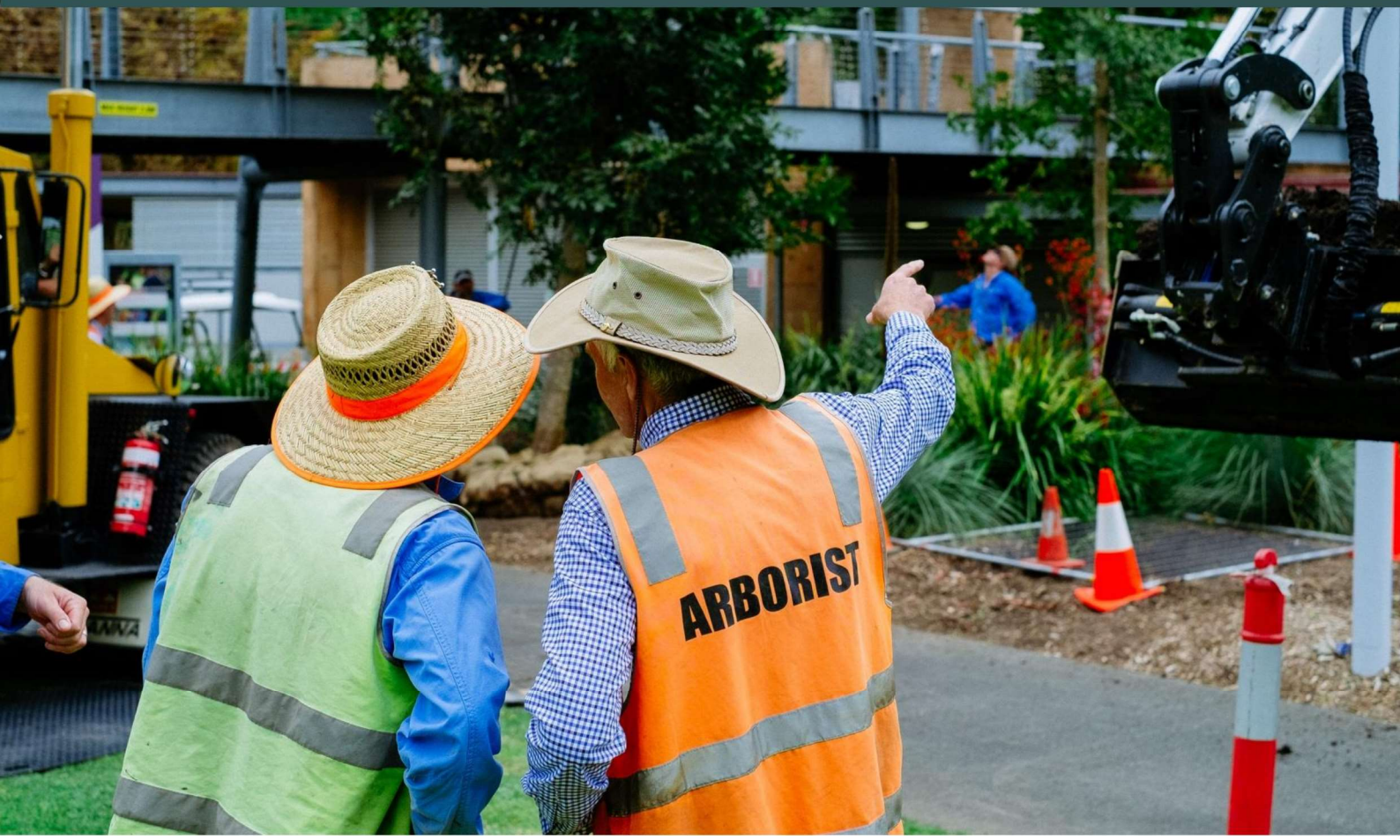
Independent
Arboricultural
Services



Arborist Comments Report

Prepared For: Provincial Building Pty Ltd

Job Date: 23 May 2024

67-69 Shore Street
Cleveland QLD 4163

IAS14905

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Approval no: DEV2024/1488

Date: 30/09/2024

Queensland
Government

Independent Arboricultural Services - Disclaimer

The material contained in this document has been prepared on an independent basis free of any bias and represents the honest opinion of the consulting arborist.

Tissue or soil samples have not been collected nor submitted for testing unless otherwise stated. Excavation is limited to minor earthworks and we submit this assessment on the basis that all data is based on visual inspection of the tree/s and its/their location, species, health and condition at the time of writing unless otherwise stated. Measurements and tree locations noted in this report are approximate and have not been determined by survey unless information and analysis has been provided by the consultant or such information is otherwise noted. Please request a more detailed arborist report if further information and analysis is required. Depending on site requirements, specific alternate specialist advice including engineering consultancy and certification maybe required in combination with this assessment. This assessment contains arborist advice and associated general information only and does not purport to provide other site-specific specialist advice such as engineering certification unless arrangement to source such advice for inclusion in this assessment has been requested and authorised.

This report containing opinions, advice and recommendations based on information and data gathered from site inspections carried out by personnel from Independent Arboricultural Services as well as information provided by the client and/or its representatives, is to be relied on by the client in that context. It is assumed that all such information provided to Independent Arboricultural Services is correct. All recommended arboricultural works detailed in this assessment including pruning of tree canopy or roots, tree removal, tree transplantation or other associated works including stump grinding or the application of any prescribed treatment shall be carried out in accordance with applicable standards including Australian Standards AS 4373-2007 Pruning of amenity trees and AS 4970-2009 Protection of trees on development sites.

The invoice for this report will be issued to the person or entity as per the address advised at the time of confirmation of appointment. Assessment in this report is based on plans provided at the time of confirmation of engagement and report preparation. Additional time required for re-assessment of report detail due to subsequent re-issue of plans after report preparation will be subject to an additional fee which will be charged at our hourly rate. This report shall not be conveyed to any third party including regulatory authority/s until full payment of this invoice is received by Independent Arboricultural Services and a finalised report has been issued unless agreement to do so has been granted.

