PART 8

SITE CONSTRUCTION

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8.1 GUIDELINE FOR WORKS WITHIN THE VICINITY OF TREES

(Trees guidelines are currently being developed. Refer Appendix 8.1 for further information)

8.2 PLACEMENT OF STRUCTURES

(Structures guidelines are currently being developed)

8.3 TRENCHLESS CONSTRUCTION

(Trenchless construction guidelines are currently being developed)

Trenchless technology is the science of installing, repairing or renewing underground pipes, ducts and cables using equipment and techniques that minimise or eliminate the need for excavation. This is increasingly viewed as the preferred technology by virtue of its decreased surface disruption particularly in the urban environment.

Reticulation by trenchless construction is the RCA's preferred method of installation, except if impracticable or unsafe.

The decision of which technique to use shall be made by the Principal Provider taking into account their design and site constraints, and notified to the RCA accordingly. Alternatively, where the RCA requires trenchless technology to be used it will be prescribed as a condition during the RON notification process.

Special care will be required when trenchless construction is selected for installation of underground services. All necessary steps shall be taken to avoid damage to any other services.

8.4 TRENCH, SAWCUT, EXCAVATION

8.4.1 General

The repair, replacement or reinstatement of any disturbance or damage to the road, other underground services, berms, street trees, fences, bridges, retaining walls, poles, cables or other structures or property shall be the responsibility of the Principal Provider unless otherwise agreed with the RCA prior to the commencement of works.

To avoid any damage to subsoil drains and other existing services, proposed details of works shall be submitted to RCA's for approval prior to any works commencing. This information can be submitted with the road opening notice.

Where existing services are damaged as a result of trenching work, the Principal Provider shall immediately advise the owner of the damaged service to arrange for repairs to be carried out before backfilling. The owner of the damaged asset shall recover all associated costs from the Principal Provider responsible for the damage. Where the work has been completed and the owner has not been notified of the damage, additional costs associated with that repair may be recovered.

8.4.2 Temporary Support for Excavations

a) Geotechnical investigations are recommended prior to works commencing, to assist in evaluating ground conditions and potential impacts on the surrounding area of the work.

b) Provision of temporary support/shoring (or other alternatives) to all trenches must be considered where unstable ground conditions are encountered. Alternative support can include battering, dewatering, ground stabilisation, sheet piling.

c) A suitably qualified person shall design and oversee installation of all temporary support/shoring. In any event, any damage to the surrounding area that may occur as a result of the work, shall be the responsibility of the Principal Provider.

d) The excavation work shall not endanger the stability of the adjacent properties, including structures located within the road reserve.

8.4.3 Sawcutting Requirements

a) When an excavation is required to be made through any concrete, asphalt or chip seal surface, the edges of the excavation or trench shall be cut with a power saw prior to the excavation of the trench. The cut is to extend through the full thickness of the surface layer in a clean straight parallel line.

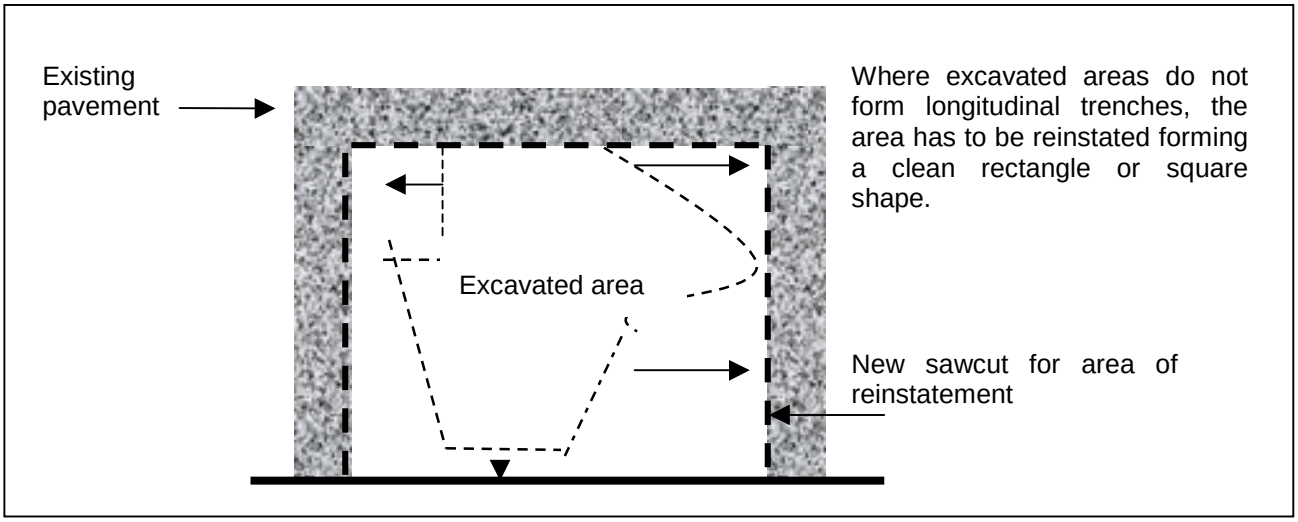
b) Areas adjacent to the excavation shall not be undercut. If slumping of material from the sides of the excavation causes depressed areas adjacent to the excavation, or if the edges of the pavement are lifted during excavation, additional saw cutting outside of the original line of the excavation and outside

the area of damage will be required. This will need to be carried out before the final surface reinstatement.

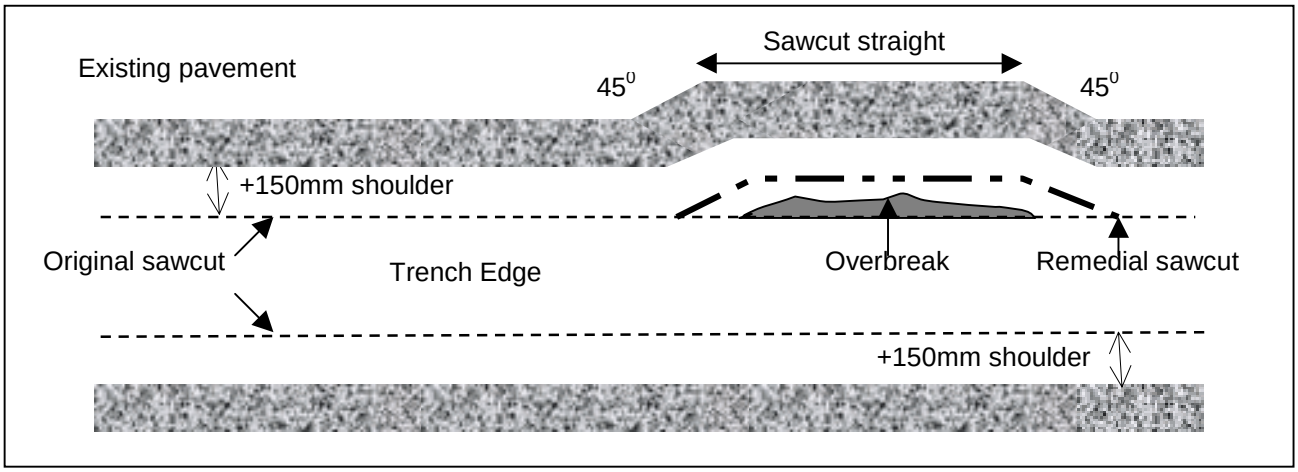
c) Joints must form a neat simple pattern to include trimming allowances. Generally this will mean parallel saw cuts on the sides of any area. All joints are to be sawcut to a depth sufficient to avoid disturbance of adjoining pavement. For effective saw cutting the depth of cutting shall be no less than 30mm.

