ANNEXURE 5

GUIDELINES FOR WORKS WITHIN THE VICINITY OF TREES

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1.0 INTRODUCTION

These guidelines apply to the interpretation of Clauses 5C.7.3.3 RULES : TREES of the Auckland City Proposed District Plan 1997, Isthmus.

The Auckland City District Plan objective in relation to trees is to protect trees and groups of trees, which significantly contribute, to the district's amenity.

Trees have an important ecological, environmental, and cultural role. They have an important contribution to make in the sustainable management of natural and physical resources of the Isthmus. Collectively they endow the landscape with distinctive environmental quality and charm.

The environmental or practical relationship between people and trees is fundamental to existence. Often land use pressure in the urban environment encroaches on the continued existence of trees. With this in mind suitable guidelines are required for work within the vicinity of trees.

These guidelines are designed to give a brief overview of how a tree functions, how the different above and below ground parts of a tree are interdependent, and how various activities may cause significant damage to trees. Suitable mitigation measures are described in these guidelines to assist in deciding the best ways to provide protection to trees, and in particular to their root systems. When prescriptive conditions are placed on work within the vicinity of trees, the relevant objective of the District Plan will be achievable and sustainable.

Early consultation with the Council and qualified arborists is also recommended.

2.0 HOW TREES FUNCTION

A tree is a dynamic living organism. All of the various parts and functions of a tree are interdependent, and understanding these parts and functions is important to prevent unnecessary damage. The trunk, crown and roots function together as a balanced system in a vigorous healthy tree. Any damage to the above or below ground tree parts will upset this balance and cause a net reduction in overall tree health.

Trees are often viewed as only trunks, branches and leaves, however a major portion of every tree, the roots, are unseen. The root system is generally overlooked and misunderstood. One of the purposes of Annexure 5 is to place importance on protecting the roots of trees.

2.1 TREE PARTS ABOVE GROUND

2.1.1 TRUNK AND LARGE BRANCHES

The trunk and branches of a tree serve three primary functions:

- structural support
- storage of food reserves
- transport of essential substances

These functions are carried out by the various tissues, which make up the trunk and branches:

- bark
- phloem
- cambium
- xylem
- sapwood
- heartwood

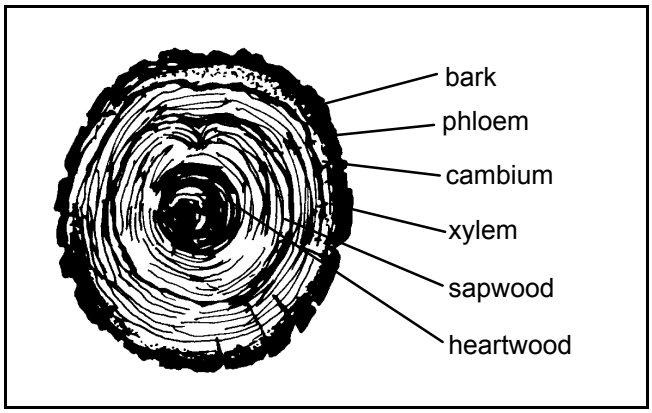


Figure 1: Cross-section of a trunk or branch showing the various tissues

Bark is the outermost layer of tissues. Bark provides some measure of defence against physical and biological damage, and helps moderate trunk and stem temperatures.

Phloem tissue is a vascular system located between the bark and cambium. Phloem is a series of connected cells designed to transport growth regulators, sugars, and carbohydrates throughout the tree.

Cambium is an active growing layer of cells which are dividing to produce new vascular tissue which is either phloem or xylem.

Xylem tissues form inward from the cambial layer, developing a second vascular system. Xylem is responsible for the uptake of water and essential elements from the roots to the leaves. Xylem becomes the wood of the tree, providing structural support and a volume of tissues used to store food reserves.

Sapwood is the outer and active layers of wood, which provide transport, storage, structural support, and protection and defence against decay pathogens.

Heartwood is the inner and nonconducting layers of older xylem. The main function of heartwood is to provide structural support for the tree.

The vascular system exists just beneath the bark of a tree, and is easily damaged. Any damage to the vascular system can have a major negative effect on tree health.

2.1.2 TREE CROWN

Twigs and smaller branches consist of the same tissues, serving the same functions as the trunk and branches of a tree. They also serve as the primary growth sites for the buds which develop into leaves, flowers, and fruits.