Factors including the absence of historical records or local knowledge, recognition of the variability of the integrity of a tree as a naturally living organism as well as the impact of conditions within its surrounds to which it maybe subject including the impacts of mechanical force and the occurrence of weather events, do not allow an arborist to guarantee the age of a tree, or the length of time a tree/s may live or such time as it /they may fail. There is no warranty or guarantee, expressed or implied that the problems or deficiencies of the plants or property in question may not arise in the future.

Executive Summary

Ground Penetrating Radar was undertaken by Sam Gilbey (AQF Level 5) on 23 May 2024 for Provincial Building Pty Ltd. Ground Penetrating Radar (GPR) was undertaken around the *Subject Trees* in a grid pattern to ascertain the level of root activity within the survey area. A Visual Tree Assessment (VTA) was undertaken on the day with management recommendations included in this report.

In summary, the following was observed:

- Dwellings, driveways, vehicles, and other structures limited the assessable area available for the GPR surveys.

Following from the ground penetrating radar the following observations are made:

- Potential root activity was observed within both assessed areas surrounding Tree 1 and Tree 2 to a depth of 0.9m below existing grade.

The following management recommendations are made:

- Based on the level of potential root activity observed within the TPZ of both Tree 1 and Tree 2, it is recommended that any below ground incursion into the TPZ of Tree 1 and Tree 2 is to be conducted via vacuum excavation.
- Pending written approval from the tree owner (and Queensland Heritage), roots encountered under 50mm diameter are to be cut cleanly by the Project Arborist. Roots encountered over 50mm diameter will require project redesign to reduce impact to identified roots.

Table of Contents

Document Tracking & Information

Project Name	Preliminary Arboricultural Assessment		
Project Arborist	Sam Gilbey (AQF Level 5)		
Client	Provincial Building Pty Ltd		
Address	67-69 Shore Street, Cleveland QLD 4163		
IAS Reference	IAS14905		
Prepared By	Sam Gilbey (AQF Level 5)		
Checked By	Roger Rankine (AQF Level 8)	**Date**	Friday, 7 June 2024
Revision	1		
Andrew Rankine ***Director***	• Diploma Arb. (AQF Level 5) • Arboriculture Australia Registered Professional Arborist • QTRA (Qualified)	• TRAQ (Qualified) • ISA Certified Arborist & Municipal Specialist AU-0269AM • QAA Qualified Member	
Roger Rankine ***Managing Director***	• Diploma Arb. (AQF Level 5) • Grad Cert Arb. (AQF Level 8) • ISA Board Certified Master Arborist (QL-001A)	• QTRA (Qualified) • TRAQ (Qualified) • QAA Qualified Member	
Mick Maher ***Business Manager***	• Diploma Arb. (AQF Level 5) • TRAQ (Qualified) • QTRA (Qualified) • Cert IV Project Management	• Cert III Conservation and Land Management • Cert II Horticulture (Turf Management) • QAA Qualified Member	
Stephen Catchpoole ***Consulting Arborist***	• Diploma Arb. (AQF Level 5) • Doctor of Philosophy in Forestry (PhD) • QTRA (Qualified)	• TRAQ (Qualified) • Bachelor of Science Forestry • Bachelor of Science (Hons Botany) • QAA Qualified Member	
Garry Rangi ***Consulting Arborist***	• Diploma Arb. (AQF Level 5) • TRAQ (Qualified) • Cert III in Civil Construction: (Plant Operations), (Pipe Laying), (Road Construction & Maintenance) • Advanced Diploma of Civil Construction • Cert III in Conservation Earthworks	• Diploma Horticulture • Diploma Project Management • Diploma Business Management • Associate Diploma (Wilderness Reserves & Wildlife) • Arboriculture Australia Registered Consulting Arborist • QAA Qualified Member	
Sam Gilbey ***Consulting Arborist***	• Diploma Arb. (AQF Level 5) • TRAQ (Qualified) • QTRA (Qualified)	• Bachelor of Science in Ecology and Conservation Biology	
Kieran Pentland ***Consulting Arborist***	• Diploma Arb. (AQF Level 5) • Grad Cert Arb. (AQF Level 8) • MSc. Arb. & Urban Forestry (AQF Level 9) • ISA Board Certified Master Arborist • QAA Qualified Member • QTRA (Qualified)	• TRAQ (Qualified) • Bachelor of Arts in Leisure Management • National Cert in Tree Management • National Cert in Horticulture	
Will Miller ***Consulting Arborist***	• Diploma Arb. (AQF Level 5) • TRAQ (Qualified) • QTRA (Qualified)	• Certificate IV Assessment and Workplace Training • Certificate in Horticultural Practices	
Jessica Andersen ***Consulting Arborist – GIS / CAD Specialist***	• Diploma Arb. (AQF Level 5) • VALID (Qualified)	• Bachelor of Design (Landscape Architecture) • QAA Qualified Member	

Contact Details

Phone	(07) 3399 5865
Enquiries	office@independentarb.com.au
Accounts	accounts@independentarb.com.au
Web	www.independentarb.com.au
Postal Address	PO Box 287, Morningside QLD 4170
ABN	65 062 099 495

Abbreviations

RCC	Redland City Council	**RPA**	Root Protection Area
DA	Development Application	**TMP**	Tree Management Plan
VPO	Vegetation Protection Order	**CMP**	Construction Management Plan
ULE	Useful Life Expectancy	**VMP**	Vegetation Management Plan
BLF	Building Location Footprint	**AS**	Australian Standard
BLE	Building Location Envelope	**AS 4373: 2007**	Pruning of amenity trees
TPZ	Tree Protection Zone	**AS 4970: 2009**	Protection of trees on development sites
SRZ	Structural Root Zone	**DBH**	Diameter at Breast Height

All comments and recommendations in this report have been determined in accordance with Australian Standards AS 4373-2007 Pruning of amenity trees and AS 4970-2009 Protection of trees on development sites. All recommended tree work should be carried out in accordance with these standards.