8.4.4 Sawcutting Examples

The following sketch is a typical plan of sawcutting and surface reinstatement when the excavated area is not a longitudinal trench:

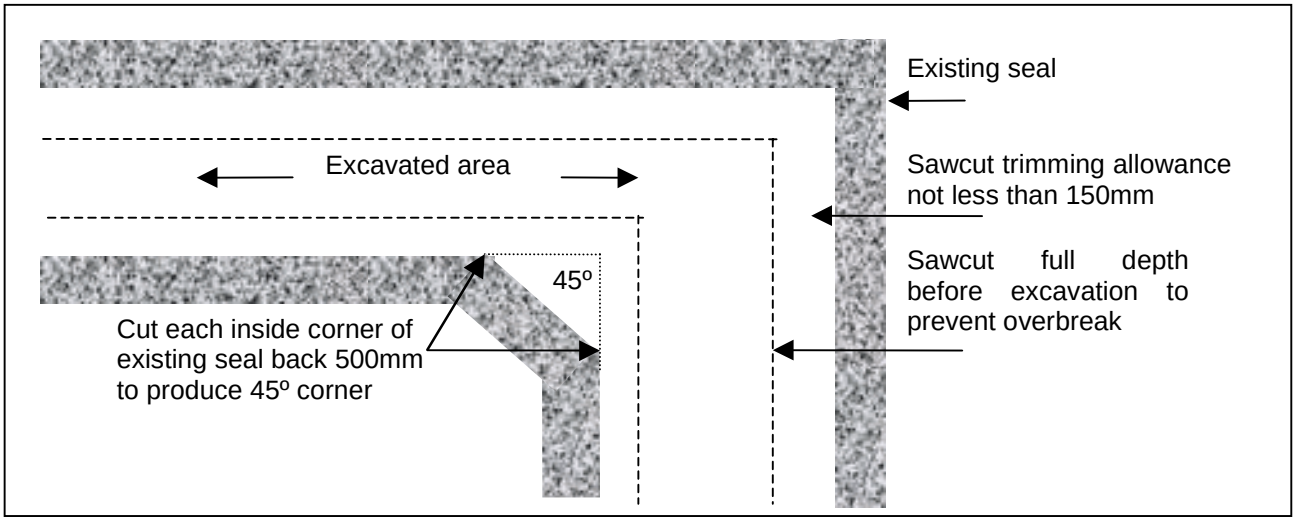


A minimum trench shoulder width of 150mm applies to all trenches in the carriageway except in concrete carriageways where a minimum shoulder width of 300mm is required. It may be necessary to increase the width to ensure the integrity of the final trench reinstatement.
The initial sawcut must take place prior to excavation. A second sawcut will be necessary to ensure that all edges are essentially straight, smooth and parallel to the line of the trench. It is recommended that the all sawcuts take place prior to excavation to minimise further damage to the surface layer. For more information please refer to Part 7 of this Code. A typical plan of saw cutting and surface reinstatement is shown below: If any overbreak occurs, a change in direction of the trench shall not exceed an angle of 45^{o}.

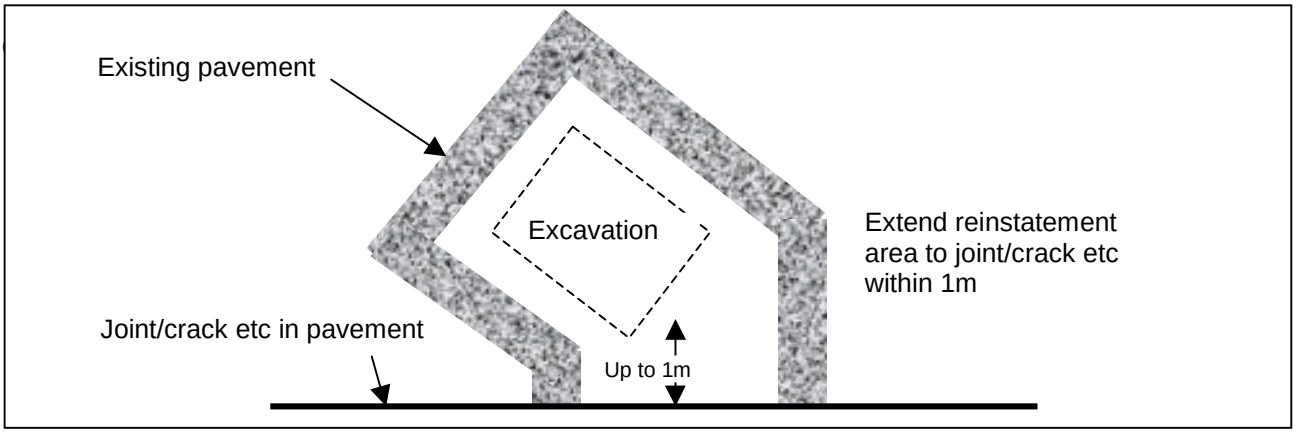


Overbreak of the trench shall not exceed 10% per 100 metres of trench and shall not be more than three separate areas within the 100 metre length of the trench, unless otherwise agreed with the RCA. Should the overbreak occur within 5 metres of each other, a straight parallel line must be formed between the overbreak.

Additional allowances shall be made when a trench excavation turns at corners, as shown below:



If the edge of the trench is within 1m of a crack, joint, edge of an existing trench, boundary or kerbline, then the existing pavement shall be replaced as part of the surface reinstatement, and sawcut accordingly.



8.4.5 Excavation

Prior to any excavation commencing, the site must be prepared in accordance with the RCA approved traffic management plan, set up by a qualified STMS. Safety at roadwork's sites shall be maintained at all times to ensure the safe movement of all road users.

As excavation proceeds, all surplus excavated material shall be removed from the work site within 48 hours. Where excavated material meets required specifications and is to be re-used, it may be stockpiled on site provided it is used within forty-eight hours. Alternatively, stockpiling arrangements may be approved by the RCA and shall be included in the Traffic Management Plan.

The RCA may require confirmation that the material meets the required specifications.

8.5 INSTALLATION OF SERVICES

a) All care shall be taken to ensure the safe and efficient installation of services. The installation must meet the requirements of the Principal Provider or the owner of the asset.