The normal growth pattern of smaller branches, twigs, and leaves maximises the total crown area available for photosynthesis and transpiration. Photosynthesis and transpiration are the primary functions of leaves.

2.2 TREE PARTS BELOW GROUND

2.2.1 TREE ROOT FUNCTIONS AND GROWTH PATTERNS

Any construction process that disrupts or interferes with tree root systems will have an adverse effect on tree health.

Roots serve four primary functions:

- anchorage and stability
- absorption of water and mineral nutrients
- transportation of essential substances
- storage of food reserves

To provide these functions tree roots require a constant supply of oxygen, water, and mineral elements, and carbohydrates. Tree roots are opportunistic, growing wherever conditions are favourable, and where moisture and oxygen are available.

Many people envision roots growing downward at steep angles from the base of the tree trunk, extending deep into the earth. This pattern of root growth is a misconception and rarely occurs. There is variation in the extent of root spread among tree species. However, the basic pattern is similar for most trees. In some cases it will be necessary to protect the root system beyond the dripline.

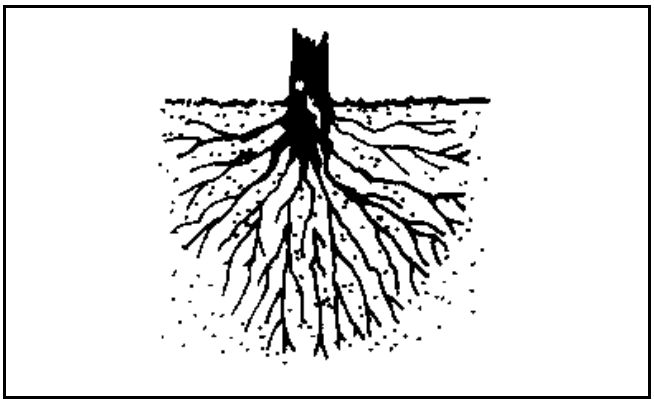


Figure 2: Rarely True

Figure 2 is how many people imagine tree root systems. While a few species do have deep tap roots most do not. This notion is more artistic than accurate.

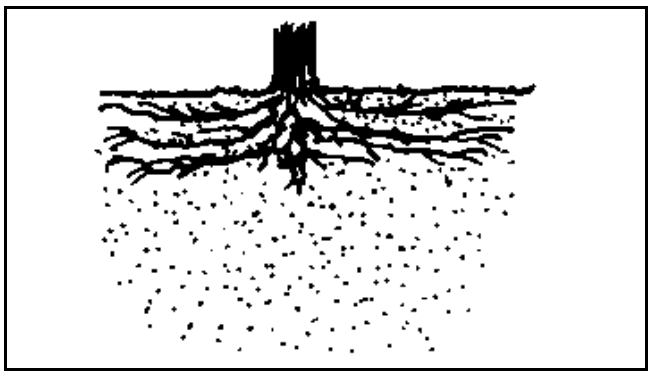


Figure 3: More Common

Roots spread to where soil conditions provide nutrients and moisture, which is usually near the surface. About 85% of tree roots are within the top 500 mm of soil. Figure 3 shows the lateral spread of roots which is more common.

Under ideal conditions tree roots can extend out from the trunk two or three times the radius of the canopy spread (dripline) or two or three times the height of the tree. The canopy spread (dripline) is ideally the minimum area around a tree which should be protected.

2.2.2 TYPICAL ROOT SYSTEMS

Typical root systems are made up of a combination of four types of roots:

- major lateral roots
- sinker roots
- woody feeder roots
- non-woody feeder roots

Major lateral roots originate from the base of a tree trunk. These roots exist near the soil surface, and grow outward in a radial, horizontal direction. Figure 4 illustrates basic tree function.