Sam Gilbey

Consulting Arborist

Map

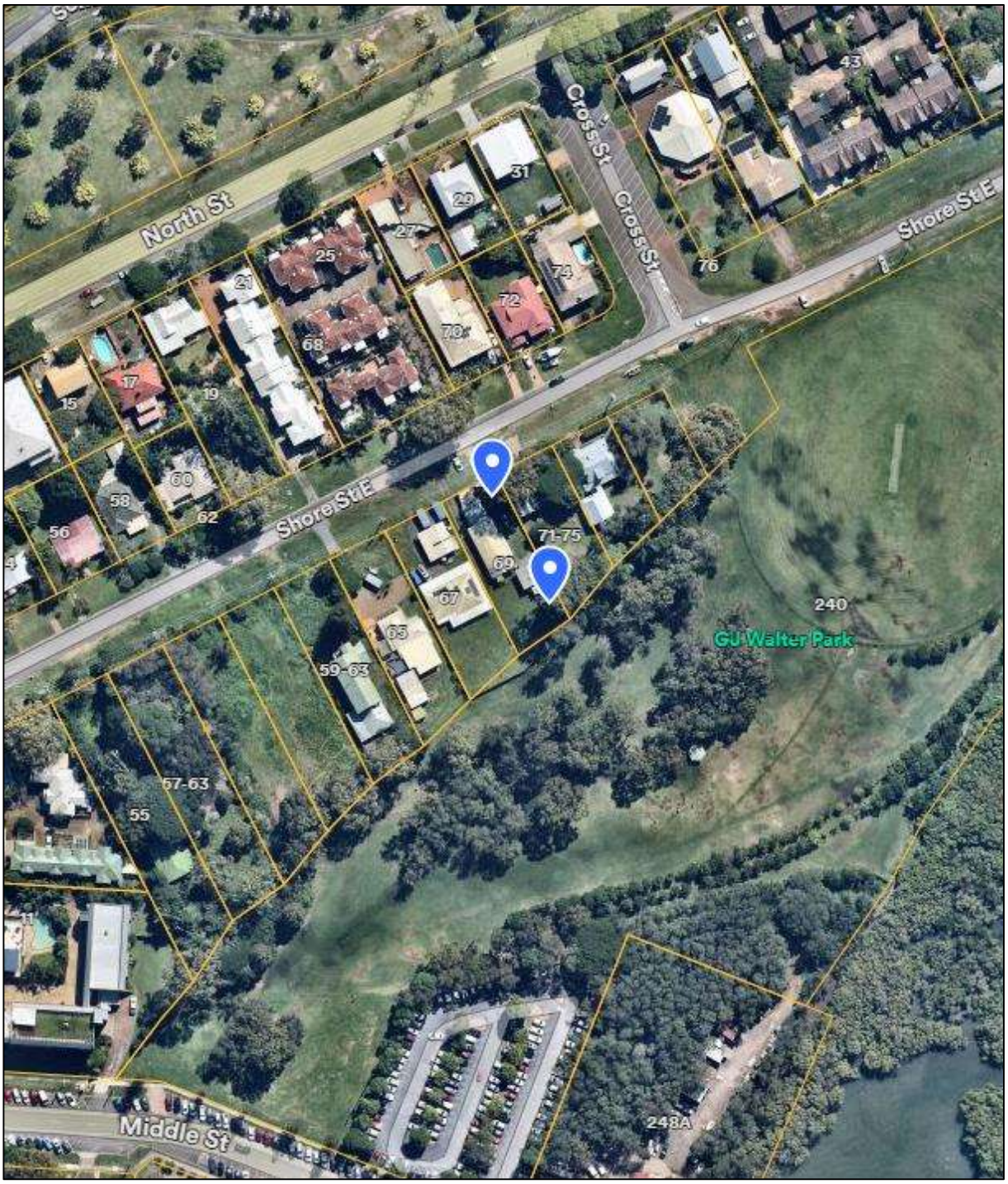


Figure 1: Subject Site (Nearmap® accessed 2024)

Introduction

This report is based on a visual inspection carried out from the ground on 23 May 2024. No soil or tissue sampling has been conducted. Tree assessment and Qualitative Visual Tree Analysis has been carried out in accordance with TRAQ ISA guidelines. Data and information provided to the client by others has been incorporated into this report as appropriate.

All Arboricultural recommendations contained in this report have been determined in accordance with Australian Standards AS 4373-2007 Pruning of amenity trees and AS 4970 Protection of trees on development sites.

For the purposes of this report reference to a Consulting or Project Arborist is held to mean an Arboricultural specialist who holds minimum Arboricultural qualifications of Dip Arb/AQF 5, appropriate professional insurances and has appropriate experience in the protection of trees on construction sites. Where tree work is specified, all recommended tree work is to be carried out in accordance with the above-mentioned standards by an appropriately trained and AQF qualified arborist practitioner/s with an up-to-date record of training and membership of a recognised Australian Arboricultural association, e.g. Qld Arboricultural Association (QAA), Arboriculture Australia (AA), or a recognised international Arboricultural association. No climbing spikes are to be used if pruning is to be carried out on live trees except in the instance of an emergency.

Qualifications of the report authors include Diploma of Arboriculture/AQF Level 5 and ISA Certified Arborist accreditation. Report authors hold current insurances and memberships including qualified memberships of Queensland Arboricultural Association (QAA), and Arboriculture Australia (AA) as well as current accreditation and membership of International Society of Arboriculture (ISA).

Independent Arboricultural Services is a qualified registrant on the QAA Register of Consulting Arborists.

Arborist Comment

Ground Penetrating Radar was undertaken by Sam Gilbey (AQF Level 5) on 23 May 2024. Ground Penetrating Radar (GPR) was undertaken around Trees 1 and 2.

A 450MHz and 750MHZ Mala Ground Explorer was utilised with the 450 MHz antenna selected and provided the clearest results of the devices utilised. Exposed roots around the stem of the *Subject Trees* were present. An example of the structure of the tree is displayed below.