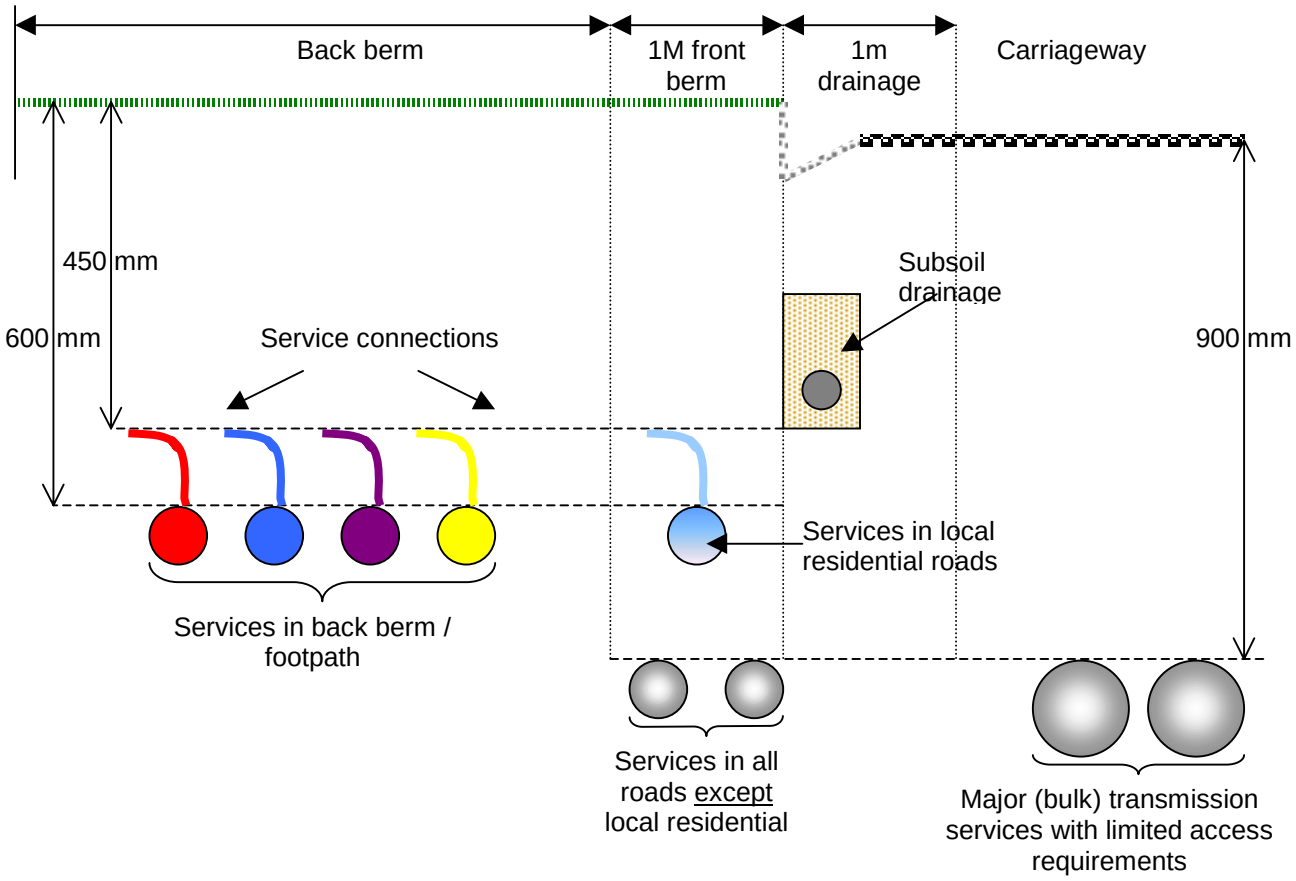
b) All bedding and cushion material must be free draining, non-compressible granular material.

c) In no case shall the cushioning exceed 300mm above the top of the service, unless specifically required by the Principal Provider. Any variance to these requirements must be agreed between the RCA and the Principal Provider.

d) All materials including bedding and cushioning shall be of sufficient quality and strength to support the imposed loading.

e) It is important to note that the drainage area is used for placement of cesspits and subsoil drainage and services should not be placed within 100mm on the kerb side and within 100mm from the vertical face of the sump.

8.5.1 Minimum Cover Requirements



Note: Minimum cover requirements includes a contingency allowance to provide for:

a) extra pavement depth required for road upgrading, road widening, placement of bus stops, parking bays, etc

b) extra depth for sub-grade strengthening

c) protection of existing utility services during road construction

d) construction tolerances

e) trees – provisions under development

f) bulk services in the carriageway only, any other services will be as agreed between the Principal Provider and the RCA

g) should utility services be placed in the front berm, 900mm minimum cover is required in all roads, except for local residential roads where 600mm cover is permitted

h) the colours are not indicative of any specific utility service. The positions of these services are dealt with in Part Five, Lay Position of Services.

i) subsoil drain depth and location could vary

j) It is important to note that the drainage area is used for the placement of cesspits, kerb and channels and subsoil drainage and should not be used for utility services.

k) A reduction of these minimum cover requirements may be negotiated between the Principal Provider and the RCA in certain circumstances. * Note These circumstances and outcomes are still the subject of discussions and are likely to be resolved early 2002. This may result in an early amendment of this particular clause.

8.6 BACKFILLING OF TRENCHES

8.6.1 General

The following requirements shall be met:

a) Backfill in trenches shall be applied as specified in Section 6.5.3 and Part 7 of the Code (Trench Reinstatement).

b) All backfill materials shall comply with approved specification as set out in Part 8 of this Code (Approved Materials).

c) All materials used for trench reinstatement shall have been sampled and tested by a certified testing agency. The RCA may request the Principal Provider to provide records of material test certification.

d) All material shall be placed and compacted in layers not exceeding 200mm, except for the top 300mm layer where compaction in 150mm layers is required. Where a trench exceeds 1.5m in depth, thicker compaction layers are permissible as per table 6.5.3 for backfill below 1.5m.

e) Compaction of materials in layers shall be achieved by mechanical compaction equipment appropriate to the size and location of the trench and the type of backfill material used.

f) Where concrete or other stabilised layers exist in the roadway, the trench shall be reinstated with similar material unless otherwise agreed by the RCA.

g) The Principal Provider will provide subsoil drainage where necessary to ensure that the ground water level is kept below 1 metre from the finished surface level. Where lowering the existing water table is likely to create adverse affects to surrounding areas, with respect to structural integrity of the surrounding ground and adjacent buildings, this requirement will not be necessary. In this situation drainage treatment will be dealt with as a specific design requirement.

h) If underbreak or other disturbance of the pavement layers occurs, the surface of such areas shall be re-cut, excavated as necessary and backfilled in compliance with the requirements of this Code.

i) Where ground water is likely to accumulate due to excavations, these areas must be permanently drained.

j) The RCA may from time to time undertake core samples of asphaltic concrete to ensure that the correct depth and materials have been used. Should such testing show that the materials and the depth do not meet the specified standards, reinstatement and all associated costs will be the responsibility of the Principal Provider. Should the materials meet the required standards, all sampling and testing costs will be met by RCA.

8.6.2 Compaction & Testing

Settlement of trenches must be avoided at all times. Generally, inadequate compaction contributes to settlement. Unstable ground conditions could also cause slumping of the surrounding area. Refer to Temporary Support for Excavations in Part 6.3.2 of this Code.

To avoid settlement, the backfill material shall be compacted in layers as set out in Section 6.5.1 (d) above. Testing shall be carried out using a Nuclear Densometer or an approved equivalent, which can demonstrate that the required compaction standards have been met. A Clegg Impact Hammer (4.5kg) may be used to monitor compaction densities, providing laboratory correlation tests have been carried out to confirm that the specified density has been achieved in accordance with ASTM D5874-95.

