structures, boundary features, trenching scars near to trees and services including drainage runs;

c) spot heights of ground level throughout the site, as a basis for avoiding changes in soil level around retained trees;

d) the approximate location of trees on land adjacent to the development site (see **4.1.3**), that might influence the site or might be important as part of the local landscape character.

4.2 Tree survey

4.2.1 A tree survey should be undertaken by an arboriculturist and should record information about the trees on a site independently of and prior to any specific design for development. [As a subsequent task, and with reference to a design or potential design, the results of the survey should be included in the preparation of a tree constraints plan (TCP), which should be used to assist with site layout design (see Clause **6**)].

NOTE For clearance of vegetation see **4.1.1**.

4.2.2 The tree survey should include all trees included in the land survey (see **4.1.3** and **4.1.4**), as well as any that may have been missed, and it should categorize trees or groups of trees, including woodlands (see **4.2.4**) for their quality and value within the existing context, in a transparent, understandable and systematic way. Where the arboriculturist deems it appropriate, the trees should be tagged with small metal or plastic tags, placed as high as is convenient on the stem of each tree.

4.2.3 Whilst master plan proposals for the development of the site might be available, the trees should be surveyed without taking these into consideration. All detailed design work on site layout should take into consideration the results of the tree survey (and the TCP) as this facilitates the logical sequence of events referred to in **3.2.2** and the flow diagram in Figure 1.

4.2.4 Trees forming groups and areas of woodland (including orchards, wood pasture and historic parkland) should be identified and considered as groups where the arboriculturist determines that this is appropriate, particularly if they contain a variety of species and age classes that could aid long-term management. It may be appropriate to assess the quality and value of such groups of trees as a whole, rather than as individuals. However, an assessment of individuals within any group should still be undertaken if they are open-grown or if there is a need to differentiate between them.

4.2.5 The quality and value of each tree or group of trees should be recorded by allocating it to one of the four categories listed in **4.3.1**. The categories should be differentiated on the tree survey plan by colour, or by suffixing the category adjacent to the tree identification number on the tree survey plan (see **4.2.6**).

NOTE Suggested colours are given in Table 1.

4.2.6 A schedule to the survey should list all the trees or groups of trees. The following information should be provided:

a) reference number (to be recorded on the tree survey plan);

b) species (common and scientific names, where possible);

c) height in metres;

d) stem diameter in millimetres at 1.5 m above adjacent ground level (on sloping ground to be taken on the upslope side of the tree base) or immediately above the root flare for multi-stemmed trees;

e) branch spread in metres taken at the four cardinal points to derive an accurate representation of the crown (to be recorded on the tree survey plan);

f) height in metres of crown clearance above adjacent ground level (to inform on ground clearance, crown stem ratio and shading);

g) age class (young, middle aged, mature, over-mature, veteran);

h) physiological condition (e.g. good, fair, poor, dead);

i) structural condition, e.g. collapsing, the presence of any decay and physical defect;

j) preliminary management recommendations, including further investigation of suspected defects that require more detailed assessment and potential for wildlife habitat;

k) estimated remaining contribution in years (e.g. less than 10, 10–20, 20–40, more than 40);

l) R or A to C category grading (see Table 1) to be recorded in plan on the tree survey plan.

NOTE 1 An example tree survey pro forma is given in Annex D (see also BS EN ISO 11091).

NOTE 2 It may be appropriate to assess and list the amenity value of trees as a separate consideration. Various methods have been proposed as aids to making this assessment (see Annex B for arboricultural organizations).

4.3 Tree categorization method

4.3.1 Trees should be categorized in accordance with the cascade chart in Table 1.

Table 1 — Cascade chart for tree quality assessment

TREES FOR REMOVAL				
Category and definition	**Criteria**			**Identification on plan**
Category R Those in such a condition that any existing value would be lost within 10 years and which should, in the current context, be removed for reasons of sound arboricultural management	• Trees that have a serious, irremediable, structural defect, such that their early loss is expected due to collapse, including those that will become unviable after removal of other R category trees (i.e. where, for whatever reason, the loss of companion shelter cannot be mitigated by pruning) • Trees that are dead or are showing signs of significant, immediate, and irreversible overall decline • Trees infected with pathogens of significance to the health and/or safety of other trees nearby (e.g. Dutch elm disease), or very low quality trees suppressing adjacent trees of better quality NOTE Habitat reinstatement may be appropriate (e.g. R category tree used as a bat roost: installation of bat box in nearby tree).			DARK RED
TREES TO BE CONSIDERED FOR RETENTION				
Category and definition	**Criteria — Subcategories**			**Identification on plan**
	1 Mainly arboricultural values	**2 Mainly landscape values**	**3 Mainly cultural values, including conservation**	
Category A **Those of high quality and value:** in such a condition as to be able to make a substantial contribution (a minimum of 40 years is suggested)	Trees that are particularly good examples of their species, especially if rare or unusual, or essential components of groups, or of formal or semi-formal arboricultural features (e.g. the dominant and/or principal trees within an avenue)	Trees, groups or woodlands which provide a definite screening or softening effect to the locality in relation to views into or out of the site, or those of particular visual importance (e.g. avenues or other arboricultural features assessed as groups)	Trees, groups or woodlands of significant conservation, historical, commemorative or other value (e.g. veteran trees or wood-pasture)	LIGHT GREEN
Category B **Those of moderate quality and value:** those in such a condition as to make a significant contribution (a minimum of 20 years is suggested)	Trees that might be included in the high category, but are downgraded because of impaired condition (e.g. presence of remediable defects including unsympathetic past management and minor storm damage)	Trees present in numbers, usually as groups or woodlands, such that they form distinct landscape features, thereby attracting a higher collective rating than they might as individuals but which are not, individually, essential components of formal or semi-formal arboricultural features (e.g. trees of moderate quality within an avenue that includes better, A category specimens), or trees situated mainly internally to the site, therefore individually having little visual impact on the wider locality	Trees with clearly identifiable conservation or other cultural benefits	MID BLUE
Category C **Those of low quality and value:** currently in adequate condition to remain until new planting could be established (a minimum of 10 years is suggested), or young trees with a stem diameter below 150 mm	Trees not qualifying in higher categories	Trees present in groups or woodlands, but without this conferring on them significantly greater landscape value, and/or trees offering low or only temporary screening benefit	Trees with very limited conservation or other cultural benefits	GREY
	NOTE Whilst C category trees will usually not be retained where they would impose a significant constraint on development, young trees with a stem diameter of less than 150 mm should be considered for relocation.			

4.3.2 The purpose of the tree categorization method, which should be applied by an arboriculturist, is to identify the quality and value of the existing tree stock, allowing informed decisions to be made concerning which trees should be removed or retained should development occur.

4.3.3 For a tree to qualify under any given category it should fall within the scope of that category's definition (R, A, B, C) and, for a tree in categories A–C, it should qualify under one or more of the three subcategories (1, 2, 3).

4.3.4 In the categories A, B, C, which together deal with trees that should be a material consideration in the development process, the subcategories are intended to reflect arboricultural, landscape and cultural values respectively. Category R trees are those which would be lost in the short term for reasons connected with their physiological or structural condition. For this reason, they should not be a consideration in the planning process (see note to **6.1**).

4.3.5 The tree survey schedule should list which subcategory applies. It is intended that each subcategory has equal weight such that, for example, an A1 tree has the same retention priority as an A2 tree. Some trees could qualify under two or even three criteria, e.g. A1 and 2 but would not accrue added value.

4.3.6 When determining the appropriate category for any given tree, group or woodland, the arboriculturist should start by determining whether the tree falls within the scope of the R category. Assuming that the tree can be retained, the arboriculturist should then proceed on the presumption that all trees are considered according to the criteria for inclusion in the high category. Trees that do not meet these strict criteria should then be considered in light of the criteria for inclusion in the moderate category. This cascade process should be repeated, as required, until the appropriate quality and value assessment is reached.

NOTE The term "group" is intended to identify trees that form cohesive arboricultural features either **aerodynamically** (e.g. trees that provide companion shelter), **visually** (e.g. avenues or screens) or **culturally** including for biodiversity (e.g. parkland or wood pasture), in respect to each of the three subcategories.

4.3.7 When assigning trees to any of the categories, the presence of any serious disease or tree-related hazards should be taken into account. If disease is fatal and/or irremediable or likely to require sanitation for the protection of other trees, the trees concerned may need to be categorized as R, even if they otherwise have considerable value. If mechanical defects present an unacceptable risk to people and property, the extent to which the defects are remediable, including the effect that this might have on the tree's remaining value, should indicate whether the tree should still be assigned to the category that it would otherwise merit.

NOTE If a layout design places category R trees in an inaccessible location such that concerns over public safety are reduced to an acceptable level, it may be preferable or possible to defer the recommendation to fell.

4.4 Additional considerations

4.4.1 During the course of a tree survey, it might be found that certain trees require immediate attention. For example, they might present an immediate and serious hazard to life or property, or they might be affected by a pest or pathogen which would cause widespread and serious damage unless eradicated. These issues should be brought to the attention of the appropriate party as soon as possible.