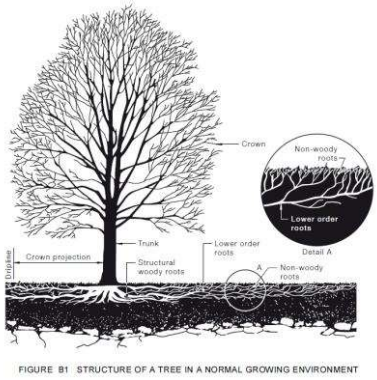


Figure 2: Source: AS4970-2009 Protect of Trees on Development Sites

Key Specifications:

- GPR Utilised: Mala EL core 450 MHZ
- Job Specifications: to undertake ground penetrating radar to identify root systems under the ground.
- Area limitations / Observations: dwelling and other structures within the TPZ of Trees 1 and 2.
- Depth Achieved: Maximum depth penetration achieved with the 750Mhz GPR appeared to be approximately 1500mm. This was based on the signal velocity applied to the dataset, obtained from hyperbola fitting methods
- Weather Conditions: Fair and sunny, no instances of rainfall.
- GPR Area: Grid lines were utilised in 500mm spacing in a X & Y pattern.
- Instruments Used: Mala EL core 450 MHZ
- Software: Object Mapper Software was utilised for the interpretation of the results.

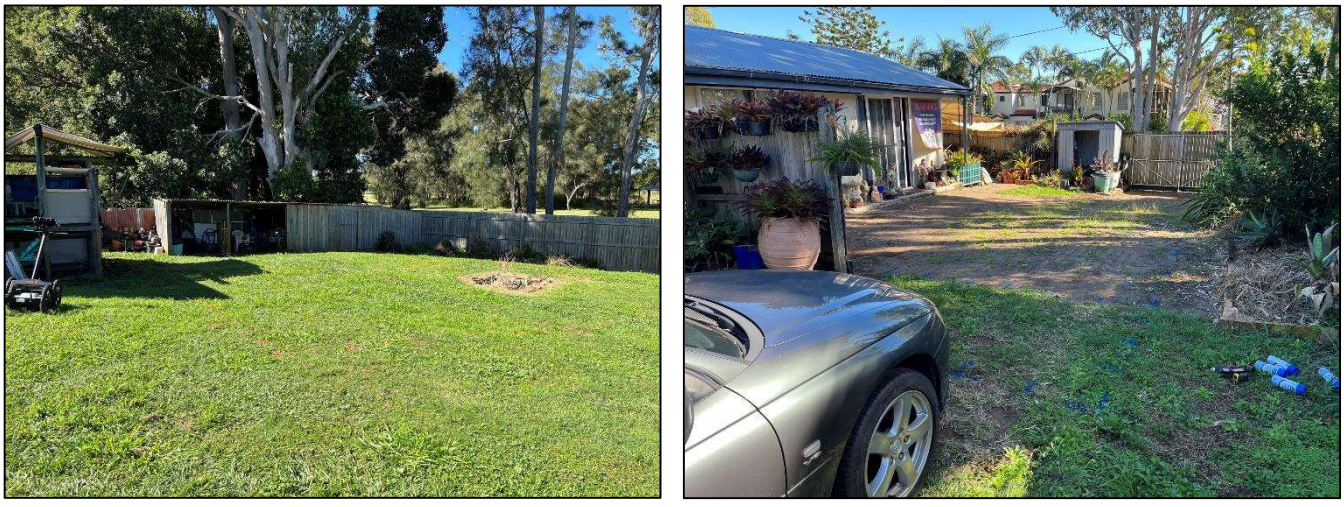


Figure 3: Working areas for Tree 1 (Left) and Tree 2 (Right)

Independent Arboricultural Services	Site: 67-69 Shore Street East, Cleveland		Author: SG
	Client: Provincial Building Pty Ltd		IAS Job Reference: IAS14905
	Date: 23 May 2024	Map Projection / Datum: MGA Zone 56 / GDA 2020	Page: 1 of 2
			Revision: 1

Legend:
- Subject Trees
- TPZ
- Potential Root Activity
- Survey Area

NearMap 2024

Note: Potential Root Activity is not an indication of root size.

N

Scale: 1 : 200

Independent Arboricultural Services	Site: 67-69 Shore Street East, Cleveland		Author: SG
	Client: Provincial Building Pty Ltd		IAS Job Reference: IAS14905
	Date: 23 May 2024	Map Projection / Datum: MGA Zone 56 / GDA 2020	Page: 2 of 2
			Revision: 1

Legend:
- Subject Trees
- TPZ
- Potential Root Activity
- Survey Area

NearMap 2024

Note: Potential Root Activity is not an indication of root size.

N

Scale: 1 : 200

Tree Locations

Figure 4: Tree Locations

Please Note: Tree Locations are an approximate only and not survey accurate. Circles indicate Tree Protection Zones as defined under AS4970:2009 – Protection of Trees on development sites

Tree Detail

Tree No.	Botanical Name	Common Name	DBH (cm)	TPZ (m)	SRZ (m)	Height (m)	Spread (m)	Health	Form	Comment
1	*Eucalyptus tereticornis*	Forest Red Gum	123	14.8	3.9	20	14	Fair	Typical	
2	*Eucalyptus racemosa*	Queensland Scribbly gum	120	14.4	3.6	20	18	Fair	Poor	Epicormic Growth, Poor crown morphology, Previously Lopped