The following requirements for testing are necessary to ensure that the compaction of the trench meets with the required standards.

a) For trench lengths of 30m or more, testing is required at a rate of at least one test per layer of backfill per 15m of trench.

b) For trench lengths less than 30m, a minimum of two tests per layer of backfill is required

c) Where the excavated area is greater than 0.5m² and less than 5m², one test per backfill layers is required.

d) It is important to note that more testing may be necessary to ensure that the required compaction standards are met. It is the responsibility of the Principal Provider to ensure that no settlement occurs.

e) A suitably qualified person shall carry out and record all testing.

8.6.3 Requirements for Backfilling and Compaction

	CARRIAGEWAY	VEHICLE CROSSING	FOOTPATH	BERM
a	*0m-0.3m Depth range* • TNZ M/4 AP40 • Max. compaction layer 150mm • Compacted minimum dry density 98% (MDD) as per TNZ B/2 Specification • Clegg reading not less than 35.	*0m-0.3m Depth range* • GAP 65 • Max. compaction layer 150mm • Compacted minimum dry density 95% MDD as per TNZ B/2 Specification • Clegg reading not less than 32	*0m-0.1m Depth range* • GAP65 • Max. compaction layer 150mm • Compacted minimum dry density 95% MDD as per TNZ B/2 Specification • Clegg reading not less than 32	*0m-0.1m Depth range* • Clean Topsoil • Max. compaction layer 150mm • Compacted minimum dry density of 90% MDD as per TNZ F/'1 Specification • Clegg reading not less than 25
b	*0.3m-1.5m Depth range* • GAP65 • Max. compaction layer 200mm • Compacted minimum dry density of 95% MDD as per TNZ B2 Specification • Clegg reading not less than 32	*0.3m-1.5m Depth range* • GAP65 • Max. compaction layer 200mm • Compacted minimum dry density of 95% MDD as per TNZ B2 Specification • Clegg reading not less than 32	*0.1m-1.5m Depth range* *1). Within 1m of kerb:* • GAP65 • Max. compaction layer 200mm • Compacted minimum dry density of 95% MDD as per TNZ B2 Specification • Clegg reading not less than 32 *2). Outside 1m of kerb:* • Other backfill materials may be used providing the required compaction standard is achieved. • Compacted minimum dry density of 95% MDD as per TNZ F/1 Specification • Clegg reading not less than 25	*0.1m-1.5m Depth range* *1). Within 1m of kerb:* • GAP65 • Max. compaction layer 200mm • Compacted minimum dry density of 95% MDD as per TNZ B2 Specification • *Clegg reading not less than 32 *2).Outside 1m of kerb:* • Other backfill material may be used Providing the required compaction standard is achieved. • Compacted minimum dry density of 90% MDD as per TNZ F/'1 Specification • Clegg reading not less than 25
c	*1.5m to top of pipe bedding material* • GAP100/GAP150 • Recommended compaction layers in 200mm • Thicker compaction layers to a maximum of 600mm are permissible provided that the required compaction standard is achieved, • Compacted minimum dry density of 90% MDD as per TNZ F1 Specification • Clegg reading no less than 25	*1.5m to top of pipe bedding material* • GAP100/GAP150 • Recommended compaction layers in 200mm • Thicker compaction layers to a maximum of 600mm are permissible provided that the required compaction standard is achieved, • Compacted minimum dry density of 90% MDD as per TNZ F1 Specification • Clegg reading not less than 25	*1.5m to top of pipe bedding material* *1). Within 1m of kerb:* • GAP100/ GAP150 • Recommended compaction layers in 200mm • Thicker compaction layers to a maximum of 600mm are permissible provided that the required compaction standard is achieved, • Compacted minimum dry density of 90% MDD as per TNZ F1Specification • Clegg reading not less than 25 *2) Outside 1m of kerb:* • Other backfill materials may be used providing the required compaction standard is achieved. • Compacted minimum dry density of 90% MDD as per TNZ F1Specification Clegg reading not less than 25	*1.5m to top of bedding material* *1). Within 1m of kerb:* • GAP100/GAP150 • Recommended compaction layers in 200mm • Thicker compaction layers to a maximum of 600mm are permissible provided that the required compaction standard is achieved, • Compacted minimum dry density of 90% MDD as per TNZ F1Specification • Clegg reading not less than 25 *2) Outside 1m of kerb:* • Other backfill material may be used providing the required compaction standard is achieved. • Compacted minimum dry density of 90% MDD as per TNZ F1Specification Clegg reading not less than 25

Notes:

a) Refer to Part 9 of this Code for further information regarding reinstatement of trenches

b) All materials specified are to meet the required standards as outlined in Part 10 of this code

c) Testing shall be carried out using a Nuclear Densimeter or an approved equivalent, which can demonstrate that the required compaction standards have been met. A Clegg Impact Hammer (4.5kg) may be used to monitor compaction densities, providing laboratory correlation tests have been carried out to confirm that the specified density has been achieved in accordance with ASTM D5874-95.

d) Clegg Impact Hammer values have been calculated as a guideline for the purposes of this Code as follows:

e) 98% MDD = 35 CIV

f) 95% MDD= 32 CIV

g) 90% MDD = 25 CIV

h) MDD is the maximum dry density or an approved equivalent

i) RCA's reserve the right to impose more stringent standards in particular circumstances or may approve lesser standards to this Code on a case by case basis

j) Note The Clegg Impact Value (CIV) specified may not necessarily achieve the dry density standard required in Section 6.5.3 of this Code. Please refer to note c) above.

8.7 SURFACE REINSTATEMENT

8.7.1 General Principles

a) Resurfacing of trenches shall be made permanent within 7 days unless the RCA and the Principal Provider agree that this is not practicable to ensure inconvenience to the public is kept to a minimum.

b) The resurfacing of all trenches within the carriageway must be paver laid for any work more than 10 linear metres or 10 square metres, by a suitably qualified person in accordance with TNZ standards.

c) The visual appearance of the finished surface of reinstated trenches is considered critical. Clean long straight lines parallel to the kerb or footpath must be achieved.

d) Trench overbreak will require fresh surface cuttings to maintain the straight-line appearance of surface finish.

e) The "1m Rule" applies to all surfaces. If the edge of the trench is within 1m of a crack, joint or existing edge of the pavement, then the existing pavement shall be replaced as part of the surface reinstatement and saw cut accordingly. Permanent resurfacing is to be undertaken within 7 days of backfilling being completed.

f) The permanent resurfacing materials shall be similar in type, quality, texture, skid resistance and strength to the surrounding materials.

g) The RCA may require a road surface level survey to be carried out where an excavation is proposed. This survey would measure the road surface level at 5 metre intervals on each kerb and immediately around the proposed excavation. Such a survey must be accurate and have sufficient offset marks so that the levels can be re-established at the same points at any stage of the roadwork. The Principal is responsible for the cost of these surveys.

h) If a dispute arises over the final surface level a "Roughometer" may be employed to establish the roughness and comparison made with existing records. The work is deemed to be rough when an average roughness is 5% greater than the average roughness prior to trenching or greater than 10% for individual readings. "

i) No trench is to be opened to traffic until either temporary or permanent resurfacing is in place.

j) The surface level of the trench shall match the surrounding surface level.

k) A contractor approved by the RCA, shall reinstate all road marking and street signs within 24 hours of final surface reinstatement

l) TNZ M10 specifies the performance requirements of the mix (Mix10, Mix14 and Mix20) and requires the Principal Provider to produce a mix design that meets these requirements. This design needs to be approved by the RCA. Different Mix designs are required for paver laid and laid by hand. The thickness of the mix indicated in the Code specifies minimum requirements.

m) The RCA may from time to time undertake core samples of asphaltic concrete to ensure that the correct depth and materials have been used. Should such testing show that the materials and the depth do not meet the specified standards, reinstatement and all associated costs will be the responsibility of the Principal Provider.