4.4.2 Particular care is needed when considering the quality and value category of young trees, especially where they occur as individual specimens. Where these are less than 150 mm stem diameter (at 1.5 m above adjacent ground level), it may be relatively straightforward to relocate them within the site (e.g. using a tree spade) or to replace them with similar replacement trees. Whilst the presence of young trees of good form and vitality is generally desirable (i.e. those trees which have the potential to develop into quality mature specimens), they should not be allowed to dominate site layout considerations. When evaluating the merits of retaining and/or relocating such trees, a comparison between the costs of the various options should be the main determining factor. However, they should be categorized as C grade trees.

NOTE It is sometimes possible to relocate mature trees. However, as this is a costly and complex operation with a variable chance of success, it is only a viable option in exceptional cases.

4.4.3 The tree survey may identify the presence of veteran trees on the site. Such trees should be considered carefully in relation to new development, as it is rarely acceptable to locate them within developed areas, rather than open space. The implications of their presence on the land use of the surrounding site should be assessed at the earliest possible stage of the planning process. Veteran trees should be assessed according to the recommendations in **4.3.1**. By this assessment, most genuine veteran trees are likely to be included in category A3.

4.5 Tree survey — post-planning

It is recognized that, on occasions, arboricultural advice is not sought until after a preliminary site layout has been prepared. Although this is not the ideal situation, timely and appropriate expert advice can still make a valuable contribution to the process of tree retention and protection. In cases where the arboriculturist is provided with a layout, the tree survey should be undertaken as described in **4.2** to provide advice on tree retention, protection, remedial or mitigation works and new landscape design. It is essential that the trees are assessed objectively and without reference to site layout proposals.

5 Tree constraints plan

5.1 General

The influence that trees on and adjacent to the site will have on the layout should be plotted on a plan called the tree constraints plan (TCP). This is a design tool which should show the below ground constraints, represented by the RPA, and the above ground constraints the trees pose by virtue of their size and position.

5.2 Root protection area (RPA)

5.2.1 In order to avoid damage to the roots or rooting environment of retained trees, the RPA should be plotted around each of the category A, B and C trees (see **4.3**). This is a minimum area in m^2 which should be left undisturbed around each retained tree.

5.2.2 The RPA should be calculated using Table 2 as an area equivalent to a circle with a radius 12 times the stem diameter for single stem trees and 10 times basal diameter for trees with more than one stem arising below 1.5 m above ground level.

Table 2 — Calculating the RPA

Number of stems	Calculation
Single stem tree	$\text{RPA}(m^2) = \left(\frac{\text{stem diameter (mm) @ 1.5 m} \times 12}{1\ 000}\right)^2 \times 3.142$
Tree with more than one stem arising below 1.5 m above ground level	$\text{RPA}(m^2) = \left(\frac{\text{Basal diameter (measured immediately above root flare (mm)} \times 10}{1\ 000}\right)^2 \times 3.142$
NOTE The 12× multiplier is based on NJUG 10 [9] and published work by Matheny and Clark [10].	

5.2.3 The calculated RPA should be capped to 707 m^2, e.g. which is equivalent to a circle with a radius of 15 m or a square with approximately 26 m sides.

5.2.4 The RPA, for each tree as determined in Table 2, should be plotted on the TCP taking full account of the following factors, as assessed by an arboriculturist, which may change its shape but not reduce its area whilst still providing adequate protection for the root system.

a) The likely tolerance of the tree to root disturbance or damage, based on factors such as species, age and condition and presence of other trees. (For individual open grown trees only, it may be acceptable to offset the distance by up to 20 % in one direction.) (See Note 1 of **11.3.5**.)

b) The morphology and disposition of the roots, when known to be influenced by past or existing site conditions (e.g. the presence of roads, structures and underground services).

c) The soil type and structure.

d) Topography and drainage.

e) Where any significant part of a tree's crown overhangs the provisional position of tree protection barriers, these parts may sustain damage during the construction period. In such cases, it may be necessary to increase the extent of tree protection barriers to contain and thereby protect the spread of the crown. Protection may also be achieved by access facilitation pruning (see **11.2.1**). The need for such measures, including the precise extent of pruning, should be assessed by an arboriculturist.

5.3 Above ground constraints

5.3.1 The current and ultimate height of category A, B and C trees should be annotated on the tree constraints plan (TCP) where this would cause unreasonable obstruction of sunlight or daylight to the development. In practice this could be represented by a segment with a radius from the centre of the stem equal to the height of the tree drawn from due North West to due East indicating the shadow pattern through the main part of the day.

NOTE 1 This varies between species and depends on foliage size and density (see BRE 350 [11]).

NOTE 2 The spatial relationship of the proposed development to the tree(s) affects the amount of sunlight received, the amount of sky visible from the development and the solar gain received by the development (see BRE 209 [12]).

NOTE 3 Proprietary software is available that can assist with calculation and plotting of tree shadow extent (see also BRE CP75/75 [13]).

5.3.2 The current and ultimate height and spread of a tree is also a constraint due to its size, dominance and movement in strong winds. For this reason, as well as in relation to shading, the existing spread of branches and the future branch growth should be taken into consideration as a constraint in the design phase.

6 Arboricultural implications assessment (AIA) and design issues

6.1 General

Whilst the tree constraints plan (TCP) should inform site layout design, it is recognized that the competing needs of development mean that trees are only one factor requiring consideration. Certain trees are of such importance and sensitivity as to prevent development occurring or to substantially modify its design and layout. However, care should be taken to avoid misplaced tree retention; attempts to retain too many or unsuitable trees on a site may result in excessive pressure on the trees during development work and subsequent demands for their removal. The end result may be fewer or less suitable trees than would be the case if arboricultural input, planning, selection, conservation and new planting is incorporated into the approved final design.

NOTE Trees are material considerations in the formal planning system, whether or not they are statutorily protected.

6.2 Tree constraints and design

6.2.1 Trees can impinge on many aspects of site development. Adequate consideration should be given to the requirements of trees by all members of the design team throughout the development process.

6.2.2 Even if there are no trees on the site, areas for future planting should be plotted on the tree constraints plan (TCP) and protected from damage, especially soil compaction due to construction activity, by the erection of barriers and/or ground protection (see **7.1**). Where such pre development protection is not implemented, prior remediation measures should be employed, such as soil ripping with a winged-tined plough or subsoil aeration.

6.2.3 During the design and planning stages the following factors should be taken into account.

a) The presence of tree preservation orders or conservation area protection.

b) The effect that development proposals may have on the amenity value of trees, both on and near the site.

c) The above and below ground constraints (see Clause **5** and **6.3.2**).

d) The construction of the proposed development (see **7.2**).

e) Whether the design and/or construction of the proposed development can be modified to accommodate retention of trees that would otherwise be at risk or lost. This includes appropriate tree surgery works that acceptably mitigate adverse effects caused by trees.

f) Infrastructure requirements, e.g. easements for underground or above ground services; highway safety and visibility splays; and other infrastructural provisions, such as substations, refuse stores, lighting, signage and CCTV requirements.

g) The end use of the space.

h) Whether tree loss resulting from the development proposals can be acceptably mitigated by new tree planting.

NOTE There is a need to avoid the cumulative damaging effects of incursions into the RPA, for example from excavation for services and the laying of permanent hard surfaces.

6.2.4 Particular care is needed regarding the retention of large old trees which become enclosed within the new development. Such trees may be less resilient and more likely to die or become potentially unsafe as a result of the pressures associated with development. Even if they survive in the short term, they may die before the new buildings are obsolete. Their subsequent removal can pose technical difficulties and be costly. Where the retention of large, mature or veteran trees is considered desirable, it may be most effective to conserve them by incorporating them into open spaces or large gardens, thereby allowing adequate space for their long term physical protection and maintenance.

6.3 Proximity of trees to structures

6.3.1 A realistic assessment of the probable impact of any proposed development on the trees and vice versa should take into account the characteristics and condition of the trees, with due allowance and space for their future growth and maintenance requirements.

6.3.2 The relationship of windows to trees which may obstruct light, should be taken into account. Excessive shading by trees should be avoided, particularly to rooms requiring light. This will vary with orientation and aspect of the building, proximity to the tree and the type of tree as foliage size and density varies with species (see also BRE Guides in the Bibliography).

6.3.3 Damage can occur to trees and structures by the continuous whipping of branches. Branch ends may have to be cut back repeatedly, possibly spoiling the shape of the tree. Trees should not be retained on the basis that their ultimate branch spread can be significantly controlled by periodic pruning, unless this is a desired management outcome (e.g. pollarded trees).

6.3.4 Large trees can cause apprehension to occupiers of nearby buildings especially during windy conditions.

6.3.5 Leaves of some species may cause problems, particularly in the autumn, by blocking gullies and gutters. Fruit can cause slippery patches and accumulation of honeydew may be damaging to surfaces and vehicles.

7 Arboricultural method statements (AMS) and the tree protection plan (TPP)

7.1 Once the layout proposals have been finalized a TPP should be prepared containing the following information:

a) trees selected for retention, clearly identified (e.g. by number) and marked on a plan with a continuous outline;

b) trees to be removed, also clearly identified (e.g. by number) and marked on a plan with a dashed outline;

c) the precise location for erection of protective barriers and any other relevant physical protection measures including ground protection (see Clause **5** and Clause **9**), to protect the RPA and marked as a construction exclusion zone on the plan (see **7.2**).