Table Legend:			
Health	**Form**	**Aged Class**	**Further Detail**
Good: Trees foliage is in exceptional condition and can be considered an excellent specimen of its species. No pests or diseases are present.	Good: Trees structure is exceptional and can be considered an excellent specimen of its species. No visible defects are present.	Juvenile: Tree will generally grow rapidly in this phase of its life cycle.	Diameter at Breast Height (DBH) measured at 1.4m above ground level. Diameter at Root Flare (DRF) measured at the base of the tree, at the trunk / root system transition zone. Diameter = circumference divided by π
Fair: Trees foliar condition is satisfactory but may be exhibiting some signs of stress such as tip dieback or chlorosis, pests or diseases may be present but not adversely affecting the tree.	Typical: Trees structure is normal for the species; some minor structural constraints may be present.	Mature: Tree has reached maturity and is producing flowers, fruits and seeds. Tree continues to grow.	Tree Protection Zone (TPZ) defined as metres radius. Calculated being DBH x 12 (minimum 2.0m and no greater than 15m).
Poor: Foliage density is sparse or largely discoloured, tree health is at or approaching a critical value which may be irreversible, pests or diseases are highly prevalent throughout the crown.	Poor: Structure is a poor example of its species and exhibits a combination of structural issues.	Full to Late Maturity: Tree has reached the maximum height for its species, elongation has stopped but the trunk continues to thicken, overall growth rate is starting to slow, foliar density may be starting to thin.	Structural Root Zone (SRZ) displaced as metres radius. Calculation being $(DRF \times 50)^{0.42} \times 0.64$ (never less than 1.5m or greater than 15m).
Dead: Tree is in advanced decline or completely dead.	Dead: Tree is in advanced decline or completely dead.	Senescent: Tree has / is starting to retract in size through dieback and shedding of limbs. Trees in this age class may be ecologically valuable, as their structure contains habitat necessary for native fauna.	

Ground Penetrating Radar

Ground Penetrating Radar (GPR) employs techniques that utilise high-frequency pulsed radio waves, usually between 10 - 2000MHz, to acquire subsurface information, to map metallic/non-metallic structures/features buried in the ground or within man-made structures. Buried objects or boundaries with an abrupt change in electrical properties create a reflection from the EM signals. Reflected signals are received by the receiver and recorded digitally in a storage device.

The purpose of the GPR is to identify anomalies also known as hyperbolas. These anomalies relate to potential underground objects such as tree roots. (Mala Australia) There are limitations to Ground Penetrating Radar and the presented results which included but not limited to

- Soil conditions and moisture conditions. The type and composition of the soil.
- Current and redundant services
- Fill placed within the working area

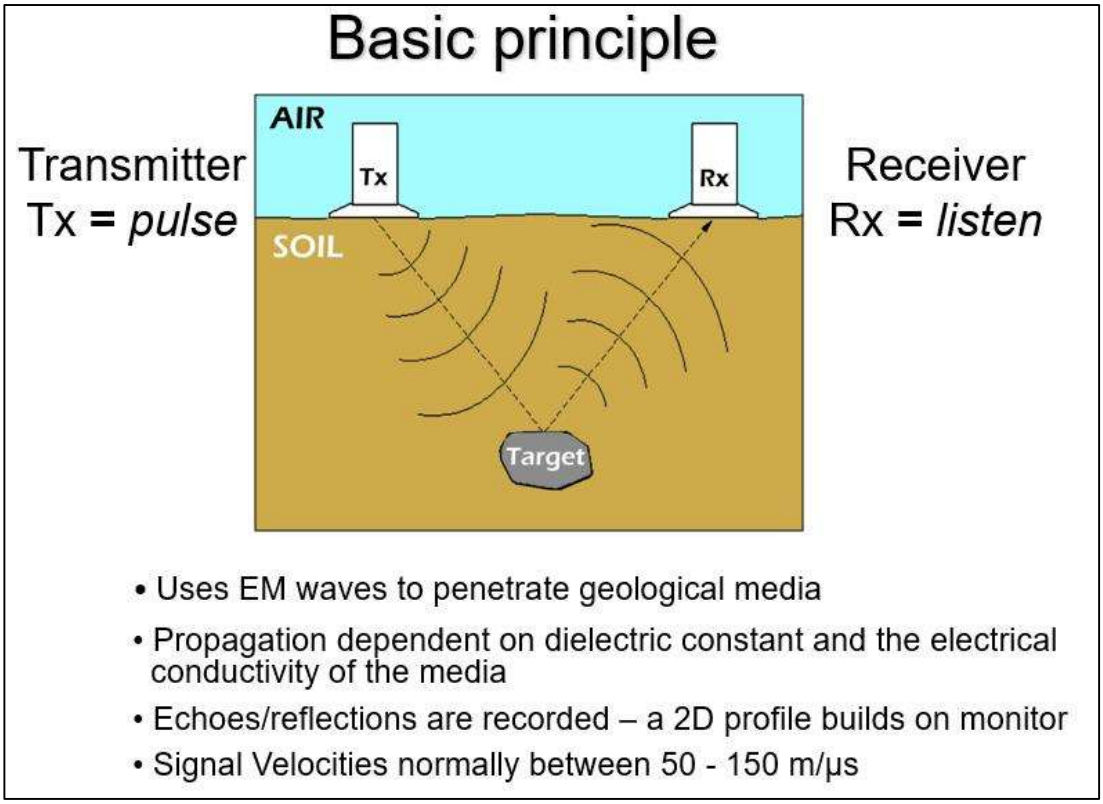
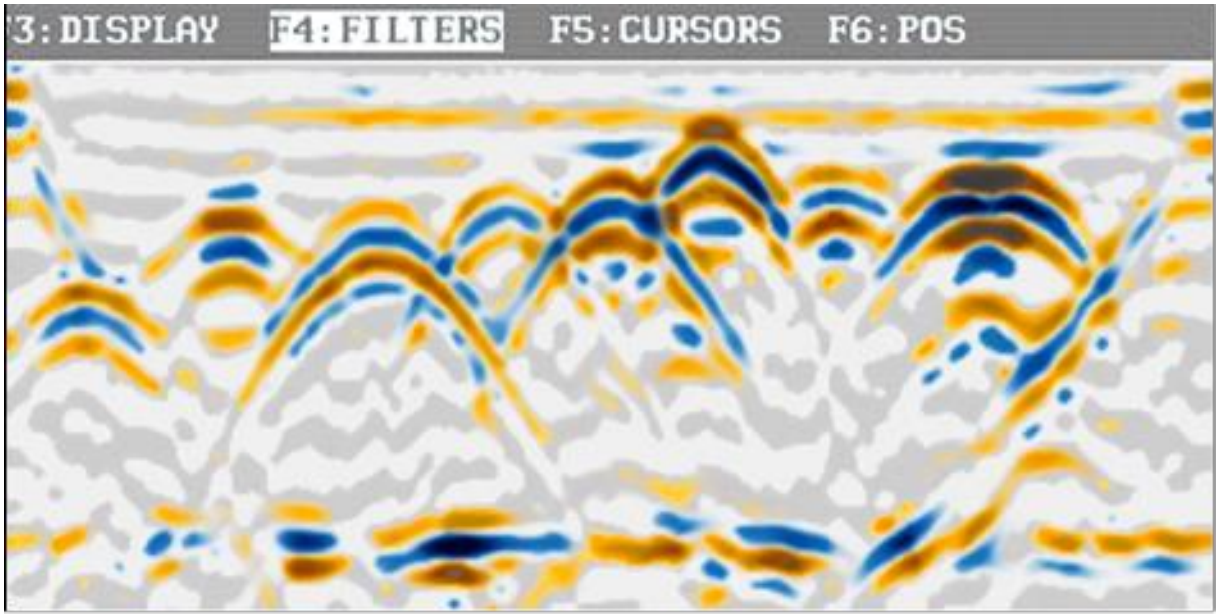


