PARTICULAR SPECIFICATION

APPENDIX H

TREE PROTECTION SPECIFICATION

NATIONAL PARKS BOARD (NPARKS) TREE PROTECTION SPECIFICATION – SITE CLEARANCE

The following works must be accomplished before any site clearing activity occurs within 30m of retained trees.

1. The Contractor shall retain an International Society of Arboriculture (ISA) certified arborist and is required to review and ensure NParks' requirements with regards to work procedures, access and haul routes, and tree protection measures are complied with at all times. All NParks' requirements are to be strictly adhered to.

2. The limits of all tree protection zones shall be staked in the field for NParks' prior acceptance.

3. Trees to be removed that have branches extending into the canopy of trees to be retained must be removed by an ISA certified arborist or NParks' approved contractor and not by the Contractor. The Contractor's appointed ISA certified arborist or NParks' approved contractor shall be permitted to remove the tree in a manner that causes no damage to the trees and understory to remain.

4. Any vegetation clearing required within the tree protection zone shall be accomplished with hand-operated equipment.

5. Trees to be removed shall be felled so as to fall away from tree protection zones and to avoid pulling and breaking of roots of trees to be retained. If roots are entwined, the Contractor's appointed ISA certified arborist may require first severing the major woody root mass before extracting the trees. This may be accomplished by cutting through the roots by hand, with a vibrating knife, rock saw, and narrow trencher with sharp blades, or other approved root-pruning equipment. Trees to be removed from within the tree protection zone shall be removed by an ISA certified arborist or NParks' approved contractor. The trees shall be cut near ground level and the stump ground out.

6. All downed branch material and trees shall be removed from the tree protection zone either by hand or with equipment sitting outside the tree protection zone. Extraction shall occur by lifting the material out, not by skidding it across the ground.

7. Vegetation, foliage, branches and wood shall be chipped and placed in the tree protection zone or composted mulch applied to a depth of 150mm; no mulch is to be applied within a 0.5m radius of the trunk base.

8. Structures and underground features to be removed within the tree protection zone shall use the smallest equipment possible, and operate from outside the tree protection zone. An ISA certified arborist shall be on site during all operations within the tree protection zone.

9. Pruning shall be performed to American National Standards Institute-A300, 'Pruning Standards' or International Society of Arboriculture “Tree Pruning Standards”.

10. A minimum of 1.8-meter high fence (hoarding) with steel posts sunk into the ground shall be erected to enclose the tree protection zone as approved by NParks. See also Detail No. 2 above.

11. Any damage to trees due to site clearing activities shall be reported to the NParks' within six (6) hours so that immediate approved remedial action can be taken to the affected tree(s). Timeliness of the remedial action is critical to the tree's health.

12. If temporary haul or access roads must pass over the root area of trees to be retained [this should be avoided] a roadbed of mulch [i.e. wood-chips or green-waste] or gravel shall be created to protect the soil. The roadbed material shall be replenished as necessary to maintain a minimum depth of 150mm.

13. All ground and chipped material should be kept on site to provide mulch for tree protection zones or temporary roadbed requirement.

NPARKS' TREE PROTECTION SPECIFICATION – DURING CONSTRUCTION

Detail Nos. 1, 2, and 11 listed in the Site Clearance Specifications (above) should be included with these Specifications.

1. Protective hoarding with a minimum height of 1.8m shall be erected as per the NParks' requirements to protect trees to be retained. The hoarding shall define and demarcate a specific protection zone for each tree or group of trees. Hoarding is to remain until all construction works have been completed and only removed with the written approval of NParks.

2. Construction trailers, traffic and storage areas must remain outside the fenced areas at all times.

3. All underground utilities and drain or irrigation lines shall be routed outside the tree protection zone. If lines must traverse the protection area, they shall be tunnelled or bored under the tree.

4. No materials, equipment, spoil, or waste or washout / wastewater may be deposited, stored, or parked within the tree protection zone (fenced area) at all times.

5. Additional tree pruning required for clearance during construction must be performed by a qualified International Society of Arboriculture, certified arborist and not by construction personnel. All pruning works should be completed as per Detail No. 9, Site Clearance Specifications (above).

6. Any herbicides placed under paving materials must be safe for use around trees, labelled for that use, and approved by NParks. Any pesticides for use on site must be tree safe and not easily transported by water, and approved by NParks.

7. If injury should occur to any tree during construction the Contractor's appointed ISA certified arborist should evaluate it as soon as possible so that appropriate treatments can be applied. No appropriate treatment shall be applied without the prior approval from NParks'.