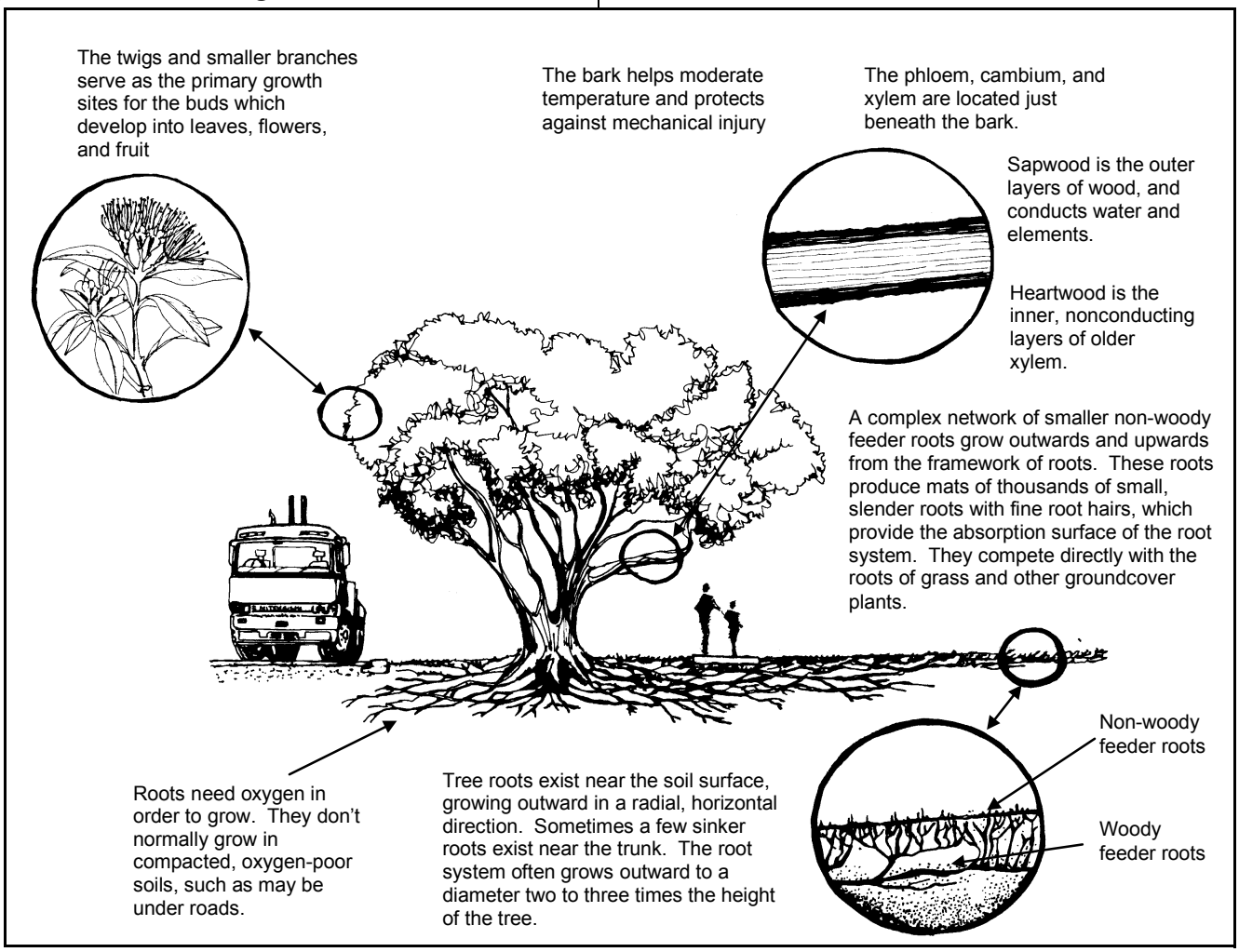
Sinker roots grow vertically downward from the lateral roots, providing additional anchorage and increasing the depth to which the root system penetrates. Sinker roots are usually found within a short distance of the tree trunk.

Major lateral roots and sinker roots provide the primary anchorage for a tree. These roots usually do not extend below one to two metres in depth.

Woody feeder roots extend from the lateral roots, and are typically located in the upper 300mm of soil.

Non-woody feeder roots grow well beyond the canopy, greatly increasing the absorption area of the root system.

Figure 4: Tree function diagram



2.3 WOUND RESPONSE

Damage to trees, unlike damage to light poles and pavement cannot be repaired. Trees are living organisms, but they do not heal. Damaged tissues are not replaced and restored with new cells. Damaged areas are physically closed off from undamaged areas, and the damaged tissue remains within the tree for the rest of its life.

The defensive reaction to wounding and the spread of decay requires a redirection of energy resources. Each time a tree responds to wounding results in a loss of energy which could have been used for healthy normal growth.

The amount of energy lost to wound response depletes the total available energy. Continued normal growth is no longer possible and repeated, extensive wounding can stress a tree to the point of decline.