Figure 5: (Source: MALA Australia)

An example of hyperbolas is enclosed below, showing the result of testing different materials and sizes at a range of depths from a controlled test undertaken by MALA Australia.



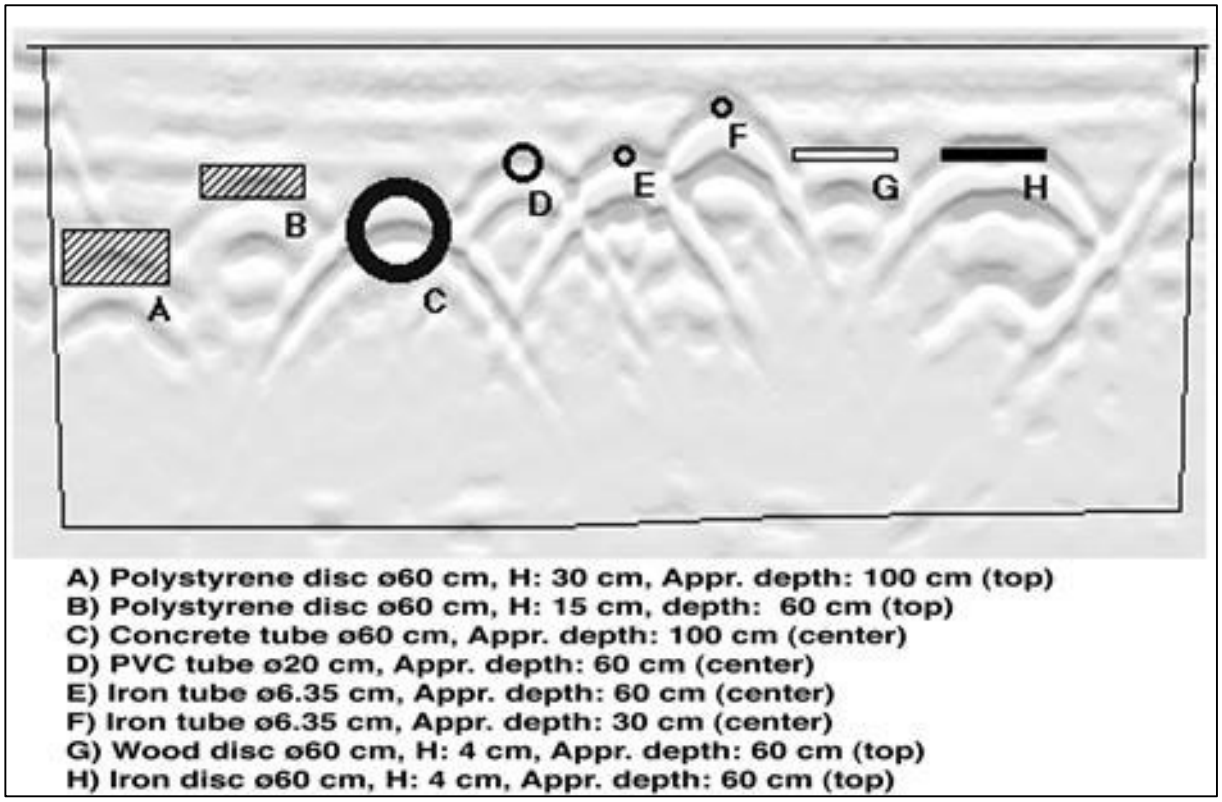
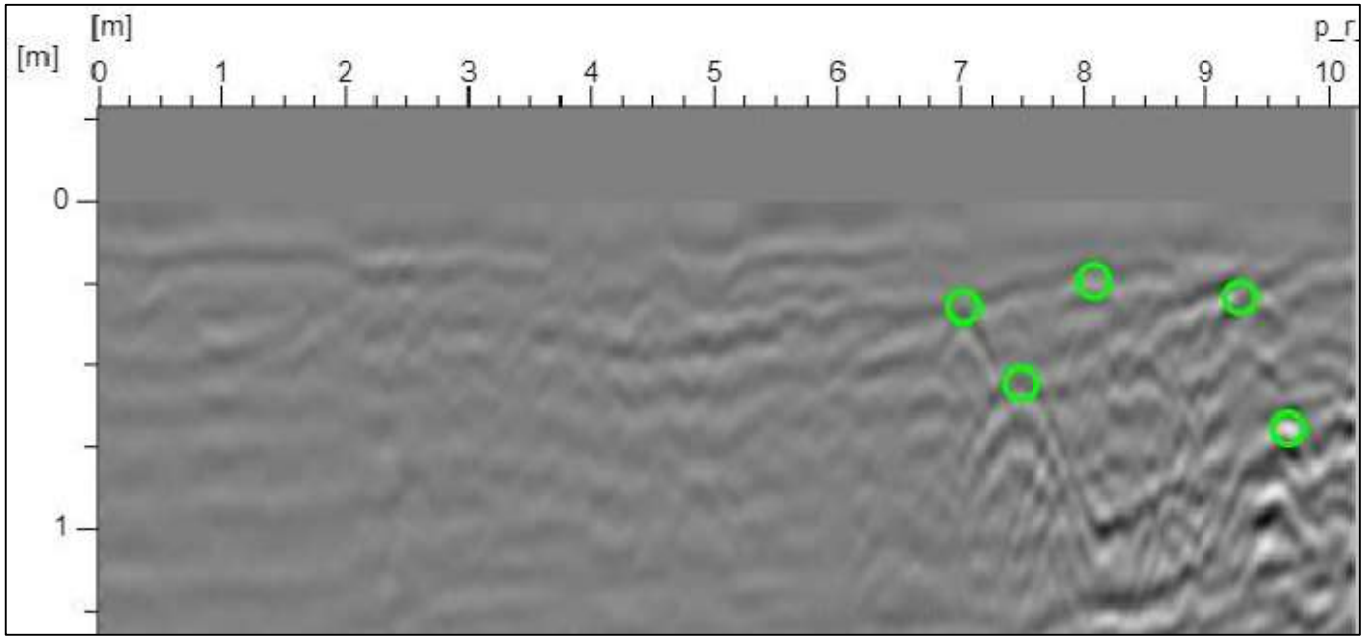