8. The Contractor's appointed ISA certified arborist must monitor any grading, construction, demolition, or other work that is expected to encounter tree roots. See also Detail No. 11 below.

9. All trees shall be irrigated at least three times per week for the period July-October over the duration of the project. Irrigation must wet the soil within the tree protection zone to a depth of 0.75m.

10. Before grading, pad preparation, or excavation for foundations, footings, walls, or trenching, trees shall be root pruned 300mm outside the tree protection zone by cutting all roots cleanly to a depth of 610mm. Roots shall be cut by manually digging a trench and cutting exposed roots with a saw, vibrating knife, rock saw, narrow trencher with sharp blades, or other approved root-pruning equipment.

11. Any roots damaged during grading or construction shall be exposed to sound tissue and cut cleanly with a saw.

12. If a temporary haul or access roads must [this should be avoided] pass over the root area of trees to be retained i.e. a roadbed of 150mm (minimum) of mulch or gravel shall be created to protect the roots of the tree. The roadbed material shall be replenished, as necessary, to maintain a minimum depth of 150mm at all times.

13. Spoil from trenches, basements or other excavations shall not be placed within the tree protection zone, either temporarily or permanently.

14. No burnt piles or debris pits shall be placed within the tree protection zone. No ashes, construction debris or rubbish may be dumped or buried within the tree protection zone.

7.5.8 An alternative solution is to excavate a narrow trench passing directly towards the 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 3). 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 sleeve a service where it passes beneath a tree in order to reduce the risk of damage to the service (see Table 2) and facilitate future servicing and repair.

7.6 Damage to trunk or branches

7.6.1 The fencing which protects the root system is usually sufficient to enclose the majority of the major branches. If branches extend beyond the fencing in positions where they are liable to impact, the branch should either be shortened back to a fork (in accordance with the recommendations of BS 3998) or the area of fencing should be increased to a point below the branch spread.

7.6.2 At all times care should be taken to avoid any equipment striking the trunk, branches or foliage. Particular care is needed with delivery vehicles, overhead cranes, mechanical excavators and piling rigs.

7.6.3 Trees can also be damaged by heat. For this reason, fires should not be lit in a position where the flames could extend to within 5 m of foliage, branches or trunk, bearing in mind the size of the fire and the wind direction. With a large fire this may necessitate keeping the fire at least 20 m from the tree.

8 Protection of existing trees against damage on site

8.1 General

8.1.1 All trees which are being retained on site should be protected by stout fencing, enclosing an area as recommended in **7.5**. Such fencing should be erected before any materials or machinery are brought on the site and before any demolition or development, including erection of site huts, is commenced. Once erected, fences should be regarded as sacrosanct, and should not be removed or altered without prior consultation with a specialist in arboriculture.

Table 1 — Protection of trees: minimum distances for protective fencing around trees

Tree age	Tree vigour	Trunk diameter	minimum distance
		mm	m
Young trees (age less than $^1/_3$ life expectancy)	Normal vigour	< 200	2.0
		200 to 400	3.0
		> 400	4.0
Young trees	Low vigour	< 200	3.0
		200 to 400	4.5
		> 400	6.0
Middle age trees ($^1/_3$ to $^2/_3$ life expectancy)	Normal vigour	< 250	3.0
		250 to 500	4.5
		> 500	6.0
Middle age trees	Low vigour	< 250	5.0
		250 to 500	7.5
		> 500	10.0
Mature trees	Normal vigour	< 350	4.0
		350 to 750	6.0
		> 750	8.0
Mature trees and overmature trees	Low vigour	< 350	6.0
		350 to 750	9.0
		> 750	12.0

NOTE 1 It should be emphasized that this table relates to distances from centre of tree to protective fencing. Other considerations, particularly the need to provide adequate space around the tree including allowances for future growth (see **6.3**), and also working space (see **6.7**), will usually indicate that structures should be further away.

NOTE 2 With appropriate precautions, temporary site works can occur within the protected area, e.g. for access or scaffolding (see **8.3**).

TABLE 11-1

Guidelines for optimum tree protection zone for trees

Species Tolerance	Tree Age	*Distance from Trunk per Unit Trunk Diameter* (m/cm)	(ft/in.)
Good	Young (< 20% life expectancy)	0.06	0.5
	Mature (20 to 80% life expectancy)	0.09	0.75
	Overmature (> 80% life expectancy)	0.12	1.0
Moderate	Young	0.09	0.75
	Mature	0.12	1.0
	Overmature	0.15	1.25
Poor	Young	0.12	1.0
	Mature	0.15	1.25
	Overmature	0.18	1.5

Source: Modified from the British Standards Institute (1991). Guidelines are for trees of average to excellent vigor.