3.0 DAMAGE TO TREES

A resource consent must be obtained for any work to cut, damage, alter, injure, destroy or partially destroy any scheduled tree or generally protected tree (including roots). Expert advice is available from Auckland City Council Arborists to ensure the health and survival of trees.

Further a 'Guide to Tree Protection Controls' is available from Council offices.

Trees are more vulnerable than many people imagine. Special care must be taken on all sites where work is to be carried out within the vicinity of trees that are to be preserved.

Damage to trees caused by construction work occurs both above and below the ground. Root systems can suffer mechanical and chemical damage. Tree trunks and crowns can be subject to various degrees of mechanical and heat damage. These types of damage to trees can be serious. These types of damage to trees can also be prevented.

Understanding the seriousness of the damage is necessary to understanding the value of preventing such damage

3.1 ABOVE GROUND DAMAGE

Many construction activities cause above ground damage to trees. Damage above ground can be a result of direct impacts with construction equipment and storage of construction materials against trees. Trees can also be damaged by improper 'pruning' for clearance by construction personnel. Figures 5 and 6 illustrates these points.

3.1.1 TRUNK AND CROWN DAMAGE

Trunk and branch wounding can range from minor outer bark damage to total structural failure of the main stem. Damage to the phloem, cambium, and xylem disrupts the flow of water, mineral elements, growth regulators, and photosynthates (sugars) between the crown and roots. The greater the circumferential damage, the greater the total amount of flow lost. Damage to wood tissues also reduces the availability of previously stored food reserves, and the amount of woody tissue available for future food storage.

Trees must also redirect resources to close the large wounds, furthering net energy loss. The exposed wood tissues at wounds provide open access for wood rotting fungi. Trees stressed or weakened by construction damage may also be predisposed to secondary insect and disease infestations.

When large branches are torn away from trees the damage is substantial. Loss of major limbs reduces the quantity of leaf area, thereby reducing the tree's total photosynthate (sugar) production.

Total leaf area is also reduced by leaf scorch and twig death. This occurs when hot exhaust gases vent from equipment operating beneath tree crowns.

Heat and fumes can kill or injure the trunks, branches and leaves, reducing the trees ability to survive.

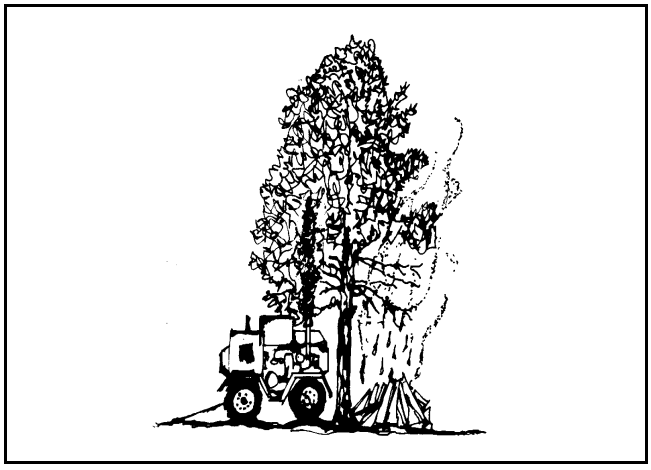


Figure 5: Keep all construction equipment, generators, and static machinery well away from the branch spread. Do not light any fires or create any source of heat or noxious fumes within the branch spread of a tree.

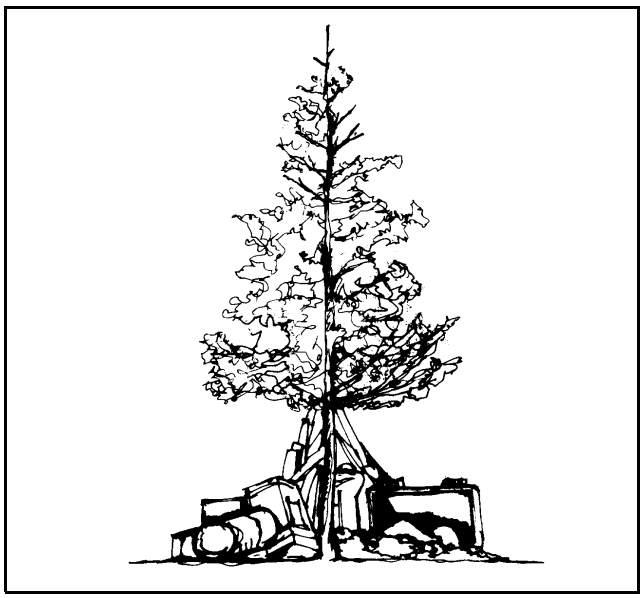


Figure 6: Do not put soil, debris, or any construction materials against tree trunks or within the root zone.