NOTE 1 While the root protection area may be plotted as a circle on the constraints plan, the position of the barrier and any ground protection should be shown on subsequent plans as a polygon representing the actual position of the protection. It is helpful during setting out, and for the purposes of enforcement if the plan is annotated with the dimensions of the exclusion zones.

d) design details of the proposed physical means of protection, indicated through drawings and/or descriptive text, including any development facilitation pruning;

e) areas of structural landscaping to be protected from construction operations to prevent the soil structure being damaged (see **6.2.2**).

f) all the details in a)–e) above should be incorporated into subsequent drawings and method statements used for design purposes or issued for use on site, to ensure that all interested parties are fully aware of the areas in which access and works may and may not take place.

NOTE 2 Attention is drawn to the CDM Regulations [7].

7.2 In order to avoid disturbance to the physical protection forming the construction exclusion zone once it is installed, it is essential to consider, make allowance for and plan all construction operations which will be undertaken in the vicinity of trees, in particular:

a) site construction access;

b) the intensity and nature of the construction activity;

c) contractors' car parking;

d) phasing of construction works;

e) the space needed for all foundation excavations and construction works;

f) the availability of special construction techniques (see Clause **11**);

g) the location and space needed for all service runs including foul and surface water drains, land drains, soakaways, gas, oil, water, electricity, telephone, television or other communication cables;

h) all changes in ground level, including the location of retaining walls, steps and making adequate allowance for foundations of such walls and backfillings;

i) space for cranes, plant, scaffolding and access during works;

j) space for site huts, temporary latrines (including their drainage) and other temporary structures;

k) the type and extent of landscape works which will be needed within the protected areas, and the effects these will have on the root system (for guidance see **11.9** for hard landscape and Clause **12** for soft landscape);

l) space for storing (whether temporary or long-term) materials, spoil and fuel and the mixing of cement and concrete.

m) the effects of slope on the movement of potentially harmful liquid spillages towards or into protected areas (see **9.4.2**).

8 Pre development tree work

8.1 General

Once a final layout for the development area has been approved, an arboriculturist should review the relationship of the development to the trees and prepare a schedule of tree works listing all the trees that require work by number, accompanied by a plan showing where each tree is located. The schedule should include all the trees to be removed to clear the main development area and those remaining that require remedial works. Remedial tree works should be based on what is required to establish acceptable levels of risk and management in the context of the proposed land use. The schedule of works should be accompanied by a detailed specification describing each work operation (see BS 3998).

NOTE Tree work is a specialist task that requires competent operatives, adequately insured. Guidance on the selection of an appropriate contractor can be obtained from the Arboricultural Association, which has a Directory of Approved Contractors (see Annex B for contact details).

8.2 Working within the RPA

8.2.1 Care should be taken to ensure during tree removal or remedial work that damage to the retained trees and/or disturbance to the RPA is avoided. Appropriate precautions should include dismantling techniques to reduce the risk of accidental damage and ground protection where excessive pedestrian movements or use of plant and machinery may lead to compaction.

8.2.2 Debris from tree work might be removed from site, chipped and left on site, or left on site in an unprocessed form as habitat depending on the site circumstances. Debris should not be burnt where it could damage the crowns of retained trees. Stumps within RPAs should not be dug or pulled out but should be ground out, if removal is required, to avoid adverse impact on retained trees. Consideration should be given to leaving standing stumps and debris as habitat for wildlife if the circumstances allow (see BS 3998[1)]).

9 The construction exclusion zone: barriers and ground protection

9.1 General

9.1.1 All trees which are being retained on site should be protected by barriers and or ground protection, as recommended in Clause **7**. Vertical barriers should be erected and ground protection installed before any materials or machinery are brought onto the site and before any demolition, development or stripping of soil commences. Areas of new or retained structure planting should be similarly protected, based on the extent of the soft landscaping as shown on the approved drawings. Once erected, barriers and ground protection should be regarded as sacrosanct, and should not be removed or altered without prior recommendation by an arboriculturist and approval of the local planning authority.

9.1.2 In the case of particularly vunerable trees or trees sited close to the construction access, the owner or developer should make arrangements for an arboriculturist to supervise necessary works and the erection of protection before the handover of land to the contractor.

9.1.3 Pre development tree work may be undertaken before the installation of tree protection, where required, with the agreement of the local planning authority (see Clause **8**).

9.2 Barriers

9.2.1 Barriers should be fit for the purpose of excluding construction activity and appropriate to the degree and proximity of work taking place around the retained tree(s). On all sites, special attention should be paid to ensuring that barriers remain rigid and complete.

9.2.2 In most cases, barriers should consist of a scaffold framework in accordance with Figure 2 comprising a vertical and horizontal framework, well braced to resist impacts, with vertical tubes spaced at a maximum interval of 3 m. Onto this, weldmesh panels should be securely fixed with wire or scaffold clamps. Weldmesh panels on rubber or concrete feet are not resistant to impact and should not be used.

NOTE The above is preferred because it is readily available, resistant to impact, can be re-used and enables inspection of the protected area.

9.2.3 It may be appropriate on some sites to use temporary site office buildings as components of the tree protection barriers.

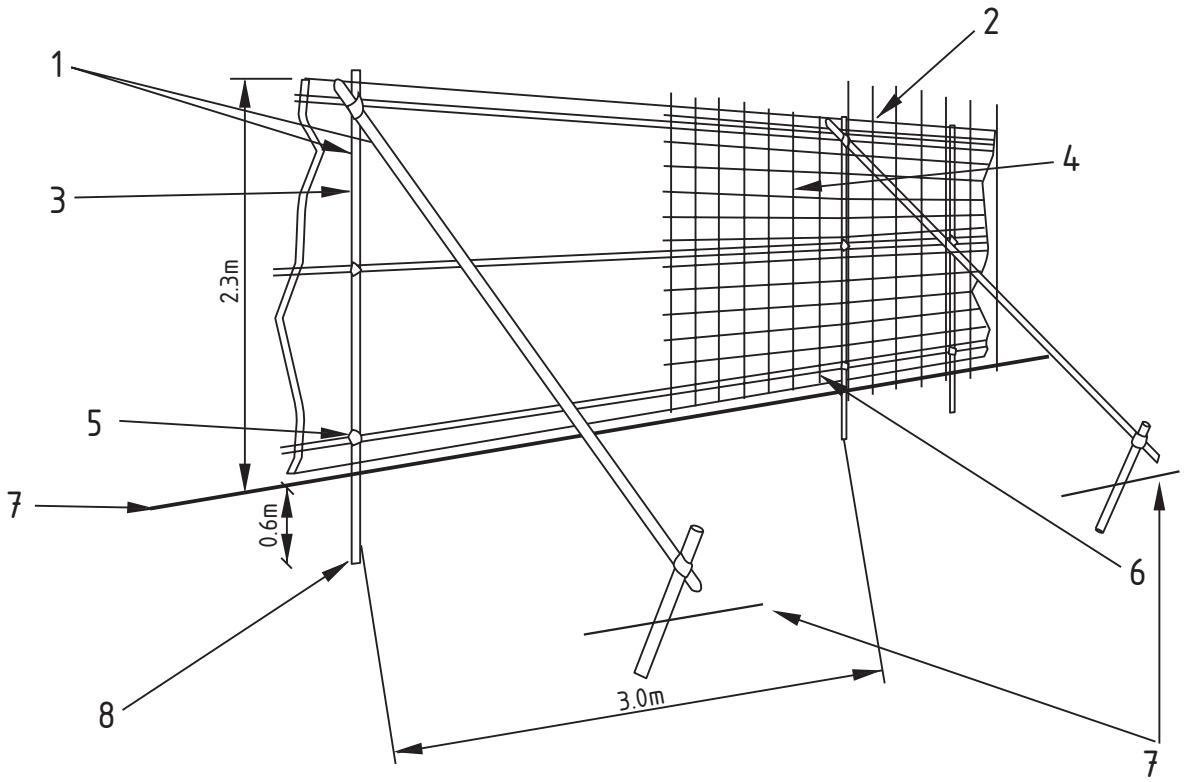
[1)] Revision in preparation.

9.3 Ground protection

9.3.1 Where it has been agreed during the design stage, and shown on the tree protection plan, that vehicular or pedestrian access for the construction operation may take place within the root protection area (RPA), the possible effects of construction activity should be addressed by a combination of barriers and ground protection. The position of the barrier may be shown within the RPA at the edge of the agreed working zone but the soil structure beyond the barrier to the edge of the RPA should be protected with ground protection.

9.3.2 For pedestrian movements within the RPA the installation of ground protection in the form of a single thickness of scaffold boards on top of a compressible layer laid onto a geotextile, or supported by scaffold, may be acceptable (see Figure 3).

9.3.3 For wheeled or tracked construction traffic movements within the RPA the ground protection should be designed by an engineer to accommodate the likely loading and may involve the use of proprietary systems or reinforced concrete slabs (see **11.8** and **11.9**).



