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TREE AND WOODLAND PRESERVATION

British Standards Institute publication

Trees in relation to construction – Recommendations
[BS5837:2005]

and the British Standards Institute (BSI) (BS) publication

Guide for Trees in Relation to Construction
[BS 5837:1991]

Matheny N., and Clark J., **Trees and Development: A Technical Guide to the preservation of Trees During Land Development**, International Society of Arboriculture, 1998 pp183

Terms used are different for the ISA and BS but essentially the planning and arboricultural processes are the same.

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Arboricultural processes are divided into 9 elements

1. Perform a **tree stand delineation**
2. **Tree survey** within development area
3. **Identify trees suitable for preservation**
4. Access the **potential impacts to trees**
5. Suggest **modifications to development plans**
6. Identify **tree work** required prior to clearing and grading or predevelopment works
7. Prepare **specification for tree preservation**
8. **Monitor** trees during construction
9. Prepare a **post-construction maintenance plan**

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Overview: Primary aim of tree preservation

Long-term survival and stability of the trees(s).

The International Society of Arboriculture (ISA) identifies three main principles:

1. Tree preservation programs must respect pattern of tree growth and development

2. Preservation must focus on preventing injury to trees

3. Tree preservation requires space

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Arboricultural Implications Assessment (AIA)

Syn: ISA-**Tree Protection Plan**

Study undertaken by an arboriculturalist, to:
- identify, evaluate and possibly mitigate the extent of direct and indirect impacts on existing trees
- especially those impacts that may arise as a result of the implementation of any site layout proposal.

ISA includes this within the written tree protection plan; typically a written report (as above)

Arboricultural Method Statement (AMS)

Syn: ISA-**Tree Protection Plan**, **Specifications**

Methodology for the implementation of any aspect of development that has the potential to result in loss of or damage to a tree.

ISA, in general terms, includes this in its *specifications* and does not require methodology be detailed for each tree.

- It is recommended that the BS AMS be adopted for the ISA tree protection plan (written spec., or method statement in report appendix).

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Foliage, **Leaf / Needle**
Colour
Size
Density

Seed / Cone Production
Size
Density

Deadwood
Size
Density

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Typical Symptoms of Tree Stress From Construction Injury

Short seasonal growth elongation

Small leaves [often yellow]

Thin foliage density

Leaf scorch

Wilting

Early defoliation, sudden leaf loss [that occurs outside normal leaf abscission period]

Epicormic shoots

Heavy seed mast production

Twig and branch dieback

Attack by borers and other stress related pests

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Bigleaf maple
Acer macrophyllum

Poor - Good
Relative species tolerance

Select species with good crown structure.
Tolerant of root pruning.
Intolerant of fill (grading).

Red alder
Alnus rubra

Poor - Moderate
Relative species tolerance

Retain only in groups or as individuals with strong taper and structure.
Relatively short lived.
Intolerant of root injury / disturbance.

Black cottonwood
Populus trichocarpa

Poor
Relative species tolerance

Mature trees prone to windthrow and trunk failure.
Also prone to extensive crown failures.

Douglas fir
Pseudotsuga menziesii

Poor - Good
Relative species tolerance

Tolerant of fill if limited to one-quarter of root zone.
Declines slowly following addition of fill.
Tolerates root pruning.
Intolerant of poor drainage
Susceptible to bark beetles following injury

Western red cedar
Thuja plicata

Poor - Moderate
Relative species tolerance

Response is very site dependant and probably related to soil moisture.
Tolerant of root pruning.
Intolerant of fill (grading).