Figure 6: (Source MALA Australia)

Ground Penetrating Radar Results – Tree 1

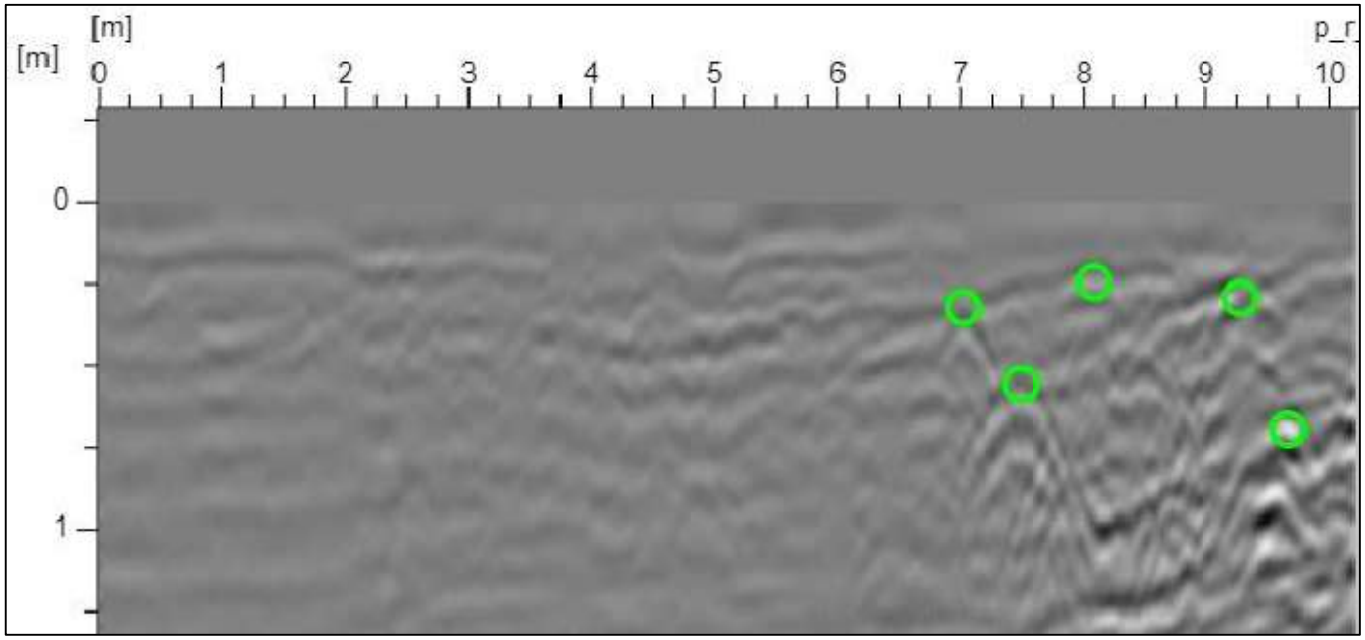
It was determined that Ground Penetrating Radar (GPR) would be utilised to determine if any root activity was extending from the *Subject Trees* in the area surveyed.

Pink = Potential Service
Green = Potential Tree Root
Black = Exposed Surface Tree Roots