1 Standard scaffold poles
2 Uprights to be driven into the ground
3 Panels secured to uprights with wire ties and where necessary standard scaffold clamps
4 Weldmesh wired to the uprights and horizontals
5 Standard clamps
6 Wire twisted and secured on inside face of fencing to avoid easy dismantling
7 Ground level
8 Approx. 0.6 m driven into the ground

Figure 2 — Protective barrier

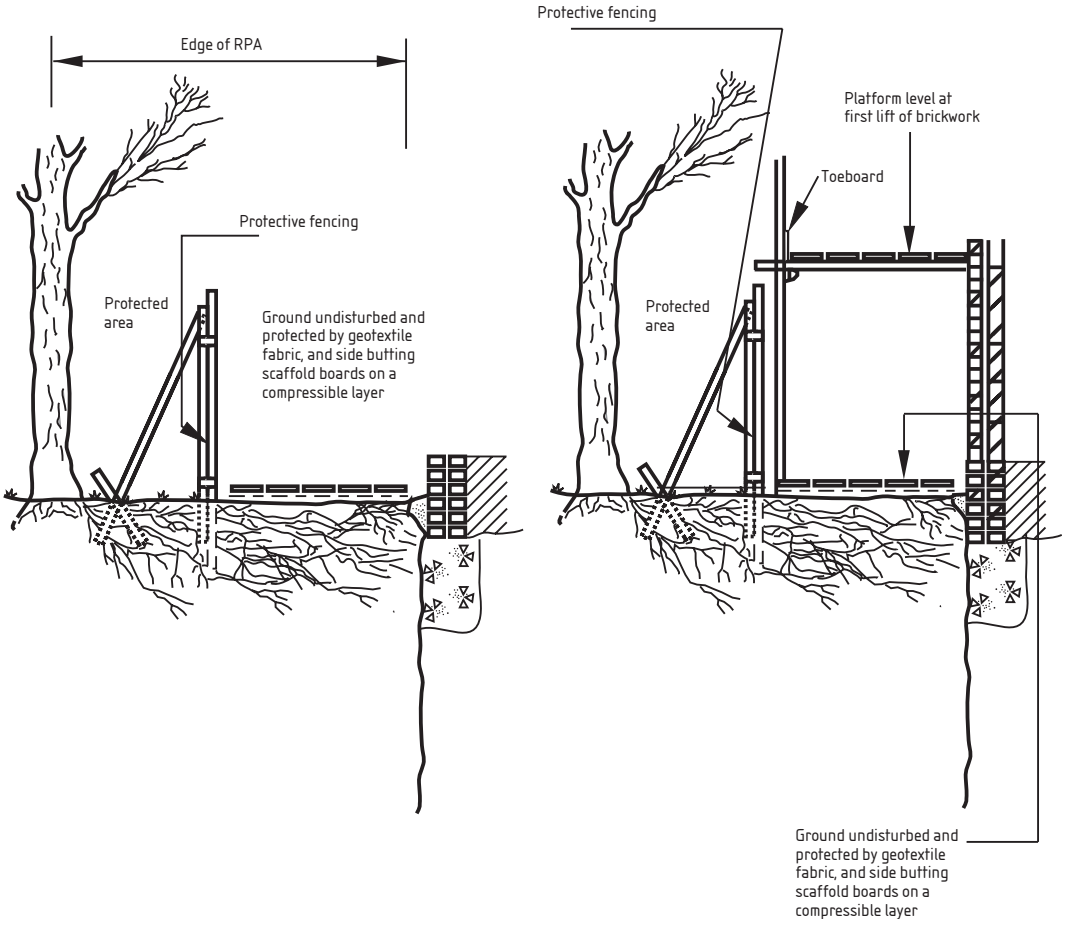


Figure 3 — Scaffolding within the RPA

9.4 Additional precautions outside the exclusion zone

9.4.1 Once the exclusion zone has been protected by barriers and/or ground protection, construction work can commence. All weather notices should be erected on the barrier with words such as:

"Construction exclusion zone — Keep out".

9.4.2 In addition the following should be addressed or avoided.

a) Care should be taken when planning site operations to ensure that wide or tall loads, or plant with booms, jibs and counterweights can operate without coming into contact with retained trees. Such contact can result in serious damage to them and might make their safe retention impossible. Consequently, any transit or traverse of plant in close proximity to trees should be conducted under the supervision of a banksman to ensure that adequate clearance from trees is maintained at all times. In some circumstances it may be impossible to maintain adequate clearance thus necessitating access facilitation pruning (see **11.2.1**).

b) Material which will contaminate the soil, e.g. concrete mixings, diesel oil and vehicle washings, should not be discharged within 10 m of the tree stem.

c) Fires should not be lit in a position where their flames can extend to within 5 m of foliage, branches of trunk. This will depend on the size of the fire and the wind direction.

d) Notice boards, telephone cables or other services should not be attached to any part of the tree.

9.4.3 It is essential that allowance should be made for the slope of the ground so that damaging materials such as concrete washings, mortar or diesel oil cannot run towards trees.

10 Avoiding damage to structures by trees

10.1 General

10.1.1 Buildings should be constructed to allow for future growth of planted or self-sown trees.

10.1.2 In some situations, trees and vegetation can adversely affect structures either by direct action (see **10.2**), or by indirect action (see **10.3**) causing shrinkage or swelling of a clay subsoil.

10.1.3 Even if no trees exist at the time of construction, they may be planted in the future or self-seeded. Consideration should be given to this possibility by having foundations in accordance with Table 3 which will allow for reasonable future vegetation, or to an engineered design (see NHBC Standards, Chapter 4.2 [14]).

10.2 Direct damage by trees to structures

10.2.1 Trees can cause direct damage to structures by:

a) the disruption of underground services and pipelines;

b) displacement, lifting or distorting;

c) the impact of branches with the superstructure;

d) structural failure of the tree.

The potential for direct damage should be taken into consideration throughout the design and construction process.

10.2.2 The growth of the base of the stem or of roots near the surface exerts relatively small forces. Whilst paving slabs or low boundary walls can be lifted or pushed aside easily, heavier or stronger structures are more likely to withstand these forces without damage, as the root distorts around the obstruction before damage occurs. The greatest risk of direct damage occurs close to the tree from the incremental growth of the main stem and secondary thickening of the roots, and diminishes rapidly with distance.

10.2.3 New tree planting should be kept at distances from structures of at least those in Table 3.

10.2.4 In the case of established trees where construction work is to take place near to the main stem and roots, the following precautions should be taken to allow for future tree growth in order to protect the structure:

a) foundations should be reinforced to resist lateral thrust; or

b) walls or structural slabs should bridge over roots allowing sufficient clearance for secondary thickening or be designed to distort without cracking; or

c) pavings and other surfaces should be laid on a flexible base to allow movement and to facilitate relaying if distortion becomes excessive.

10.2.5 Water leaking from damaged drains, sewers or water mains encourages localized root growth. Roots are then likely to enter a drain or sewer through the defect and proliferate, causing blockage and an enlarging of the initial defect. Provided they are further from trees than distances stipulated in Table 3, intact drains are not likely to suffer direct damage and will not attract roots. Damage to drains and sewers can be avoided by the following:

a) re-routeing services to conform to Table 3;

b) ensuring watertight joints;

c) in clay soils, use of flexible materials and/or joints to accommodate movement;

d) not using perforated land drains near trees.

10.2.6 Allowance should be made for the swaying of stem and branches during storm conditions. Branches which are liable to strike the structure should be pruned back to a suitable branching point (see BS 3998). Trees in a condition that renders them liable to collapse should not be retained near structures (see category R in Table 1).

Table 3 — Minimum distance (m) between young trees or new planting and structure to avoid direct damage to a structure from future tree growth

Type of structure	Diameter of stem at 1.5 m above ground level at maturity		
	<30 cm	(30–60) cm	>60 cm
Buildings and heavily loaded structures	—	0.5	1.2
Lightly loaded structures such as garages, porches etc.	—	0.7	1.5
Drains and underground services			
<1 m deep	0.5	1.5	3.0
>1 m deep	—	1.0	2.0
Masonry boundary walls[a]	—	0.5	1.0
	—	(1.0)	(2.0)
In situ concrete paths and drives[a]	—	0.5	1.5
	(0.5)	(1.0)	(2.5)
Paths and drives with flexible surfaces or paving slabs[a]	—	0.5	1.0
	(0.7)	(1.5)	(3.0)

[a] These distances assume that some movement and minor damage might occur. Guidance on distances which will generally avoid all damage is given in brackets.

10.3 Indirect damage by trees to structures

For guidance on avoiding indirect damage by trees to structures see NHBC Chapter 4.2 [14].

11 Demolition and construction in proximity to existing trees

11.1 General

11.1.1 Whilst the most reliable way to ensure tree retention is to preserve the RPA completely undisturbed, it may be necessary to undertake demolition operations and/or to incorporate hard surfaces and other construction within it. The ability of the tree(s) to tolerate some disturbance depends on individual circumstances including prevailing site conditions. Accordingly the advice of an arboriculturist should be sought for any operations within the root protection area. It should be noted that, in general, the older the tree, the less successfully it will adapt to new conditions. For this reason, the details of designs incorporating such trees should be considered with particular care (see also **6.2.3**).