3.2 BELOW GROUND DAMAGE

Tree roots often suffer extensive injury and loss as a result of construction work happening around them. The main causes of construction damage below ground are:

- soil compaction
- direct root loss
- soil grade changes
- chemical contamination

3.2.1 SOIL COMPACTION

The soil within the root zone of a tree can suffer compaction damage by general construction traffic, operation of heavy equipment, and by the storage of construction materials within the root zone. The soil may also be intentionally compacted as an engineering requirement of construction.

Compaction of the soil changes soil structure and increases bulk density. This causes a decrease in supplies of oxygen necessary for root respiration, an accumulation of carbon dioxide and other toxic gases, and affects water infiltration rates. See Figure 7.

Some soil types become more impervious to water, and others retain more water. This leads to either drying or water-logging of soils surrounding tree roots. Such changes in soil moisture can cause direct root mortality.

Abnormal soil moisture and compacted soil structure can also prevent roots growing into new areas.

Symptoms of compaction may not be immediately obvious and trees may die several years after compaction damage has occurred.

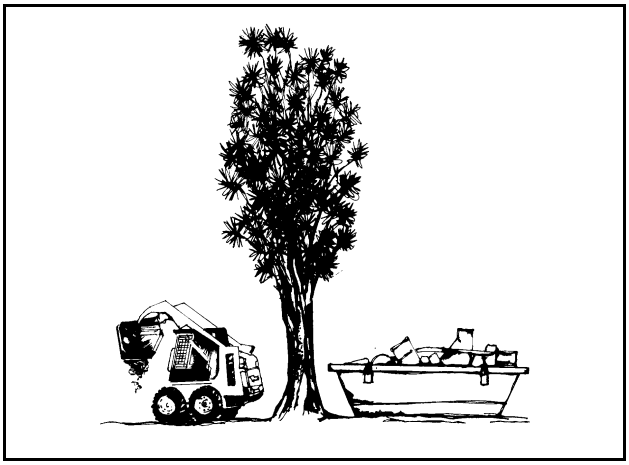


Figure 7: Do not operate any vehicles or machinery over the root zone.

Although you may have seen healthy trees growing in areas covered by impervious materials (such as concrete or asphalt) these trees have usually grown under such conditions since they were saplings. Mature trees may be killed by new surfacing.

Seek any necessary Consents and advice of a qualified arborist before installing hard surfaces over the root system of any scheduled or otherwise protected trees.

3.2.2 DIRECT ROOT LOSSES

Excavating and trenching machines are commonly used in construction. This equipment has the potential of causing extensive root loss when no concern is given to root systems during trenching and excavating activities.

Roots can be severed, torn away, or crushed causing serious wounding and loss of normal structural stability. This can lead to direct tree mortality and/or uprooting. Less severe damages may lead to drying out, and death of exposed roots. Roots that are badly damaged are prone to decay pathogens. The physical loss of roots will affect the trees stability and ability to survive, and may lead to a decline in tree health. See Figure 8.

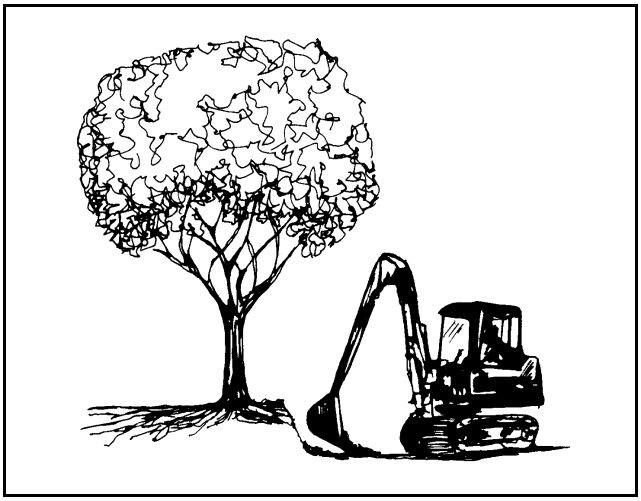


Figure 8: Do not trench or excavate within the root zone of trees, this may sever roots. Root severance can cause instability, creating a hazardous situation.