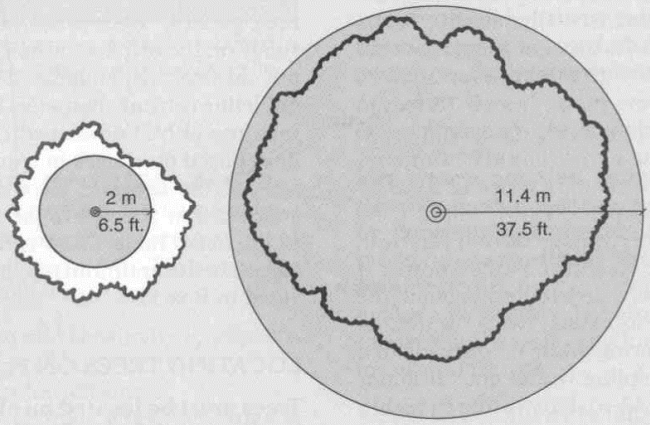
BOX 11-1

Determining the Tree Protection Zone

To calculate the optimum tree protection zone (see Table 11-1):

1. Evaluate the species tolerance of the tree: good, moderate, or poor.
2. Identify tree age: young, mature, overmature.
3. In Table 11-1, find the distance from the trunk that should be protected per unit of trunk diameter.
4. Multiply the distance by the trunk diameter to calculate the optimum radius for the tree protection zone.

Examples:



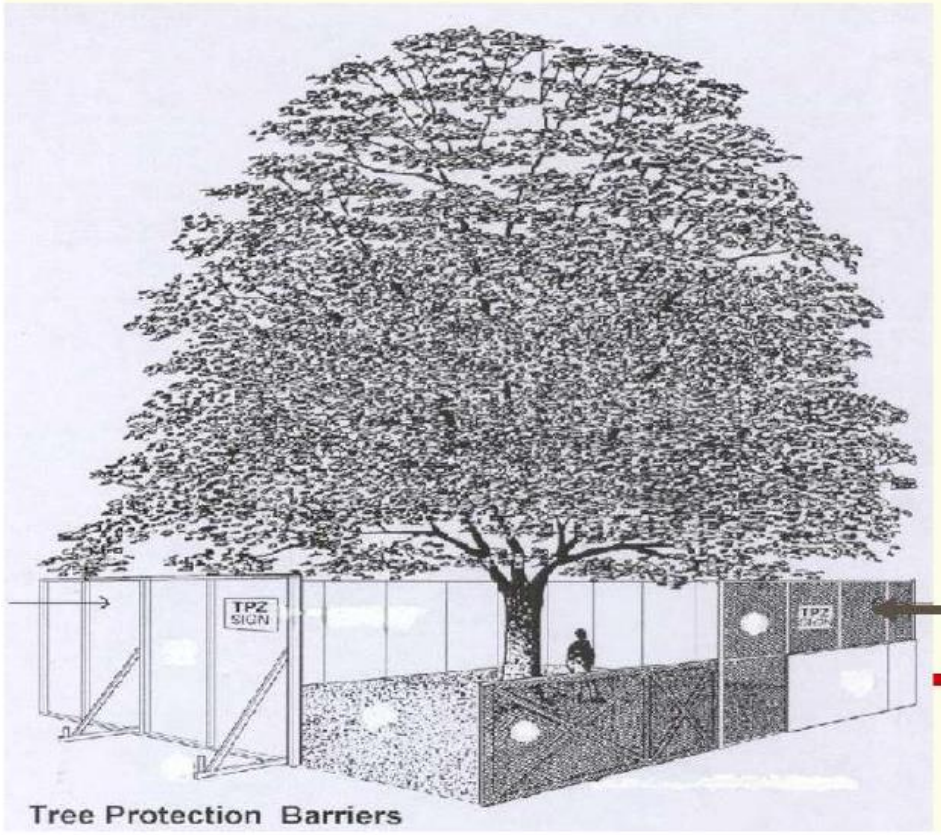
(Left) A 15-year-old, healthy, 33-cm (13-in.) diameter Raywood ash (*Fraxinus* 'Raywood') (good tolerance, young age):

0.06 m × 33 cm = 1.98-m radius tree protection zone
0.5 ft × 13 in. = 6.5-ft radius tree protection zone