11.1.2 Where it is intended to undertake demolition or construction operations within the root protection area, precautions should be taken to maintain the condition and health of the root system (see Annex C) and in particular to:

a) prevent physical damage to the roots during demolition or construction (such as by soil compaction or severing);

b) make provision for water and oxygen to reach the roots;

c) allow for the future growth of the root system;

d) preserve the soil structure at a suitable bulk density for root growth and function (in particular for soils of a high fines content).

11.1.3 Throughout the process of demolition or construction, including piling (see **11.6.3**), the soil structure within the root protection area should be protected. The methods of protecting trees from damage during all phases of demolition and construction work should conform to Clause **7** and Clause **9**.

11.2 Requirements for tree protection during demolition

11.2.1 Where demolition is proposed on a site where trees are to be retained, access facilitation pruning (see also Clause **8**) should be undertaken to prevent injurious contact between demolition plant and the tree(s). Any such pruning should be undertaken in accordance with a specification prepared by an arboriculturist.

11.2.2 Demolition of structures (including underground structures) within what would otherwise be a RPA should proceed according to the principles outlined in Clause **9**. Barriers should be erected and fit for purpose ground protection installed to the edge of the existing structure.

11.2.3 All plant and vehicles engaged in demolition works should either operate outside the RPA, or should run on a temporary surface designed to protect the underlying soil structure. Where such ground protection is required, it should be installed prior to commencement of operations (see **9.3**).

11.2.4 Where trees stand adjacent to structures scheduled for demolition, it may be necessary to undertake demolition inwards within the footprint of the existing building (often referred to as "top down, pull back"). Where levels of dust build-up on trees are likely, it may be necessary to seek the advice of an arboriculturist on remedial measures, e.g. hose down the tree(s) immediately following any significant accumulation of dust.

11.2.5 Where an existing hard surface is scheduled for removal, care should be taken not to disturb tree roots that may be present beneath it. Hand held tools or appropriate machinery should be used (under arboricultural supervision) to remove the existing surface. Tree roots exposed by such operations should be treated in accordance with details in **11.3**.

11.2.6 The advice of an arboriculturist should be sought where underground structures present within the RPA are/will become redundant. In general it is preferable to seal these off as this avoids the need for significant excavation.

11.3 Principles for avoiding tree root damage during construction

11.3.1 Prior to the installation of a new ground surface, existing ground cover vegetation (e.g. grass sward) should be killed using an appropriate herbicide (see *Pesticides Handbook* [15]). Herbicides that can leach through the soil, e.g. products containing sodium chlorate, should not be used. Specialist advice should be sought in order to determine the most suitable herbicide treatment.

11.3.2 The soil surface should not be skimmed to establish new paving or other surfaces at the former ground level. Loose organic matter and/or turf should be removed carefully using hand tools. The new surface should then be established above the former ground level, using a granular fill, where required.

11.3.3 If ground levels are to be raised within the RPA this should be achieved by use of a granular material which does not inhibit vertical gaseous diffusion. Examples of suitable granular materials include, no-fines gravel, washed aggregate, or cobbles. Depending on the California Bearing Ratio (CBR) of the soil, it may be necessary to install a load suspension layer such as a cellular confinement system.

11.3.4 In concentration carbon dioxide is detrimental to tree root function. Because this gas principally diffuses vertically through the soil, new impermeable surfacing within the RPA should be restricted to a maximum width of 3 m and situated tangentially to one side of a tree only, or confined to an area no greater than 20 % of the root protection area, whichever is the smaller.

11.3.5 Any excavations which have to be undertaken within the root protection area should be carried out carefully by hand, avoiding damage to the protective bark covering larger roots. Roots, whilst exposed, should be wrapped in dry, clean hessian sacking to prevent desiccation and to protect from rapid temperature changes. Roots smaller than 25 mm diameter may be pruned back, preferably to a side branch, using a proprietary cutting tool such as bypass secateurs or handsaws. Roots larger than 25 mm should only be severed following consultation with an arboriculturist, as they may be essential to the tree's health and stability. Prior to backfilling, any hessian wrapping should be removed and retained roots should be surrounded with sharp sand (builders' sand should not be used because of its high salt content which is toxic to tree roots), or other loose granular fill, before soil or other material is replaced. This material should be free of contaminants and other foreign objects potentially injurious to tree roots.

NOTE 1 The use of a trenching saw reduces the risk of longitudinal root shattering which can often occur where backactors are used to excavate trenches near to trees.

NOTE 2 Due to the demands that hand excavation places on a development project and its limitations with regards to health and safety considerations, it may be preferable to employ no-dig techniques.

11.4 Provision for water and oxygen

11.4.1 It is essential to maintain adequate supplies of water and oxygen for trees through the soil. Porosity is important particularly where the new hard surface covers an area of previously unmade ground, under which tree roots may have developed preferentially. New impermeable surfacing should not cover more than 20 % of the root protection area.

11.4.2 No-fines granular materials should be used wherever fill or a sub-base is required to help to ensure adequate gaseous diffusion. Due to the need to avoid excavation, and thereby root severance, within the RPA such sub-bases should be formed using a cellular confinement system such as a load suspension layer laid at ground level.

11.4.3 Excess water in the root protection area should be avoided, particularly on clay soils where waterlogging can occur. In these cases, the hard surface should slope away from the tree to avoid ponding. Provided surface water is not liable to be contaminated by salt or toxic run-off from oil or petrol, a permeable surface should be employed. If contamination is likely to be a problem, an impermeable surface may be used to prevent entry of toxic material (however see **11.4.1**).

11.4.4 If excess water is likely to be a problem, consideration should be given to the provision of suitable land drainage. Such drains should not be located within root protection areas.

11.5 Allowance for future growth

11.5.1 Future growth can lift paths or distort light structures such as walls (see also **10.2** and Table 3). Where such structures, including surfaces, are unavoidable near to trees, design and construction specification should take account of future growth.

11.5.2 If it is necessary to build a wall or similar structure over a root greater than 50 mm diameter, provision should be made for future diameter growth by surrounding the root with uncompacted sharp sand, void-formers, or other flexible fill materials, and by laying an adequately reinforced lintel or raft over the surface.

11.6 Foundations within the RPA

11.6.1 The insertion of structures within root protection areas may be justified if this allows the retention of a good quality tree (category A or B, see Table 1). However, it is essential that careful consideration is given to foundation design (see **11.6.2**). In such cases, the use of traditional strip footings, in particular those constructed tangentially across the root zone, can result in severe damage to tree roots and should be avoided.

11.6.2 Root damage can be minimized by using a combination of the following:

— piles or radial strip footings both of which should be located to avoid major tree roots;

— beams, slabs, suspended floors, where all should be laid at or above ground level, and cantilevered as necessary to avoid tree roots.

In order to arrive at a suitable solution, site specific and specialist advice regarding foundation design should be sought from an arboriculturist and an engineer.

11.6.3 Where piling is to be installed near to trees, the smallest practical pile diameter should be used as this reduces the possibility of striking major tree roots, and reduces the size of the rig required to sink the piles. The latter is particularly important where piling within the branch spread is proposed, as mini-rigs reduce the need for access facilitation pruning. Sheathed piles protect the soil and adjacent roots from the potential toxic effects of concrete.

11.7 Underground and above ground services

11.7.1 Trenching for the installation of underground services severs any roots present and may change the local soil hydrology in a way that adversely affects the health of the tree. For this reason particular care should be taken in the routeing and methods of installation of all underground services. Wherever possible, they should be kept together and trenchless techniques used. At all times where services are to pass within the RPA, detailed plans showing the proposed routeing should be drawn up in conjunction with an arboriculturist. Such plans should also show the levels and access space needed for installing the services and be accompanied by arboricultural method statements (AMS).

11.7.2 As an alternative to trenchless techniques, a possible solution is to hand excavate a narrow trench passing directly towards a tree along a radius to not closer than 1 m from the trunk, tunnel straight beneath the tree, preferably not less than 750 mm deep, and exit on the opposite side along another radius (see Figure 4). Provided the trench is kept as narrow as possible, the amount of root severance will be minimal, and will be far less than if a trench passes close beside the tree. It may be necessary to make provision to facilitate future servicing and repair without further damage to the tree roots.

11.7.3 Consideration should be given to the routeing of above ground services in order to avoid the need for detrimental and repetitive pruning. In this regard the current and future crown size of the tree should be assessed. Tree branches can be pruned back with care (see BS 3998) to provide space.