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Assessment of relative condition of trees in individual tree survey

Condition Rating	Overall Vigor	Canopy Density	Amount of Deadwood	History of Failure	Pests	Extent of Decay
1	Severe Decline	<20%	Large; major scaffold branches/primary	More than one scaffold/primary	Infested	Major - conks and cavaties
2	Declining	20-60%	Twig and branch dieback/tertiary and primary	Scaffold branches/ primary	Infestation of significant pests	One to a few conks; small cavaties
3	Low/Moderate	60-90%	Small twigs/tertiary	Small branches/ secondary	Minor	Present at pruning wounds
4	Good	90-100%	Little or none	None	Minor	Present at pruning wounds
5	Excellent	100%	None	None	None or insignificant	Absent

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Tree Survey: Post-Planning

This is where an arboricultural assessment is not obtained until after a preliminary site layout has been prepared.

Although this is not the ideal situation, timely and appropriate expert advice can still make valuable contributions to the process of tree retention and protection.

In cases where the arborist is provided a layout, the tree survey should be completed as detailed in the Tree Survey section.

This would then involve providing advice on tree retention, protection, remedial or mitigation works and new landscape design.

It is essential that the trees be assessed objectively and without reference to site layout proposals.

This is covered under the Arboricultural Implications Assessment (AIA) and Design Issues.

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Tree Constraints Plan

The influence trees have on the site layout design is plotted on the Tree Constraints Plan (TCP).

- This illustrates both above ground owing to their size and position
- and the underground constraints due to the Root Protection Area (RPA).

The RPA is presented separately as it is a new method of determining the soil and root area to be protected.

It has not yet been adapted by the ISA but is in part based on their formula for calculation of a Tree Protection Zone (TPZ).

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Critical Factors in Evaluating Tolerance to Construction Impact

- The likely tolerance of any form of tree to root disturbance or damage. This is based on factors such as species, age and condition and presence of other trees. (For individual open grown trees, it may acceptable to offset the distance by up to 20% in one direction
- 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
- The soil type and structure
- Topography and drainage
- Where any significant part of the trees' crown overhangs the provisional position of the 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.

The arborist determines all this.

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Arboricultural Implications Assessment (AIA) and Design Issues

The tree constraints plan, discussed previously, is utilised in the design layout.

It should however be taken in context as trees are only one factor requiring consideration in this regard.

Important and sensitive trees may prevent development or dramatically alter its design.

Retention of unsuitable trees, or too many, should be removed from consideration so as to avoid excessive pressure on trees during development and subsequent demands for their removal.

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

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Clearing and grading works

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Clearing and grading works

Activity	Impact	Methods/treatments to minimise damage
Stripping site of organic surface soil before grading; clearing unwanted vegetation; demolishing existing structure's	Root loss	- Restrict stripping of topsoil around trees - Install fences to protect trees from injury - Any woody vegetation to be removed adjacent to trees remain should be cut at ground level and not pulled out by equipment - Otherwise root injury to remaining trees may result - Arborist may be needed for adjacent tree removal if crowns are intertwined
Lowering of grade, scarifying, preparing sub-grade for fill and structures	Root loss	- Before grading, root prune tree at edge of excavation to a depth required - Spoil beyond cut face can be removed by equipment sitting outside the drip line of the tree - Use retaining walls with discontinuous footings to increase the distance that natural grade is maintained from trunk

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Clearing and grading works

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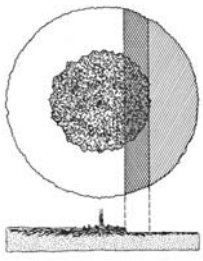
Clearing and grading works



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Clearing and grading works

Dr. Olaf K. Ribeiro, Ribeiro Tree Evaluations, Inc,

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Clearing and grading works

Dr. Olaf K. Ribeiro, Ribeiro Tree Evaluations, Inc,

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Clearing and grading works

Activity	Impact	Methods/treatments to minimise damage
Trenching for utilities, stormwater system, drains	Root loss	- Avoid open trenching in rooting area - Tunnel under roots, if possible. If not, within root area, dig trench by hand, bridging roots greater than 1 inches / 254 mm - Consolidate utilities into one trench
Compacted surface soils	Unfavourable conditions for root growth; chronic stress from reduced root systems	- Fence trees to keep traffic and storage out of root area - Provide a storage area and traffic route/area for construction activity away from trees - Where traffic cannot be diverted, protect soil surface