(Right) A healthy 60-year-old, 76-cm (30-in.) diameter black walnut *(Juglans hindsii)* (poor tolerance, mature age):

0.15 m × 76 cm = 11.4-m radius tree protection zone
1.25 ft × 30 in. = 37.5-ft radius tree protection zone

Protection Barriers – Tree Protection Zone (TPZ)



Plywood or approved material

1

Tree Protection Zone (TPZ)

- Based on BSI 5837.1991 guidelines
- Trees tolerant of construction:
  - High vigour: TPZ 2-5m radius
  - Low vigour: TPZ 3-7m radius
- Trees intolerant of construction:
  - High vigour: TPZ 3-7m radius
  - Low vigour: TPZ 5-10m radius

NATIONAL PARKS

2

Examples of Radius of Tree Protection Zone (TPZ) for different Tree species

(Y – Young <1m girth, S – Semi-mature 1-1.5m girth, I – Intermediate 1.5-2m girth, M – Mature >2m girth)

Name of tree	Using BSI 5837:1991 TPZ guidelines TPZ is radius (m) from tree centre							
	Normal Vigour				Low Vigour			
	Y	S	I	M	Y	S	I	M
Acacia auriculiformis	2	3	4	5	3	5	6	7
Adenantherapavonina	2	3	4	5	3	5	6	7
Adinandradumosa	2	3	4	5	3	5	6	7
Agathisdammara	3	5	6	7	5	8	9	10
Alstoniaangustiloba	2	3	4	5	3	5	6	7
Alstoniaaugustifolia	2	3	4	5	3	5	6	7
Alstoniascholaris	2	3	4	5	3	5	6	7
Anacardiumoccidentale	2	3	4	5	3	5	6	7
Andirainermis	2	3	4	5	3	5	6	7
Annonamuricata	2	3	4	5	3	5	6	7
Araucaria excelsa	2	3	4	5	3	5	6	7
Araucaria heterophylla	2	3	4	5	3	5	6	7
Arfeuilleaarborescens	2	3	4	5	3	5	6	7
Artocarpusheterophyllus	2	3	4	5	3	5	6	7
Azadirachtaexcelsa	2	3	4	5	3	5	6	7
Azadirachtaindica	2	3	4	5	3	5	6	7
Barringtoniaasiatica	2	3	4	5	3	5	6	7
Bauhinia X blakeana	2	3	4	5	3	5	6	7
Bucidabuceras	2	3	4	5	3	5	6	7
Caesalpiniaferrea	2	3	4	5	3	5	6	7
Callistemon citrinus	2	3	4	5	3	5	6	7
Callistemon viminalis	2	3	4	5	3	5	6	7
Calophylluminophyllum	2	3	4	5	3	5	6	7
Cassia fistula	2	3	4	5	3	5	6	7
Casuarinaequisetifolia	3	5	6	7	5	8	9	10
Chrysophyllumcainito	2	3	4	5	3	5	6	7
Cinnamomuminers	2	3	4	5	3	5	6	7
Clitoriaracemosa								
Cratoxylumformosum	2	3	4	5	4	5	6	7
Dalbergialatifolia	2	3	4	5	4	5	6	7
Dalbergiaoliveri	2	3	4	5	4	5	6	7