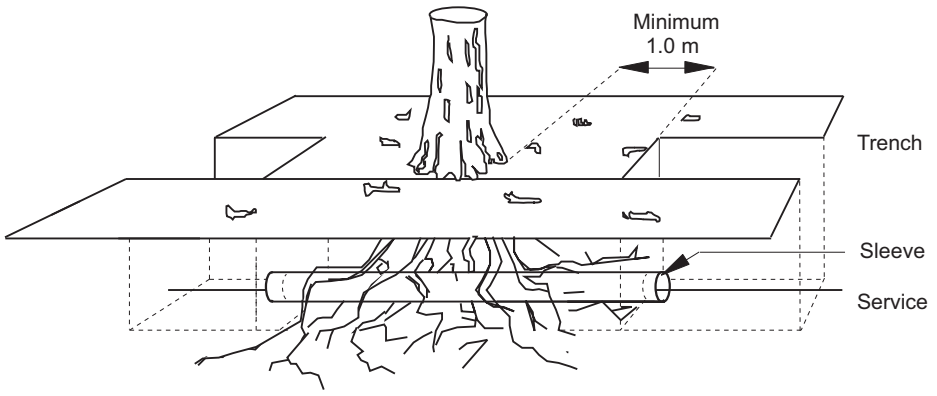


Figure 4 — Trenching along radii to minimize damage

11.8 Low-invasive vehicular access in proximity to trees

11.8.1 Where the construction of hard surface access cannot be avoided within the root protection area, a no-dig design should be used to avoid root loss due to excavation. In addition the structure of the hard surface should be designed to avoid localized compaction, by evenly distributing the carried weight over the track width and wheelbase of any vehicles that will use the access. Such designs might include the use of a three dimensional cellular confinement system as an integral component of the sub-base, to act as a load suspension layer. Driveways and roadways constructed according to this principle can be designed to be suitable for most types of traffic. Where this type of access is proposed, site-specific and specialist advice should be sought from an engineer and an aboriculturist in order to ensure that it is fit for purpose.

NOTE The use of two dimensional load suspension systems is not recommended.

11.8.2 Where the new access would cover in excess of 20 % of the RPA or be wider than 3 m within it, it should be constructed so as to allow moisture infiltration and gaseous diffusion.

NOTE It is an engineering requirement that roads constructed to a standard suitable for adoption by a local authority are waterproof. For this reason, such roads are impermeable and should, therefore, not exceed the 20 %/3 m limit of RPA coverage referred to above.

11.9 Types of hard surface and their suitability in proximity to trees

11.9.1 *General*

If a hard surface is proposed above the granular material, a permeable and gas-porous finished surface (wearing course) should be installed.

In some situations, consideration should be given to constructing the final surface prior to the main building works, so as to provide protection for the roots at subsequent stages. However, it may be desirable to protect the final surface from damage with a temporary covering.

11.9.2 *Washed gravel*

Washed gravel retains its porosity unless excessively consolidated, and is particularly useful where changes of level occur or an irregular shape is needed around the stem of a tree. Gravel is easily renewed or topped up. Although weeds may become established, they can be controlled by chemical or mechanical means. However, gravel is rarely suitable for use where there is vehicle or pedestrian traffic for example, in residential areas. Materials with a high fines content, such as binding gravels or hoggin, should not be used due to their almost impermeable texture when consolidated.

11.9.3 *Paving slabs and block pavers*

Paving slabs and block pavers are available with built in infiltration spaces between the slabs or blocks. These are ideal, though they should be laid dry-jointed on a sharp sand foundation to allow air and moisture to penetrate to the rooting area.

11.9.4 *In situ concrete*

As in situ concrete forms an impermeable surface, falls and openings should be provided for water and air to enter the soil. This can be achieved by forming 50 mm diameter holes in the construction of a slab at regular spacings of 300–600 mm (as determined by an engineer) and back-filling the resulting holes with no-fines gravel or aggregate. A high standard of materials and workmanship is needed if frost damage and excessive wear are to be avoided.

11.9.5 *Bitumen paving*

Bitumen paving can consist of porous or impermeable material. As the interstices in unsealed tar paving will eventually become blocked by silt, all such paving should be laid following the same principles as those for impermeable surfaces. Its use within the RPA should, therefore, be restricted to the parameters set out in **11.3.4**.

11.10 Edge supports

The excavation needed for the placement of kerbs, edgings and their associated foundations and haunchings can damage tree roots. Within the RPA, this should be avoided either by the use of alternative methods of edge support or by not using supports at all.

For example, where kerbing is required for light structures, such as footpaths, peg and board edging may be acceptable. For more substantial structures, such as estate roads, railway sleepers may be acceptable, retained in place with track pins or road pins. In some situations, for example where the roadway needs to traverse a lateral slope, gabions could be used to provide a kerbing solution (in this example, the gabions are installed on the down-hill side of the road). Gabions can be inter-linked, or pinned in place. Where it is necessary to pin kerbing in place, the pins should, where practical, be located clear of any major tree roots visible on the surface.

12 Soft surfaces around trees

12.1 General considerations

Soft surface finishes, including turf, mulch and cultivated beds, are preferred around trees as there is less likelihood of damage to trees by construction and there is provision for adequate penetration of water and air into the soil.

12.2 Prevention of damage

Tractor mounted rotavation or other heavy mechanical cultivation should not occur within the RPA. Any cultivation should be undertaken carefully by hand or pedestrian controlled light machinery, to minimize damage to the tree, particularly the roots. Changes of ground level within the root protection area of established trees should be avoided. Advice on the implications of proposed level changes and appropriate mitigation measures should be obtained from an arboriculturist.

12.3 Avoidance and remediation of compaction

In order to avoid compaction, there should be no vehicle or plant access within the root protection area. Where compaction has occurred, advice should be sought from an arboriculturist on de-compaction measures, such as forking, spiking, subsoil replacement by hand-dug radial trenching or subsoil aeration using compressed air injection equipment.

12.4 Herbicides

Herbicides for use in the vicinity of existing trees should be appropriate for the type of vegetation to be killed. Special care should be taken to avoid any damaging effects upon existing plants and trees to be retained, species to be introduced and existing sensitive habitats, particularly those associated with aquatic or drainage features.

NOTE When selecting and applying herbicides, attention is drawn to Health and Safety regulations on their use [16].

12.5 Planting and ground cover

Where grass is used as a ground cover, an area with a minimum radius of 500 mm from the base of trees should be left clear of turf or seed and mulched using an appropriate material (see **12.6**). This reduces competition for water and nutrients for young and newly planted trees. For all trees, a grass-clear area reduces the risk of mechanical damage to bark caused during routine maintenance by mowing or strimming machinery. Where possible, trees should be set within or surrounded by shrub planting and an appropriate mulch. This deters access and associated soil compaction, requires less frequent maintenance than grass and enables water penetration and gas diffusion through an open soil structure.

12.6 Use of mulch

12.6.1 Open soil and shrub planting areas around trees should be mulched to inhibit weed growth, reduce groundwater evaporation, resist compaction, enable gaseous exchange and water penetration to roots, and reduce maintenance requirements. The mulch material should be weed-free, non-matting, easy to apply, containable within the area of application and readily available. Fine particle organic mulch forms a more complete soil cover than a coarse, loose material. Coarse mulch material should be applied to a greater depth to achieve the desired benefits.

12.6.2 Appropriate materials for mulches include inorganic granular materials, such as gravels, stone chips and pea shingle, or organic granular materials, such as shredded bark, bark chips, hard hulls and husks or well-composted green waste to conform to PAS 100. Care should be taken to ensure that the latter material does not form an impermeable mat nor inhibit gaseous exchange to the bark of the tree or soil. Organic mulches should, therefore, not be spread up to the stem. Appropriate depth of mulch should be between 50 mm and 100 mm depending on the material and the design context. The area around the tree should be well-watered prior to the application of mulching material.

12.6.3 The use of peat should be avoided for reasons of sustainability. Non-composted organic materials such as grass cuttings, leaves, straw, sawdust or wood chips should not be used as these extract nitrogen from the soil as they decompose and may promote weed or harmful forms of fungal growth. Black plastic matting should not be used around trees as it inhibits water penetration and gaseous exchange, although permeable geotextile mats can be beneficial in controlling weeds around new plantings. Calcareous rock chippings (i.e. limestones) should not be used as these may raise the pH of soils to the detriment of most tree species.

13 Design considerations for new planting

13.1 General

13.1.1 The purpose of proposed new planting should be understood from the start of the design process so that appropriate choices of structure, location and species can be made. Advice on detailed design should be sought from a landscape architect or other competent person experienced in landscape design.

13.1.2 Trees may perform a variety of roles, both aesthetic and functional:

— shelter planting to benefit buildings, people, crops or stock;
— screen planting to hide the unsightly or create privacy;
— planting to define or divide spaces, or to define or direct routes or views;
— specimens or groups can be used for architectural effect to complement buildings;
— for their inherent aesthetic qualities;
— providing character or sense of place;
— softer, natural elements to counter the artificial lines of the built environment;
— for their contribution to nature conservation, biodiversity and biomass;
— reducing air pollution;
— providing shade; and
— controlling erosion.

13.1.3 All new tree planting proposals should take into consideration the future use, layout and design of a development site, constraints of soil and climate, the local landscape character and the contextual surroundings. As trees generally form the dominant elements of the long-term landscape structure of a site, careful consideration should be given to their ultimate height and spread, form, habit and colour, density of foliage and maintenance implications.

13.2 Planting adjacent to buildings

13.2.1 On all soils, it is inadvisable to plant trees at distances closer to a structure than those shown in Table 3 unless special precautions have been taken. Paths, patios and driveways, where they are not constructed to appropriate standards (see **10.3** and [14]) can be vulnerable to damage by trees with surface rooting characteristics. In addition, on shrinkable soils account should be taken of the foundation construction of existing and proposed nearby structures; planting should not compromise the structural performance of the foundation.