	CARRIAGEWAY	VEHICLE CROSSING	FOOTPATH	BERM
	• Surfacing of Approved surfacing materials generally will be but not limited to: 30mm TNZ Mix 10 40mm TNZ Mix 14 50mm TNZ Mix 20 or Chipseal or Special paving must match existing special paved area. • The resurfacing of all trenches within the carriageway must be paver laid for any work more than 10 linear metres or 10 square metres, by a suitably qualified person in accordance with TNZ standards • 200mm 20MPa Concrete with approved reinforcement • The finish surface to match the surrounding surface. All road markings to be reinstated within 48 hours. Refer 6.6.11 • In areas where the RCA has applied special treatments to carriageway areas to improve the strength and quality of that area, reinstatement is required to match existing construction.	• Surfacing of 30mm AC Mix 10 • 150 mm 20MPa Concrete for Residential crossings • 200mm 20MPa Concrete for Commercial crossings and carriageways • Reinstate special surfaces to match existing • For vehicle crossing details refer to RCA's standard drawings	• Surfacing of 30mm AC Mix 10 • 100mm 20 MPa Concrete or as required by special circumstances e.g. Commercial Footpaths, Cycleways, Vehicle Crossings • Red chip or Red Slurry seal to be reinstated to standard • Reinstate special surfaces to match existing surface, full reinstatement of the area is required e.g. Brick Band and special paving areas •	•

8.7.2 Temporary Surface Reinstatement

The following criteria apply to temporary surfacing:

a) Temporary surfaces can be of either hot or cold mix and must be laid in manner and depth to be durable for both vehicular and pedestrian use. The Principal Provider must maintain the surface until permanent surfacing has been undertaken.

b) Permanent resurfacing is required within 7 days of a temporary seal being placed, unless as otherwise agreed, by the RCA.

c) Steel plates may be used in carriageways provided that they are skid resistant, secured and cushioned with rubber matting to prevent rocking, moving or noise. They must be of sufficient strength and quality to support imposed traffic loading.

d) Should steel plates be used "uneven surface" road works signs and "slippery surface"(TW-17) warning sign/s must be displayed to warn traffic of the potential hazards.

e) When steel plates are used, a ramp with hotmix must be formed and filleted to ensure safe pedestrian and vehicular access. The ramps must be adequately secured to the surface and maintained for the duration of the work.

f) Temporary road markings and all other necessary traffic measures must be in place to ensure that hazards are avoided, and parking restrictions are maintained.

g) Any damage to the temporary surface must be repaired immediately.

h) Temporary road markings may be applied in the interim using a quick drying durable and removal approved paint. Adhesion strips or similar is permitted.

8.7.3 Special Paving and Treatment Areas

a) In areas where the RCA has applied special treatments to carriageway areas to improve the strength and quality of that area, reinstatement is required to match existing construction.

b) If materials are not available to match existing construction an alternative approach will be agreed between the Principal Provider and the RCA.

c) The reinstatement of special paving areas shall match the original standard, with the same quality, texture, type, colour and material of the existing pavement with no visible evidence of the trench reinstatement.

d) A contractor approved by the RCA shall carry out the reinstatement of special paving areas, unless otherwise agreed by the RCA.

8.7.4 Grassed and Planted Areas

a) All grassed areas that are disturbed by trenching work shall be reinstated with compacted and rolled topsoil that is free from clay, stones and lumps. Refer Section 9.11 and 9.12.

b) The grass area shall be maintained to meet the original standard.

c) All planted areas disturbed by the trenching work shall be reinstated to the original condition.

d) Issues related to damaged trees must be carried out with prior approval from the RCA and all works in the vicinity of trees may require resource consent.

8.7.5 Concrete Surfaces

a) Concrete carriageways shall be constructed in accordance with the trench detail set out in Part 9.4 of this Code. The concrete will need a minimum compressive strength of 20MPa after 28 days, or before full traffic loading are applied, whichever is sooner in accordance with NZS 3104 or NZS 3108.

b) Use of admixtures is permitted to gain the required concrete strength before 28 days.

c) Concrete reinstatement of trenches shall achieve 80% of its specified strength prior to exposure to all traffic.

d) Expansion and or construction joints shall be formed to match existing surface. Alternatively expansion joints are to be installed at 4m centres.

e) The line and level of the reconstructed surface shall match the crossfall and level of the adjacent undamaged surface.

f) Concrete surfaces to be broom finished, if no overlay is required.

g) When an overlay of asphalt is required, it is necessary to ensure that the concrete surface is made rough prior to overlay, to facilitate binding between the asphalt and the concrete.

h) Expansion joints are to be provided at the required spacing to match existing surface.

i) The 1m rule applies

8.7.6 Concrete Vehicle Crossings

a) Concrete vehicle crossings shall be reinstated to match existing design standards. Refer to Part 9.5 of this code.

- If there is one existing expansion joint and/or construction joint then that affected panel will be replaced.

- If no expansion and/or construction joint exists, then one new expansion joint must be constructed, provided that it is no less than 300mm from the edge of the trench, then that complete affected panel of the vehicle crossing from the expansion joint to the boundary or carriageway is replaced.

b) Where existing trenches are evident, then the affected panel will be replaced.

c) Concrete vehicle crossings shall be reinstated with a minimum concrete thickness of 200mm for commercial crossings and 150mm for residential crossings.

8.7.7 Chipseal Surfaces

a) It is necessary to lay 30mm Mix 10 on a waterproof membrane and texturised with a one or two coat chipseal to match existing.

b) All chipseal design must be undertaken in accordance with TNZ M/6 specification

c) All construction of chipseal surfaces must be undertaken in accordance with TNZ P17 specification.

d) Sweeping and basecourse surface preparation

e) Spraying of binder at approved rate and conditions

f) Spreading and rolling of appropriate grades of chip

g) Sweeping and removal of excess and loose chip

8.7.8 Surfacing Methods

All parts of the surface that are damaged during or as a result of the work being undertaken shall be repaired. The construction shall be carried out as follows:

a) All asphaltic concrete surfaces mix design to be undertaken in accordance with TNZ M10 specification.

b) Paver laid asphaltic concrete material shall be laid and compacted to meet the required compaction specifications TNZ P9.

c) Where the surface is hand laid, then the following requirements apply:

- The mix produced complies with the approved mix design
- The mix laid to acceptable roughness requirements and construction tolerances

d) All asphaltic concrete surfaces shall be laid to provide adequate skid resistance.

e) Insitu air voids of the laid mix shall be between 3% and 6% as measured by a Nuclear Densimeter.

f) All edges are to be saw-cut.

g) Trimming allowance is to be a minimum of 150mm on either side of the trench.

h) The basecourse layer shall be swept free of all loose material before a tack coat is applied.