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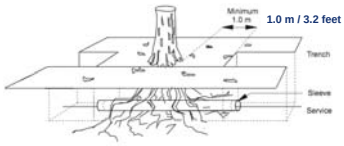
Clearing and grading works

Tree diameter	Auger / Trenchless distance from tree
5-9 inches	5 feet
10-14 inches	10 feet
15-19 inches	12 feet
over 19 inches	15 feet



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Clearing and grading works

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Tree Protection Zone (TPZ)
Area - radial distance - based on the radial distance m/ft Identified by an arboriculturalist

- To be protected during development,
- Including demolition and construction work,
- Involving the use of barriers and/or ground protection fit for the purpose to ensure the successful long-term retention of a tree.

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ISA - Tree Protection Zone / Root Protection Area

Species Tolerance	Tree Age	Distance from trunk feet per inch trunk diameter
Good	Young (<20% life expectancy) Mature (20-80% life expectancy) Overmature (>80% life expectancy)	0.5 feet 0.75 feet 1 foot
Moderate	Young Mature Overmature	0.75 feet 1 foot 1.25 feet
Poor	Young Mature Overmature	1 foot 1.25 feet 1.5 feet

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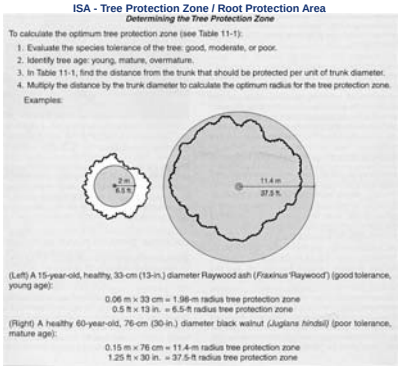
ISA - Tree Protection Zone / Root Protection Area



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Arboricultural Method Statements (AMS) and the Tree Protection Plan (TPP)

Once the layout design has been finalised a Tree Protection Plan should be prepared contain the following information.

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

- Trees to be removed, also clearly identified (e.g. by number) and marked on a plan with a dashed outline or as determined by the planning authority the precise location for erection of protective barriers and any other relevant physical protection measures including ground protection to protect the TPZ and marked as a construction exclusion zone on the plan

NOTE: while the tree protection zone 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 the dimensions of the exclusion zones

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ISA - Tree Protection Zone

Tree Protection Barriers

- must establish a protection zone that covers the trees optimum rooting zone
- should be of substantial construction i.e. plywood, chain-link or sheet metal fence
- fines and penalties for violating the area demarcated by the barrier. This can either be included in the contract or specifications
- location of the barrier is determined by the certified arborist based on species tolerance, condition, and age
- the barrier placement should also account for working space

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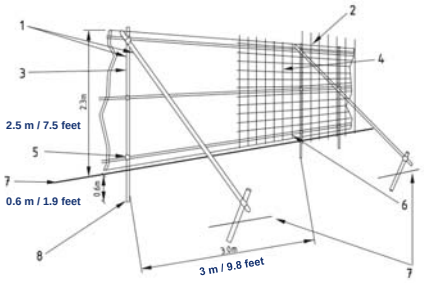

1 Standard scaffold poles
2 Uprights to be driven into the ground
3 Panels secured to uprights with wire ties and where necessary standard scaffold clamps
4 Weldmesh wired to the uprights and horizontals
5 Standard clamps
6 Wire twisted and secured on inside face of fencing to avoid easy dismantling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

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Examples of Tree Protection Zone (Additional)

Tree protection signage; with details of fines and arborist contact details

Figure No.4, General Illustration of Tree Protection Area

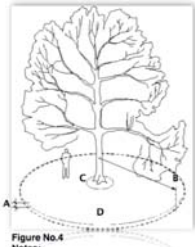

Figure No.4
Notes:
A: Install / maintain a 12 inches/ 300mm depth of woodchip mulch (absolute minimum)

B: Install / maintain a 12 inches/300mm woodchip mulch from the outer limit of branch spread or specified tree protection area; whichever is furthest.