13.2.2 The effect of shade created by new trees and the likely extent and density of the tree crown when fully grown should be taken into consideration before new planting adjacent to buildings. Careful design and species selection should allow residents to enjoy reasonable light and the trees to develop into mature specimens. Special care should be exercised when considering planting large and/or fast growing evergreen trees as screens or hedging as these can be particularly oppressive, obstructing light all year round and requiring frequent maintenance to restrict their growth.

NOTE For information on planting adjacent to boundaries see Annex A and [6], [12] and [13].

13.3 Planting adjacent to roads

Roadside trees can make a significant contribution to the character of new developments. Their siting and species selection should be carefully co-ordinated at an early stage with other highway design considerations and, in the case of adopted roads, with the agreement of the relevant highway authority. Sight line requirements, lighting schemes, CCTV, underground and overhead service routes and avoidance of physical obstruction or damage should all be taken into account with due consideration for future growth and periodic maintenance requirements.

13.4 Planting in the vicinity of services

Trees should not be planted where they might obstruct overhead power lines or cables. In new developments, underground services should be ducted or otherwise protected at the time of construction to enable trees to be planted nearby without conflict (see utilities guidance documents [17]). Root barriers should be constructed, where considered necessary, under expert advice to reduce the risk of tree root intrusion into service runs.

14 Ground works and preparation for new planting

NOTE BS 4428 contains recommendations and guidance on general landscape operations with sections on preliminary investigations, drainage, grading and cultivation, tree planting, and woodland planting.

14.1 Drainage

New development may have an effect on the existing drainage pattern and ground water levels of a site, due to increased areas of hard surface and consequential drainage requirements. Existing trees may suffer due to an alteration in the supply of groundwater, whilst younger specimens and new plantings may be more likely to adapt to the changed conditions. Expert advice on both drainage and trees should be taken where ground water conditions are liable to such change.

14.2 Soil conditions

Before any of the landscape operations listed in BS 4428 are undertaken and where contamination is apparent, soils in areas to be planted should be analysed for structure and content by a specialist laboratory and expert advice taken on remediation measures for new planting if this is required. If contaminants (e.g. oil or diesel fuel, toxic materials, heavy metals, etc.) are present, soils should either be removed to the full depth for planting and new soil imported or expert advice obtained on remediation measures, which may include limiting the choice of species for planting. Where the structure of the soil is in an unsuitable condition to encourage growth, a number of remediation measures may be required including physical decompaction by mechanical plant or compressed air injection, the incorporation of bulky additive materials and new drainage systems. The advice of an arboriculturist should be sought for all works in the root protection area.

14.3 Surfaces around newly planted trees

NOTE BS 4428 provides recommendations for the treatment of soft surfaces, but excludes hard surfaces.

14.3.1 Where surfaces are paved, the settlement of the soil in tree pits which occurs gradually after planting may cause movement of the paved area. This may involve the partial collapse or instability of paving or disruption of flexible surfaces, where these are laid over prepared pits. The unpaved area around new plantings should, therefore, be of an adequate size to enable surrounding paving to be retained by a conventional edging and foundation (e.g. brick, concrete, stone or treated timber) set at a distance where it is unlikely to be affected by settlement. It may be appropriate for the outer edges of the backfilled area to be treated as a transition zone using interlocking surface reinforcement grids backfilled with a surface dressing of a permeable, granular material (e.g. gravels, shingles, other aggregates) which can be topped up if required. Due allowance should be made for the future growth of stem and roots of a tree when considering the finished dimensions and the design of edge or kerb treatments of tree pits and planted areas

Where load-bearing paving is to be laid over pits, it should either:

a) be laid when the soil has settled and the level made good; or:

b) be laid on a supported foundation that spans the tree pit; or

NOTE Such a foundation may be constructed from reinforced concrete, or comprise bearers made from steel or concrete.

c) incorporate a tree grille with appropriate support around the edges.

d) utilize structural soil.

14.3.2 Where there is any risk of a tree pit receiving surface water run off that may be contaminated, for example by rock salt, fuel spillages or other materials that may be toxic or harmful to plants, paving should be designed and laid to fall away from the pit.

15 Post development management

15.1 Existing trees

15.1.1 Trees growing on a site before development takes place may, if adversely affected, be in decline over a period of several years before they die. This varies greatly depending on the age, species and condition of the tree, the soil conditions, climate, and the extent of damage incurred during development. A programme of inspections and necessary work for the treatment of symptoms as they develop should be drawn up in conjunction with an arboriculturist. This programme may include recommendations for frequency of inspection and/or beneficial tree work and should take the form of an arboricultural management plan.

15.1.2 Where the trees in question are protected by planning controls, the planning authority should be informed and any necessary agreements obtained prior to such work.

15.1.3 Prior to handover, following completion of development, the arboriculturist should look for signs of intolerance to the change in conditions and the effect of the development and any accidental damage to identify the need for further tree works in addition to those originally specified at the beginning of the development process.

15.1.4 An arboriculturist should consider appropriate cultural operations. These may include irrigation, or measures to enhance the soil structure and organic nitrogen levels in the soil.

15.1.5 Where the development design incorporates the need for active management following the completion of construction works, a tree or landscape management plan should be prepared and a copy supplied to all parties who may have an interest in the future management of the site or parts of it.

15.2 New plantings

Maintenance of newly planted trees is of particular importance during the critical establishment period, of at least two years and may, where required by planning conditions, be five years or more following planting. A detailed maintenance schedule covering the establishment period should be prepared in conjunction with the landscape design proposals and appropriate arrangements made for its implementation.

Annex A (informative)
Trees and the law

A.1 General

Trees in any location may be protected by legislation. Where development is proposed, additional legal protection may be appropriate and can be enforced by the local authority. Attention is drawn to legal controls and liabilities under common law for consideration at the earliest stages of potential site development.

A.2 Legal protection for trees

A.2.1 The Town and Country Planning Act 1990 (as amended) [1] requires that, except in certain circumstances, "no work shall be carried out which will affect trees over a certain size which are situated in conservation areas". Six weeks' notice of intent has to be given to the local authority before the work is carried out. This provides an opportunity for the local authority to make a tree preservation order (TPO), under this Act, to protect the trees.

A.2.2 Tree preservation orders allow for trees to be protected either as individuals, groups, areas or woodlands. The orders have the effect of preventing the cutting down, topping, lopping, uprooting, wilful damage or wilful destruction of trees, except in certain circumstances, other than with consent of the local authority.

A.2.3 Even when no specific legal protection exists, it may be necessary to obtain a felling licence. These apply if the volume of timber exceeds specified amounts; site clearance, even of small areas, before detailed planning permission has been granted could exceed the felling licence quota. The Forestry Commission, under the Forestry Act 1967 (as amended) [2] administers felling licences.

A.3 Wildlife and habitat considerations

A.3.1 Para. 47 of Planning Policy Guidance Note 9: Nature Conservation [18] states that "the presence of a protected species is a material consideration when a local planning authority is considering a development proposal which, if carried out, would be likely to result in harm to the species or its habitat".

The Wildlife and Countryside Act 1981 (as amended) [3], the Conservation (Natural Habitats etc.) Regulations 1994 [4], and the Countryside and Rights of Way Act 2000 [5] protect species of flora and fauna.

A.3.2 The protection afforded to bats makes it illegal to intentionally injure or kill a bat, or to damage, disturb or obstruct access to a roost. As from 31 January 2001, under the Countryside and Rights of Way Act 2000 [5], it is an offence to recklessly disturb bats or recklessly damage or obstruct access to any structure or place that bats use for shelter or protection. Where bats are found to be present consultation needs to be carried out with the Statutory Nature Conservation Organization i.e. English Nature[2)], the Countryside Council for Wales[3)], Scottish Natural Heritage[4)] or Northern Ireland Environment and Heritage Service[5)] before starting any work.

Substantial penalties can be incurred for contravention of any of these forms of legal protection for trees and wildlife.

A.4 Legal protection for trees on development sites

A.4.1 Section 197 of the Town and Country Planning Act 1990 [1] states "it shall be the duty of the local planning authority to ensure, whenever it is appropriate, that in granting planning permission for any development adequate provision is made, by the imposition of conditions, for the preservation or planting of trees". It also states that "it shall be the duty of the local planning authority to make such orders under section 198 [of the Act] as appear to the authority to be necessary in connection with the grant of such permission."

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2) Contact English Nature at Northminster House, Peterborough PE1 1UA or www.englishnature.org.uk/contactlink.htm

3) Contact Countryside Council for Wales at www.ccw.gov.uk.

4) Contact Scottish Natural Heritage at 12 Hope Terrace, Edinburgh EH9 2AS or www.snh.org.uk.

5) Contact Northern Ireland Environment and Heritage Service at www.ehsni.gov.uk.

A.4.2 It is usually appropriate for a tree preservation order to be placed on trees that are an amenity and structurally sound. The effect of proposed development on trees protected by a tree preservation order ranks as a material consideration, which should be considered by the local authority when determining a planning application under section 70 of the Town and Country Planning Act 1990 [1].