8.7.9 Joint Sealing of Carriageway Surfaces

Within 1 week of final reinstatement taking place, either side of joints in carriageway shall be sealed with hot poured rubber bitumen. The material Polyflex 2 or an approved equivalent in accordance with TNZ C/6 specification. All joints shall be water blasted to remove loose dirt and other foreign matter then dried, and the sealant shall be applied and levelled with a sealing shoe in a 100mm band across the joint with an overlap of 50mm on either side of the joint.

8.7.10 Service Covers and Benchmarks

Service covers including fire hydrant boxes, water supply boxes, tobies and manholes shall be reinstated to the correct road level and line. The following requirements shall also apply:

a) All service covers shall be filled with and match the surrounding material in special paving areas, and in areas of high traffic volumes or as identified by the RCA, except for fire hydrant and valve covers.

b) This applies to both carriageway and footpath areas.

c) Resurfacing up to the frame of the service cover shall match the existing surrounding surface.

d) Structural design of service covers in the pavement; (ie. manholes and covers, valves, hydrants, survey department lids etc) shall be comply with HN-HO-72 load rating or Austroads AS3996: 1992 or an approved equivalent to withstand anticipated loading with a reasonable margin of safety.

e) Suppliers are to provide the Council with a Producer Statement - Design confirming that the covers comply with the requirements of the NZ Building Code B1 and TNZ Traffic Loading HN - HO 72.

f) The specific location of the chambers shall be approved by the Council on a case by case basis prior to installation, as part of the Road Opening Notice

g) All new service covers shall identify the owner of the service cover, except for fire hydrants and valve covers.

h) All services covers shall be fitted to the manufacturers specifications

i) No rocking shall occur

j) All service covers must be skid resistant to the required standards

k) The RCA may request the cooperation of the Principal Provider to replace existing lids with new lids to address possible safety or amenity concerns.

l) Care shall be taken not to disturb and/or damage survey marks, survey standards or boundary pegs. Should such damage occur, the owner must be notified immediately and remedial works undertaken to the owner's satisfaction. All service covers shall meet appropriate slip and/or skid resistant specifications.

8.7.11 Kerb and Channel

When trenching crosses the kerb and channel and section is damaged, then the damaged section shall be replaced to the original line and level and in accordance with the RCA's standard details. Where an excavation extends under a concrete channel or kerb and the channel has not subsided, cracked or been damaged, it may remain in place. Alternatively, a minimum of 200mm deep concrete foundation must be placed to support the channel. The concrete must have a minimum strength of 20MPa at 28 days. All blue stone kerbs must be salvaged and be re-used to match existing blue stone kerbs.

8.7.12 Road Marking and Signs

Prior to the commencement of works, the Principal Provider must offset or otherwise record the location of the existing road marking and/or signs. It shall be necessary to replace the road markings with the same type, in accordance with TNZ M/7 and the latest version of TNZ P/12 specification. Various types of road markings include:

a) Non-reflectorised road marking paint

b) Reflectorised road marking paint

c) Thermoplastic road markings

d) Various types of raised pavement markers that are fixed in an approved manner

Information on all the existing road marking details within the area of work shall be submitted with the road opening notice prior to commencement of work.

All road markings shall be reinstated within 24 hours of permanent resurfacing being undertaken. All road signs that have been disturbed as a result of the works shall be replaced to the approval of the RCA.

8.8 Clean Up and Make Good

As work proceeds, the Principal Provider shall progressively carry out all restoration and tidying up work. At completion the Principal Provider shall have cleared away all rubbish, cleaned, and swept the area and left the site in a similar condition to that which existed before the works commenced.

The Principal shall clean all catchpits, and repair and reinstate all road surfaces, fencing, walls, floors lawns, gardens, paths, walls and make good any damage which may have been caused through the works being undertaken.

Appendix 1 Guideline for Working in the Vicinity of Trees 8.1

1. 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.

1.1 Tree Parts Above Ground

1.1.1 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:

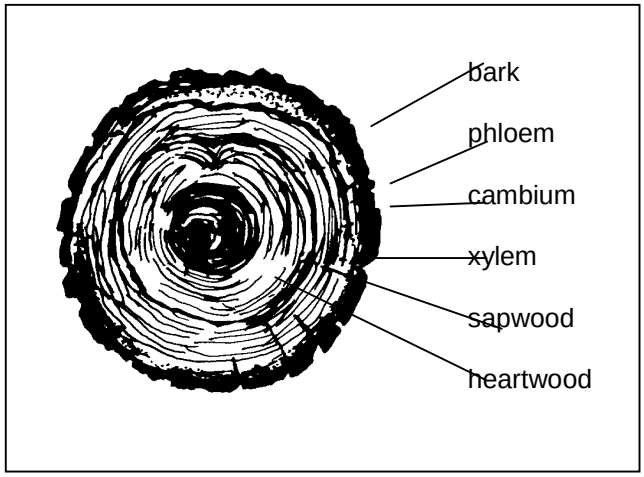


Figure 1: Cross-section of a trunk or branch showing the various tissues

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.

1.1.2 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.

1.2 Tree Parts Below Ground

1.2.1 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 shows 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.

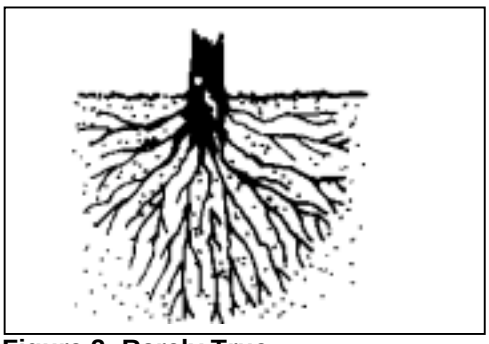


Figure 2: Rarely True

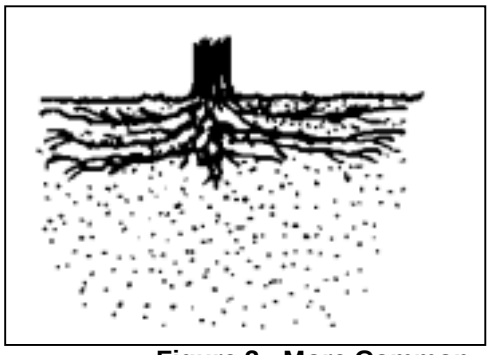


Figure 3: More Common

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.