3.2.3 SOIL GRADE CHANGES

Leveling, filling, and cutting of soil grades will result in the same types of damaged associated with excavating, trenching, and soil compaction. Grading may also remove the nutrient-rich topsoil that supplies basic elements trees require for growth. See Figure 8.

Lowering or cutting grades can remove a large percentage of feeder roots. Raising or filling grades around trees reduces air diffusion and exchange in the root zone. As little as **100 mm** of soil placed over the established root systems of some species is enough to kill them.

Even if grade changes are not made directly in the root zone they may be close enough to root systems to affect water drainage. Again, this may cause root dieback due to changes in soil moisture content.

3.2.4 CHEMICAL DAMAGE

Leaking or spilling of fuel, lubricants or hydraulic oils, or intentional dumping of masonry resinates, paints, acids, solvents, or any other toxic substances may kill roots or impede their functions. When such toxins are deposited in tree root zones they adversely affect tree health or directly cause tree mortality. See Figure 9.

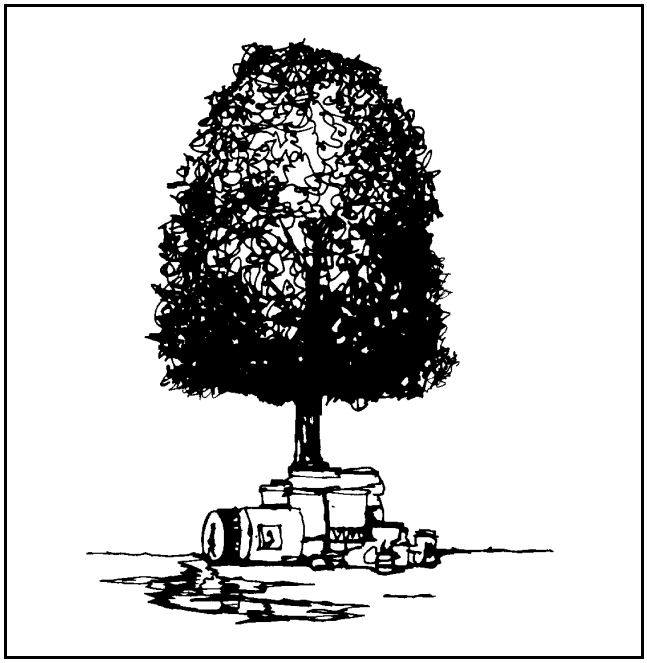


Figure 9: Do not store or dispose of any toxic substances within the root zone.

4.0 PROTECTION AND CARE OF TREES

Trees should be protected on the work site by defining an appropriate area around them, and by excluding all construction operations from the protected area.

The success of the tree protection process will depend on the cooperation of all persons involved in the design, construction and implementation of the protective measures.

It is essential for those involved in the siteworks to appreciate the need for maintaining the area of protection around trees. Breaching the protective zone can easily lay to waste the time, effort and expense which has gone into the protection of the trees.

4.1 PROTECTIVE FENCING

Before any materials or machinery are brought on site, or before any demolition, or development begins protective fencing must be erected around all trees which are to be retained. Trees on adjacent properties affected by the construction works must also receive appropriate protective fencing. See Figure 10.

The fencing must be strong and appropriate to the degree of construction activity taking place on the site.

The protected area around trees must be of dimensions recommended in Figure 11. The temporary fencing around

this area must be maintained throughout construction works. The temporary fencing shall be 1.8 - 2m high and must prevent access within the protected area.

No works shall be carried out within the protected area. No materials shall be stored within the protected area.

Notices should be erected on the fencing with words such as 'Protected area - no operations within fenced area'.

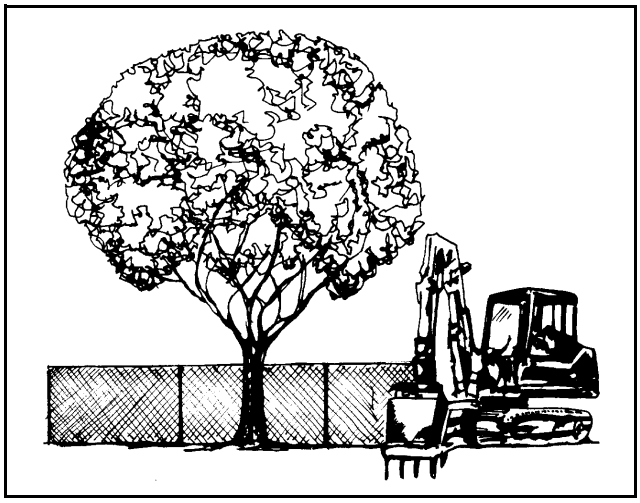


Figure 10: The fencing must be strong and appropriate to the degree of construction activity taking place on the site.