Name of tree	Using BSI 5837:1991 TPZ guidelines TPZ is radius (m) from tree centre							
	Normal Vigour				Low Vigour			
	Y	S	I	M	Y	S	I	M
Delonixregia	2	3	4	5	4	5	6	7
Dilleniasuffruticosa	2	3	4	5	3	5	6	7
Diospyrosblancoi	3	5	6	7	5	8	9	10
Dryobalanopsoblongifolia	2	3	4	5	3	5	6	7
Duriozibethinus	3	5	6	7	5	8	9	10
Dyeracostulata	2	3	4	5	3	5	6	7
Elaeocarpusmastersii	3	5	6	7	5	8	9	10
Enterolobiumcyclocarpum	2	3	4	5	3	5	6	7
Enterolobiumsaman(= *Samaneasaman*)	2	3	4	5	3	5	6	7
Erythrinaglauca(= *Erythrinafusca*)	2	3	4	5	3	5	6	7
Erythrophleumguineense (= *Erythrophleumsuaveolens*)	2	3	4	5	3	5	6	7
Eucalyptus camaldulensis	2	3	4	5	3	5	6	7
Eugenia grandis(= *Syzygiumgrande*)	2	3	4	5	3	5	6	7
Eugenia longiflora (= *Syzygiumlineatum*)	2	3	4	5	3	5	6	7
Eugenia oleina (=*Syzygiumcampanulatum*)	2	3	4	5	3	5	6	7
Fagraeafagrans	3	5	6	7	5	8	9	10
Ficusbenjamina	2	3	4	5	3	5	6	7
Ficuselastica	2	3	4	5	3	5	6	7
Filiciumdecipens	3	5	6	7	5	8	9	10
Garciniamangostana	3	5	6	7	5	8	9	10
Gardenia carinata	2	3	4	5	3	5	6	7
Gliricidiasepium	2	3	4	5	3	5	6	7
Gnetumgnemon	2	3	4	5	3	5	6	7
Grevillearobusta	2	3	4	5	3	5	6	7
Hopeaodorata	2	3	4	5	3	5	6	7
Hymenaeacourbaril	3	5	6	7	5	8	9	10
Khayagrandifoliola	2	3	4	5	3	5	6	7
Khayanyassica	2	3	4	5	3	5	6	7
Khayasenegalensis	2	3	4	5	3	5	6	7
Kopsiaflavida(= *Kopsiaarborea*)	2	3	4	5	3	5	6	7
Lagerstroemia flosreginae	2	3	4	5	3	5	6	7

Name of tree	Using BSI 5837:1991 TPZ guidelines TPZ is radius (m) from tree centre							
	Normal Vigour				Low Vigour			
	Y	S	I	M	Y	S	I	M
Mangiferaindica	2	3	4	5	3	5	6	7
Manikarazaopta	2	3	4	5	3	5	6	7
Maniltoabrowneoides	2	3	4	5	3	5	6	7
Maranthescorymbosa	2	3	4	5	3	5	6	7
Melaleucagenistifolia	2	3	4	5	3	5	6	7
Melaleuca golden gem	2	3	4	5	3	5	6	7
Melaleucaleucodendron	2	3	4	5	3	5	6	7
Meliaazedarach	2	3	4	5	3	5	6	7
Meliaexcelsa	2	3	4	5	3	5	6	7
Mesuaferrea	3	5	6	7	5	8	9	10
Micheliachampaca	3	5	6	7	5	8	9	10
Micheliax alba	3	5	6	7	5	8	9	10
Milletiaatropurpurea	2	3	4	5	3	5	6	7
Millettiapinnata	3	5	6	7	5	8	9	10
Mimusopselengi	2	3	4	5	3	5	6	7
Nepheliumlappaceum	2	3	4	5	3	5	6	7
Pangiumedule	2	3	4	5	3	5	6	7
Peltophorumpterocarpum	2	3	4	5	3	5	6	7
Planchonellaobovata (=*Pouteriaobovata*)	2	3	4	5	3	5	6	7
Plumeriaobtusa	2	3	4	5	3	5	6	7
Plumeriarubra	2	3	4	5	3	5	6	7
Podocarpuspolystachus	2	3	4	5	3	5	6	7
Pometiapinnata	2	3	4	5	3	5	6	7
Pterocarpusindicus	2	3	4	5	3	5	6	7
Samaneasaman	2	3	4	5	3	5	6	7
Sandoricumkoetjape	2	3	4	5	3	5	6	7
Saracathaipingensis	2	3	4	5	3	5	6	7
Scheffleraactinophylla	2	3	4	5	4	5	6	7
Sindorawallichii	3	5	6	7	5	8	9	10
Sterculiafoetida	3	5	6	7	5	8	9	10
Sterculiaparviflora	2	3	4	5	4	5	6	7
Sterculiaparvifolia	2	3	4	5	4	5	6	7
Stereospermumfimbriatum	2	3	4	5	4	5	6	7
Strebluselongatus	3	5	6	7	5	8	9	10

Name of tree	Using BSI 5837:1991 TPZ guidelines TPZ is radius (m) from tree centre							
	Normal Vigour				Low Vigour			
	Y	S	I	M	Y	S	I	M
Swieteniamacrophylla	2	3	4	5	4	5	6	7
Tabebuiapallida	2	3	4	5	4	5	6	7
Tabebuiarosea	2	3	4	5	4	5	6	7
Tamarindusindica	2	3	4	5	4	5	6	7
Tectonagrandis	3	5	6	7	5	8	9	10
Terminaliacatappa	2	3	4	5	4	5	6	7
Vitexpinnata	2	3	4	5	3	5	6	7
Xanthostemonchrysanthus	2	3	4	5	3	5	6	7