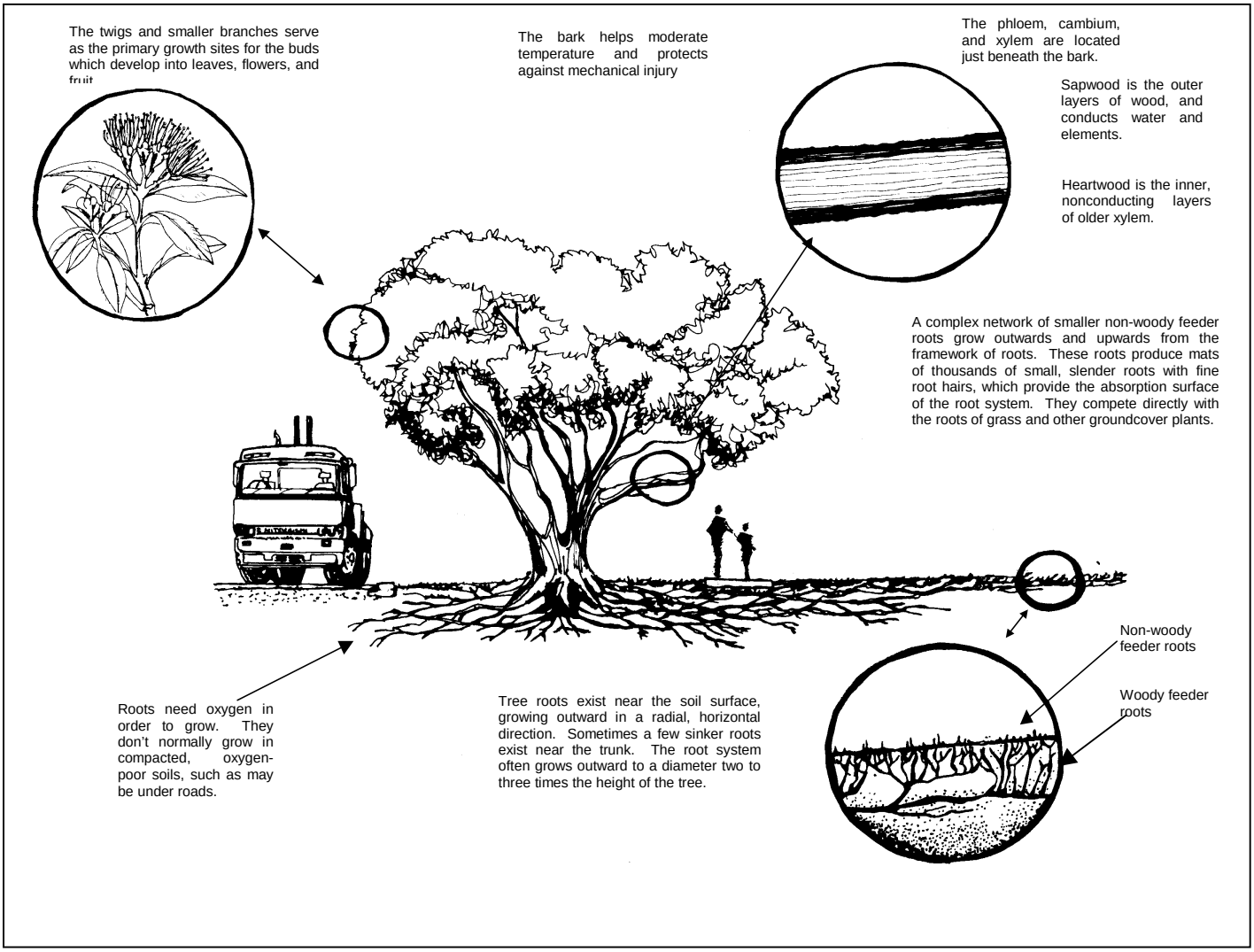
1.2.2 Typical Root Systems

Typical root systems are made up of a combination of four types of 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.
- 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.

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.

Figure 4: Tree function diagram



1.3 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.

2. 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

2.1 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.

2.1.1 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.

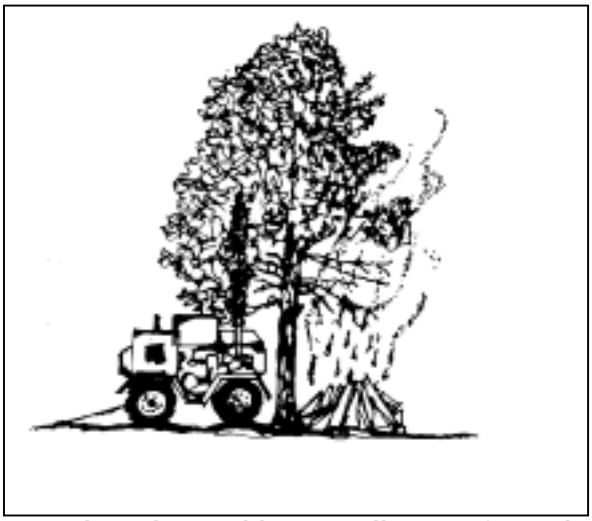


Figure 5:Keep all construction equipment, generators, and static machinery well away from the branch spread. Do not light any fires or create any source of heat or noxious fumes within the branch spread of a tree.

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.

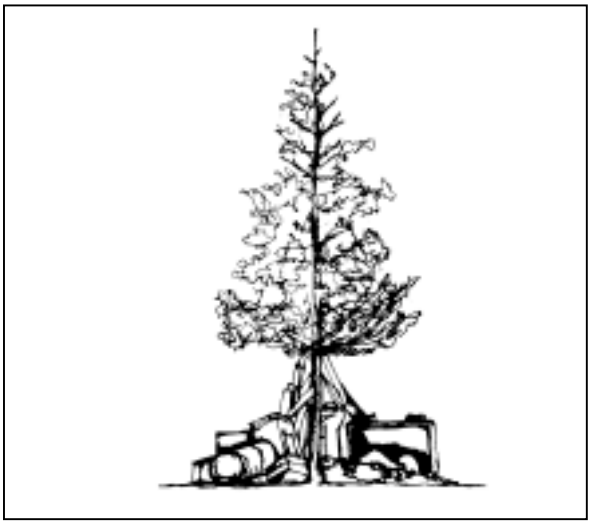


Figure 6: Do not put soil, debris, or any construction materials against tree trunks or within the root zone.

2.2 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

2.2.1 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.

2.2.2 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.

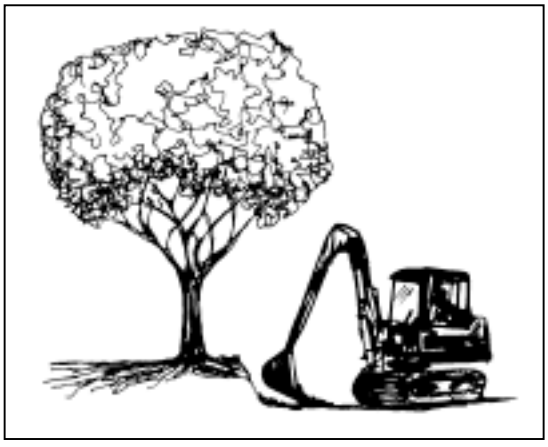


Figure 8: Do not trench or excavate within the root zone of trees, this may sever roots. Root severance can cause instability, creating a hazardous situation.

2.2.3 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.

2.2.4 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.