Protection hoarding is required, unless otherwise stated, and should be installed prior to site works; install at point **B** around the edge of the protection area.

C: Maintain area at base of trunk free of mulch. As a guide use the following formula to determine the distance:

Girth X 0.5 = distance mulch should be kept away from the trunk

D: Maintain an absolute uniform minimum 12 inches/300mm depth of woodchips. No construction / development equipment, materials, and or spoil within area **B** described above and illustrated in Figure No.4, General Illustration of Tree Protection Area.

Examples of tree protection in a streetscape (left) and open sight (right). Note fixed chain-link fence

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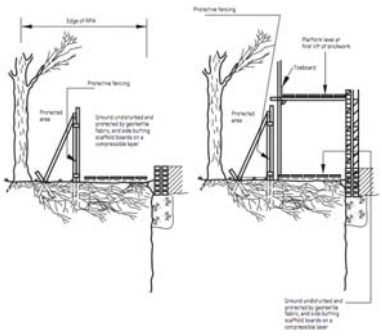

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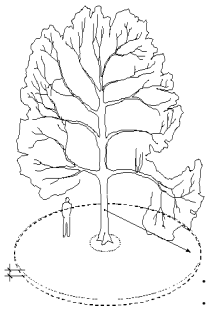

Mulch Usage for Mitigation and Treatments

- Moderates soil temperature
- Conserves soil moisture
- Provides organic matter and improves root density
- Reduces compaction and improves soil structure
- Eliminates turf grass competition

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Construction Damage

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Evaluation of Construction Impacts

Must include an assessment on the health and structure of the tree(s); Risk Assessment

In addition the following should also be addressed:

- destruction of the general root system, particularly loss of rooting area
- damage to the root collar and structural roots
- mechanical injury and damage to the stem
- changes in soil structure such as compaction, fill(s), erosion, and loss of organic matter
- changes in wind loading in the crown, which is particularly related to potential for failure
- damage to branches
- decline in overall health
- obstructions

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Other Post-Construction Requirements

Irrigation

- The amount of water applied must be appropriate to the species requirement
- Light, frequent irrigation's should be avoided. Irrigation should wet the entire root zone and be allowed to dry before another application
- Excess irrigation from new landscapes should be avoided. Runoff from plantings should be minimised and or directed away from trees
- Wetting the trunk should be avoided

Pruning

- Annual inspection of retained trees is required. Prescribed treatments are typically based on the results of inspection
- Pruning to mitigate risk is the priority following construction impacts

Mulching

- See section on mulching previously
- Application of 100 – 150 mm / 4 - 6 inches of mulch is recommended to the edge of the drip line or Tree Protection Zone, which ever is greatest
- Mulch should be kept away from the trunk base

Fertilisation

- An assessment of the soil nutrient content is preferred prior to any application so that specific nutrient deficiencies can be targeted
- Application of a balanced slow release, low concentration, fertiliser is recommended

Direct Damage to Roots

This may only be determined from identifying the position of service trenches and the limits of other excavations.

Where roots have been severed the anchorage of the tree may have been seriously reduced.