A.4.3 Where a tree preservation order exists prior to planning permission being granted it should not normally be a block to effective use of a site. It serves to deter damage to or clearance of trees prior to planning permission being granted and provides a means of enforcing their protection during development work.

A.4.4 When planning permission is granted, planning conditions may be imposed to provide for the erection of protective fencing (see Clause **9**) and other measures for ensuring the well-being of trees during development.

NOTE It is considered inappropriate for planning conditions to be used to provide long-term protection to trees when tree preservation orders are available as a specific provision for this purpose.

A.4.5 Where circumstances require it, local authorities should apply a planning condition requiring the developer to appoint an arboriculturist to oversee the project. This person has a duty to monitor and confirm the implementation and maintenance of tree protection measures, as agreed with the local authority. Planning conditions may be imposed requiring tree planting to be undertaken as part of a project, and a tree preservation order can be made to apply to such trees once they have been planted so as to achieve their long term protection.

A.4.6 The consent of the local authority is not needed to carry out work on trees required to enable a person to implement a planning permission. Felling etc. cannot be said to be required when planning permission has been given on an outline application only, nor when development is exempt from planning control.

A.4.7 ***Enforcement of protection during development***

The effectiveness of measures to protect trees and ensure their healthy survival through development depends on co-operation between site owners, developers, contractors, arboriculturists and local authorities.

If the local authority considers that there has been a breach of planning conditions that provide for the protection of trees, it can serve an "enforcement notice"; if necessary this can be followed by a "stop notice" (Town and Country Planning Act 1990 [1], sections 172, 183, 184; *Planning policy guidance note 18: Enforcing planning control* [19]; *DoE Circular 10/97— Enforcing planning control: Legislative provisions and procedural requirements* [20]). When considering the need for such enforcement, local authorities should consider that trees can be damaged very easily (see Annex C) and that survival of trees is most likely to be achieved by maintenance of protection at all times.

A.4.8 ***Common law claims and litigation concerning trees***

A.4.8.1 *General*

Problems caused by trees on development sites can result in disputes giving rise to common law claims and litigation. Such problems are particularly likely where trees grow across boundaries between properties and cause damage to the property of a third party. For instance, root activity can affect structures other than those on the development site. The crowns, stems and roots of trees may have structural weaknesses, which if they fail, could result in damage to property or injury to people. Leaves and fruit falling from trees, obstruction of light and problems of poisonous plants have all been considered by the courts. Legal advice should be sought where trees may become a problem.

Careful planning and design should minimize the possibility of litigation after completion of the development.

A.4.8.2 *Planting adjacent to boundaries*

Problems with trees on or close to boundaries have resulted in litigation on many occasions, and the rights and responsibilities of tree owners and their neighbours are, in this respect, well documented in law. The government has published guidance on high hedges (*Hedge height and light loss* — ODPM, 2002 [21]) which advises on reasonable standards for evergreen hedges in domestic gardens. Careful consideration of new planting to anticipate both the likely encroachment of roots or overhang of branches of the fully grown tree relative to the site boundary can prevent potential future conflict, while the possibility of direct mechanical damage to boundary fences and walls can be avoided by allowing room for growth and movement (see Table 3).

Annex B (informative)
Useful contacts

This annex provides a list of organizations from whom additional advice can be obtained.

Ancient Tree Forum c/o Woodland Trust, Autumn Park, Dysart Road, Grantham, Lincolnshire NG32 6LL Tel: 01476 581135 Email: ancient-tree-forum@woodland-trust.org.uk Website: www.woodland-trust.org.uk/ancient-tree-forum	**Horticultural Trades Association (HTA)** Horticulture House, 19 High Street, Theale RG7 5AH Tel: 0118 930 3132 Email: info@the-hta.org.uk Website: www.the-hta.org
Arboricultural Advisory and Information Service Forest Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey GU10 4LH Helpline: 09065 161147 Tel: 01420 22022. Email: admin@treehelp.info Website: www.treehelp.info	**Institute of Chartered Foresters** 7A Colme Street, Edinburgh EH3 6AA Tel: 0131 225 2705 Email: icf@charteredforesters.org Website: www.charteredforesters.org
Arboricultural Association Ampfield House, Ampfield, Nr. Romsey, Hants SO51 9PA Tel: 01794 368717. Email: admin@trees.org.uk Website: www.trees.org.uk	**Institute of Civil Engineers** 1 Great George Street, London SWIP 3AA Tel: 020 7222 7722 Email: secretariat@ice.org.uk Website: www.ice.org.uk
British Association of Landscape Industries (BALI) Landscape House, Stoneleigh Park, National Agricultural Centre, Warwick CV8 2LG Tel: 0870 770 4971 Email: contact@bali.org.uk Website: www.bali.co.uk	**Institute of Leisure and Amenity Management** Lower Basildon, Reading, Berks RG8 9NE Tel: 0491 873558 Email: info@ilam.co.uk Website: www.ilam.co.uk
Building Research Establishment Garston, Watford, Herts WD25 9XX Tel: 01923 664000 Email: enquiries@bre.co.uk Website: www.bre.co.uk	**Institution of Structural Engineers** 11 Upper Belgrave Street, London SWIX 8BH Tel: 020 7235 4535 Fax: 020 7235 4294 Website: www.istructe.org.uk
Commission for Architecture and the Built Environment (CABE) The Tower Building, 11 York Road London SE1 7NX Tel: 020 7960 2400 Email: enquiries@cabe.org.uk Website: www.cabe.org.uk	**International Society of Arboriculture, UK and Ireland Chapter** 148 Hydes Road, Wednesbury, West Midlands WS10 0DR Tel: 0121 556 8302 Email: enquiries@isa-uki.org Website:www.isa-uk.org

Useful contacts (*continued*)

Landscape Institute 33 Great Portland Street, London W1W 8QG Tel: 020 299 4500 Email: mail@l-i.org.uk Website: www.l-i.org.uk	**Royal Institution of Chartered Surveyors** 12 Great George Street, London SWIP 3AD Tel: 0870 333 1600 Email: contactrics@rics.org Website: www.rics.org
National House Building Council Buildmark House, Chiltern Avenue, Amersham, Bucks. HP6 5AP Tel: 01494 735 363 Website: www.nhbc.co.uk	**Royal Town Planning Institute** 41 Botolph Lane, London EC3R 8DL Tel: 020 7929 9494 Email: online@rtpi.org.uk Website: www.rtpi.org.uk
Royal Institute of British Architects (RIBA) 66 Portland Place, London W1B 1AD Tel: 020 7580 5533 Email: info@inst.riba.org Website: www.riba.org	

Annex C (informative)
Damage to trees

C.1 General

C.1.1 Trees that have good health and stability are well adapted to their surroundings. Any development activity which affects the adaptation of trees to a site could be detrimental to their health, future growth and safety. Tree species differ in their ability to tolerate change but all tend to become less tolerant after they have reached maturity or suffered previous damage or stress. Planning and subsequent site management should aim to minimize the effect of change.

C.1.2 The part of a tree most susceptible to damage is the root system, which, because it is not immediately visible, is frequently ignored. Damage to, or death of the root system affects the health, growth, life expectancy and safety of the entire tree. The effects of such damage may only become evident several years later. Damage may be the result of a number of insignificant but compounding factors that accumulate over time.

C.1.3 Damage to the stem and branches of a tree is not usually sufficient to kill the tree directly but may make it unsafe by affecting the weight of distribution of the crown or by facilitating decay in the long term. Such damage may also be disfiguring.

C.2 Extent and form of the root system

C.2.1 The root system is typically concentrated within the uppermost 600 mm of the soil, although it may be deeper within the dense mass of roots and soil close to the base of the tree. Within a short distance of the stem the roots are highly branched, so as to form a network of small-diameter woody roots, which typically extend radially for a distance much greater than the height of the tree, except where impeded by unfavourable conditions. All parts of this system bear a mass of fine, non-woody absorptive roots

C.2.2 The root system does not generally show the symmetry seen in the branch system. The development of all roots is influenced by the availability of water, nutrients, oxygen and soil penetrability. As far as these conditions allow, the root system tends to develop sufficient volume and area to provide physical stability.

C.2.3 The uptake of water and mineral nutrients by the root system takes place via the fine roots, typically less than 0.5 mm diameter. Their survival and functioning — which are essential for the health of the tree as a whole — depend on the maintenance of favourable soil conditions. The fine roots are short-lived, with the majority dying each winter and with fresh ones developing in response to the needs of the tree.

C.2.4 All parts of the root system, but especially the fine roots, are vulnerable to damage. Once roots are damaged, water and nutrient uptake is restricted until new ones have grown. Mature and over-mature trees respond slowly, if at all, to damage of their woody roots.

Annex D (informative)
Example tree survey pro forma

This annex provides an example of a tree survey pro forma.

TREE SURVEY SCHEDULE

Client:

Site:

Date of Survey:

Arboricultural Consultant/Surveyor:

Tagged:

Weather:

See explanatory notes at 4.2.6

Tree reference number	Species	Height m	Stem diameter mm	Branch spread m	Height of crown clearance m	Age class	Physiological condition	Structural condition	Preliminary management recommendations	Estimated remaining contribution years	Category grading
1				N E S W							
2				N E S W							
3				N E S W							
4				N E S W							

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