4.2. INSTALLATION OF UTILITY SERVICES

Detailed plans are required to show the routing of all services in the proximity of trees, and must indicate the area needed for installation of the services.

Care is also needed in routing above ground services to avoid excessive pruning requirements before or after the installation of services.

If an alternative route can not be used then the installation of underground services must be done in a way that minimises damage to trees, for example using techniques such as thrusting and/ or hand digging.

Open cut trenching can cause major damage to tree roots, as shown in Figure 12a. Thrusting minimises and localises damage to tree roots, as shown in Figure 12b, and is the preferred method of service installation.

4.2.1 THRUSTING AND DIRECTIONAL DRILLING

Traditional methods of service establishment (ie open cut trenching) can cause massive root damage and ground disturbance therefore the 'change of environment' for the tree will be high.

The action of 'thrusting' or 'directional drilling' is the most preferred method of service establishment within the dripline of trees. When these two methods are used, the 'change of environment' around the tree is minimised.

All machinery and starting pits associated with the action of thrusting or directional drilling should remain outside the dripline of trees. This is to minimise any root loss or ground compaction that may arise from the works.

If the thrusting rod or directional drill-head becomes stuck underneath the dripline of a tree, then the arborist responsible for the trees on the site should be contacted prior to the retrieval process. Any retrieval of a thrusting rod or directional drill-head under the dripline of a tree should be undertaken with hand tools unless otherwise stated by the arborist responsible for the trees on the site.

4.3 HAND DIGGING

The excavation method of 'hand digging', if carried out correctly, has the potential to have a 'no more than minor' effect on the health and safety of the tree/s which are within the line of works. The objective of hand digging is to retain the majority of roots.

Great care should be taken when hand digging within, or close to, the dripline of a tree. Works should be undertaken with due care and attention. The more time and care spent on hand digging, the less impact the work will have on the health and safety of the tree.

The main motivation for using hand digging as a method of excavation is root retention. When digging within the dripline of a tree, carefully remove the soil making sure that any roots accidentally discovered are not repeatedly hit or severed. Take care not to damage the outer 'bark' of roots as this is the area where the transport of nutrients and water to the rest of the tree occurs.

Fact. Hand digging takes time. Allow enough time for this method of works to occur when planning your job. If there is a lot of hand digging to be done on your site, train up a specialist crew who will become skilled in this method of excavation and therefore reduce the time that is required to achieve the work.

The majority of the roots are usually found near the soil surface. It may be possible to excavate by hand to a certain depth and then, in the absence of any roots that are to be retained, excavation by another method may be possible.

Prior to the work occurring, seek advice from the arborist responsible for the trees on the site as to how to proceed with the method of hand digging.