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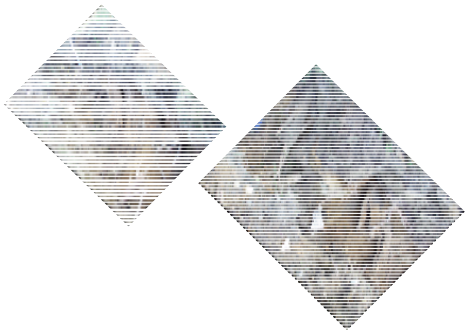

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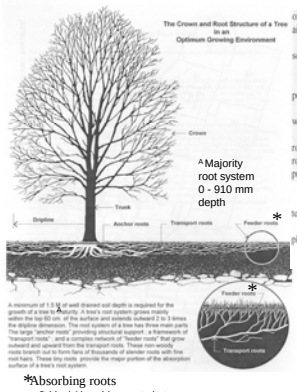
Root Growth Requirement: sustaining the root system



oxygen in soil atmosphere (for root survival)	3%	21%
air pore space in soil (for root growth)	12%	60%
soil bulk density restricting root growth (g/cc)	-	1.4 clay
	-	1.8 sand
penetration strength (water content dependent)	0.01kPa	3MPa
water content in soil	12%	40%
root initiation (O2% in soil atmosphere)	12%	21%
root growth (O2% in soil atmosphere)	5%	21%
progressive loss of element absorption in roots (O2% in soil atmosphere)	10%	21%
temperature limits to root growth	40°F/4°C	94°F/34°C
pH of soil (wet test)	pH3.5	pH8.2

Soil Density and Tree Root Growth

- High density soils will reduce root growth
- Limiting root growth will limit tree potential

*Absorbing roots
- Critical Absorbing roots in top 450 mm of soil

The entire root system is typically concentrated within the uppermost 910 mm / 36 inches of the soil:

- although it may be deeper within the dense mass of roots and soil close to the trunk and in sinker roots
- within a short distance the root system branches, forming a network of small diameter woody roots, that typically extend radially for a distance much further than the height of the tree
- this is except where impeded by unfavourable conditions

All parts of this system bear a mass of fine absorbing roots (non-woody / soft tissue).

Absorbing root system within the top 450 mm / 18 inches

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Any excavations that encounter roots over 25 mm / 1 inch diameter requires particular care be used to avoid damage; hand excavation is usually prescribed, avoiding damage to the bark.

Other methods of excavation are now available i.e. hydro or pneumatic excavation.

Roots exposed should be surrounded by sharp (washed) sand before replacing soil or other material in the excavation area.

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Indirect (and Direct) Damage to Roots

Tree roots develop in the soil at a level where oxygen and moisture are available in the appropriate concentrations.

Sudden alteration of the depth of soil over roots as a result of lowering (Direct) or raising the soil level within the branch spread or area designated as critical to the survival of the tree can kill the roots and as a result the tree may die.

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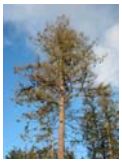

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Root Invigoration

As per previous illustration:

- No treatment within X3 DBH [A]
- Treatment area to include 50% of area [B] within Tree Protection Zone (TPZ)
- Treatment of soil to 15 cm / 6 inches depth
- Incorporation of organic matter and slow release fertiliser
- Mulch treatment within TPZ.

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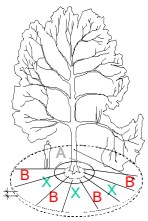
Soil compaction



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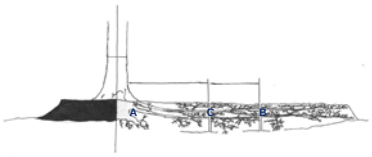

A-AA: Preference is to keep all cuts outside the Tree Protection Zone or dripline.

A-B: Optimum minimum distance for root cutting; DBH* X5

A-C: Absolute minimum distance for root cutting; DBH X3

A-C is the closest root cutting distance. Cutting closer creates a high risk of failure. Increase distances if tree(s) are large, leaning, root decay is present and so on.

*Trunk diameter at 1.3m / 4.5 feet height

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Risk Rating for Root Loss and or Root Decay

Critical Risk: >50% of roots with significant decay / loss, or if affected roots is uphill or opposite lean

High Risk: >33% of roots with significant decay / loss, or if affected roots is uphill or opposite lean

Moderate Risk: <33% of roots with some decay or cut

Low Risk: no decay or cut roots, not in low or wet site and so on

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