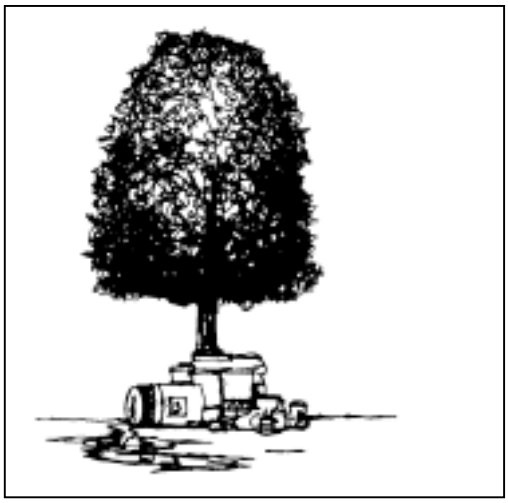


Figure 9: Do not store or dispose of any Toxic substances within the root zone.

3. 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.

3.1 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’.

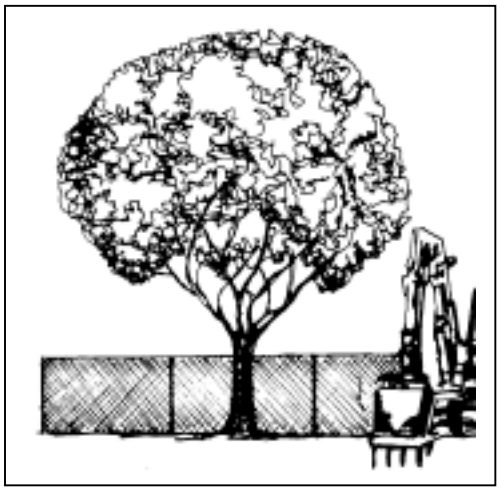


Figure 10: The fencing must be strong and appropriate to the degree of construction activity taking place on the site.

3.2 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.

3.2.1 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.

3.3 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.

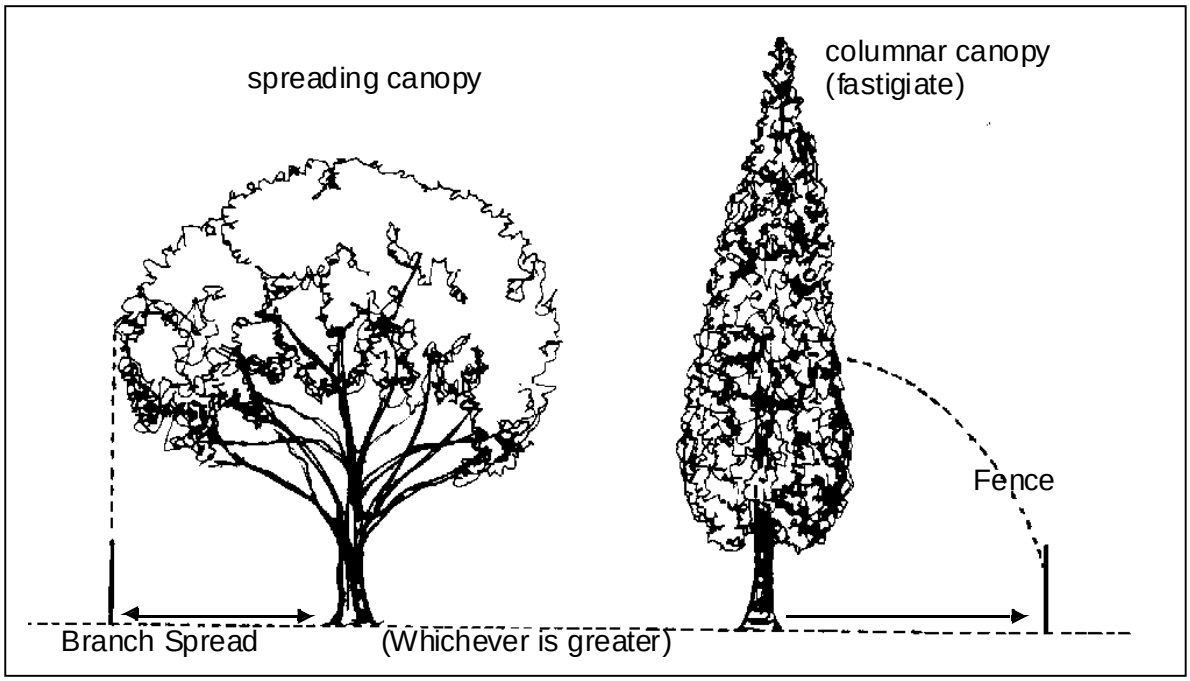


Figure 11: Dimensions for locating protective fencing

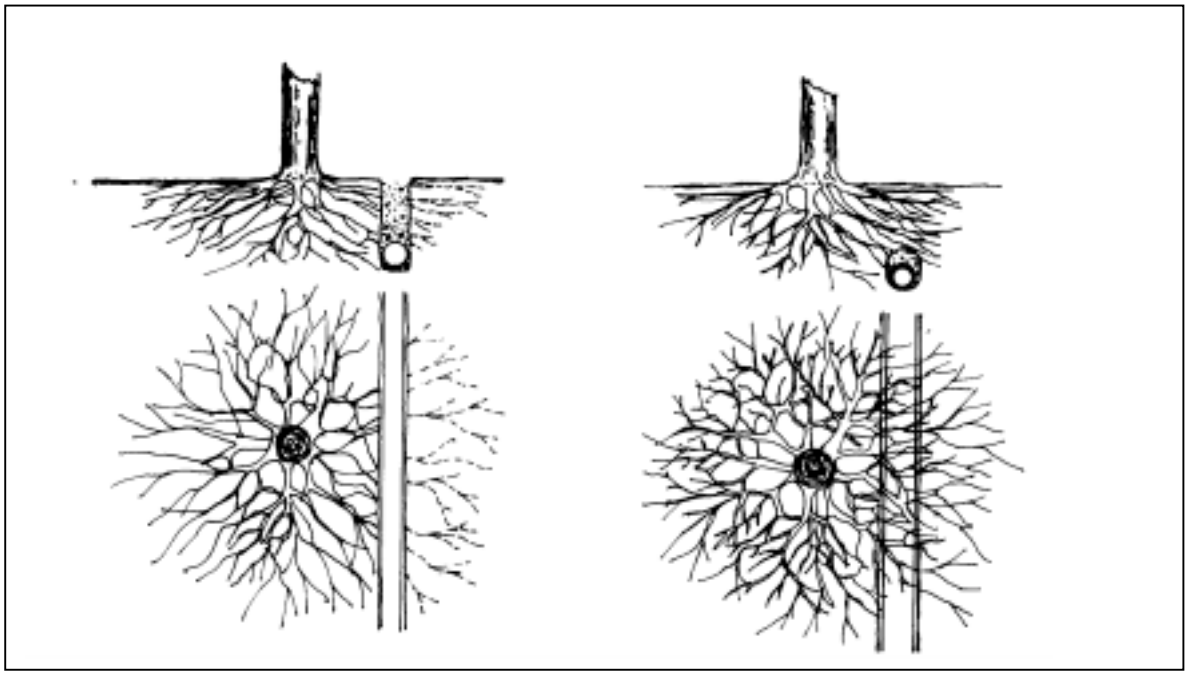


Figure 12a: Trenching causes major damage

Figure 12b: Thrusting minimizes damage