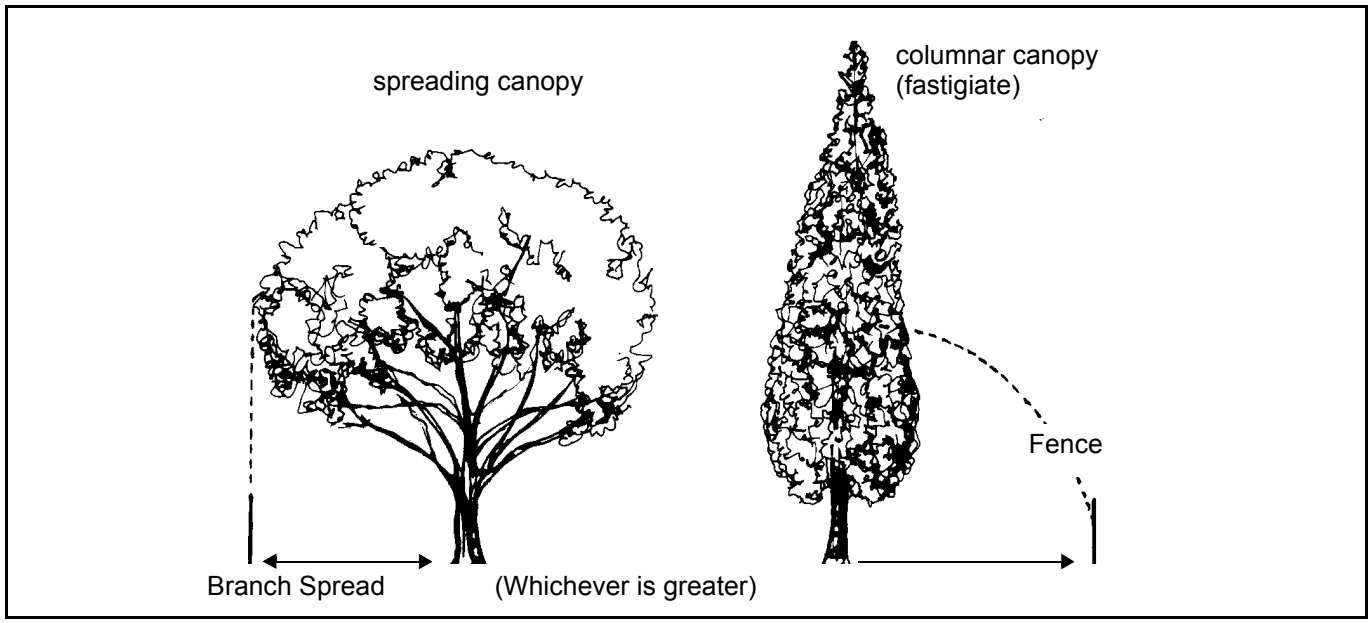


Figure 11: Dimensions for locating protective fencing

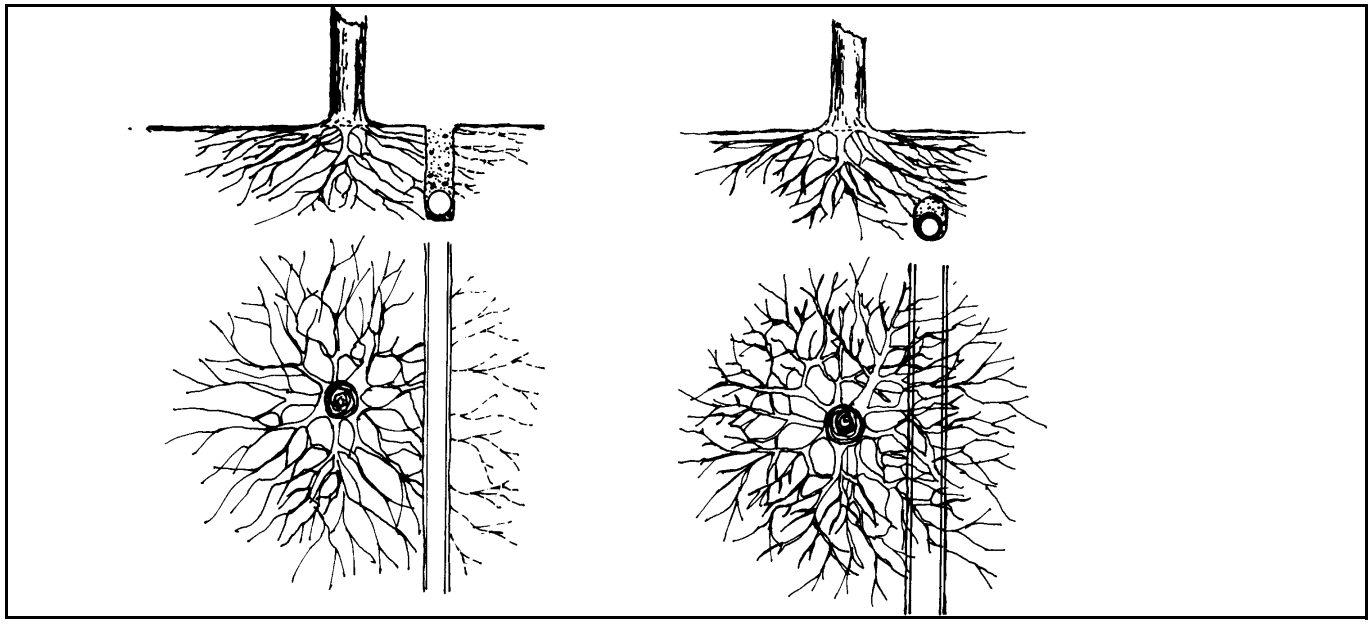


Figure 12a: Trenching causes major damage

Figure 12b: Thrusting minimizes damage