Depth of Roots from Cross Section – Tree 1

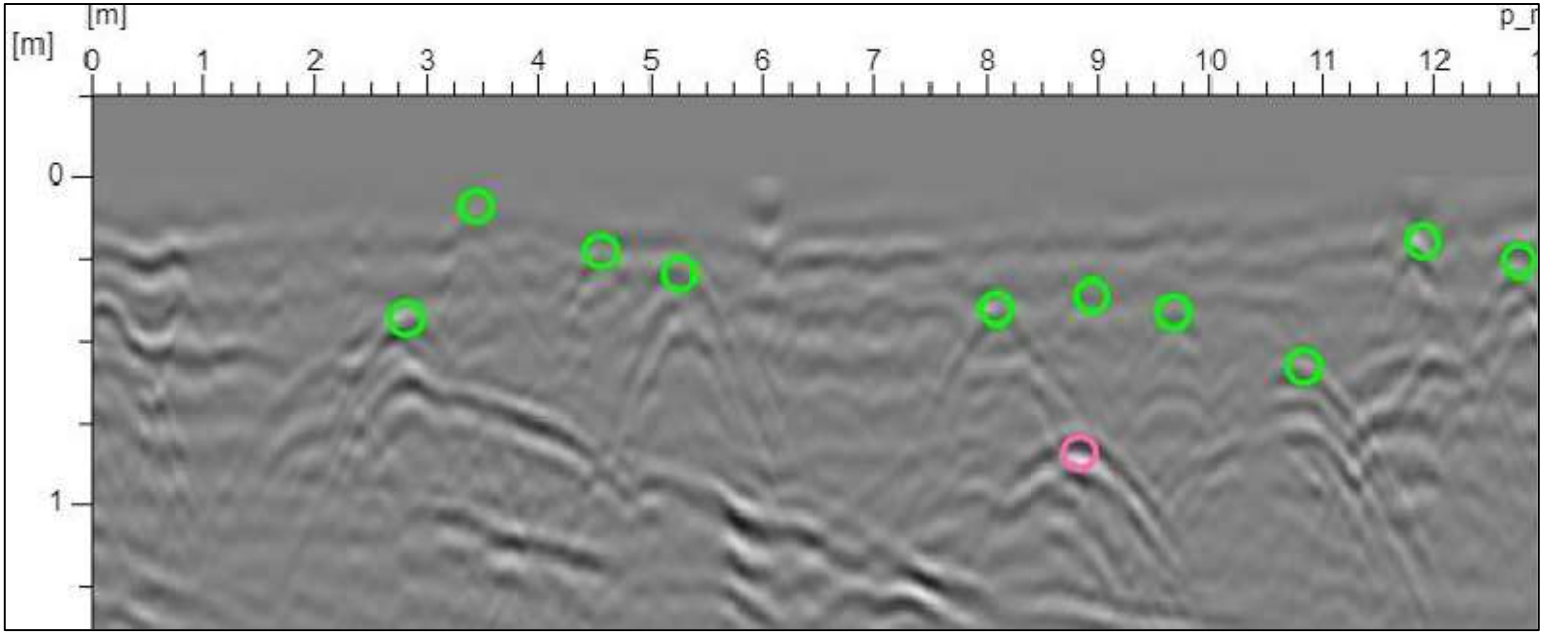
Analysis of the fifty five (55) radargrams that comprise this project revealed that potential root activity was identified to a depth of 0.9m below the existing ground surface.



Ground Penetrating Radar Results – Tree 2

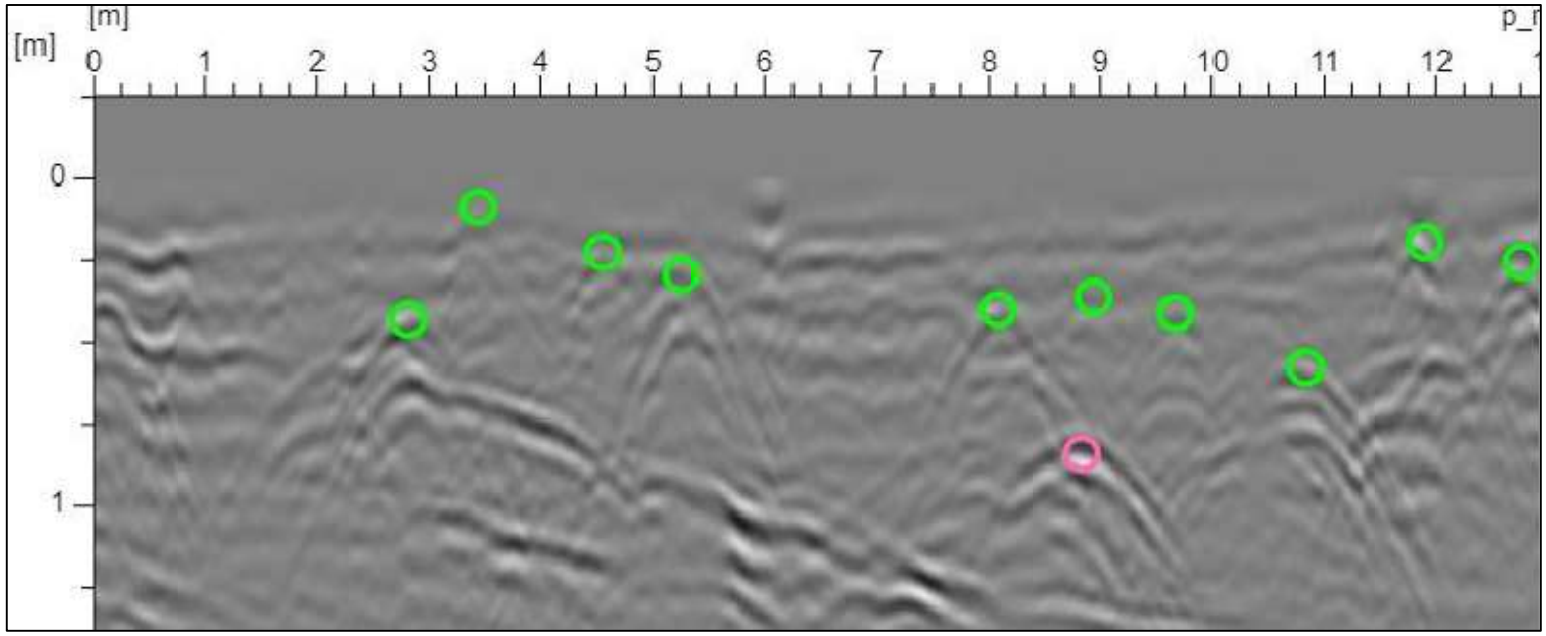
It was determined that Ground Penetrating Radar (GPR) would be utilised to determine if any root activity was extending from the *Subject Trees* in the area surveyed.

Pink = Potential Service
Green = Potential Tree Root
Black = Exposed Surface Tree Roots



Depth of Roots from Cross Section – Tree 2

Analysis of the fifty (50) radargrams that comprise this project revealed that potential root activity was identified to a depth of 0.9m below the existing ground surface.



Tree Risk Summary

The Tree Locations figure (provided herein) displays the trees according to their assessed risk, using the colours shown in the Tree Risk Summary table:

Type	Extreme	High	Medium	Low
Amount	0	0	0	2

Risk Matrix

Risk Rating

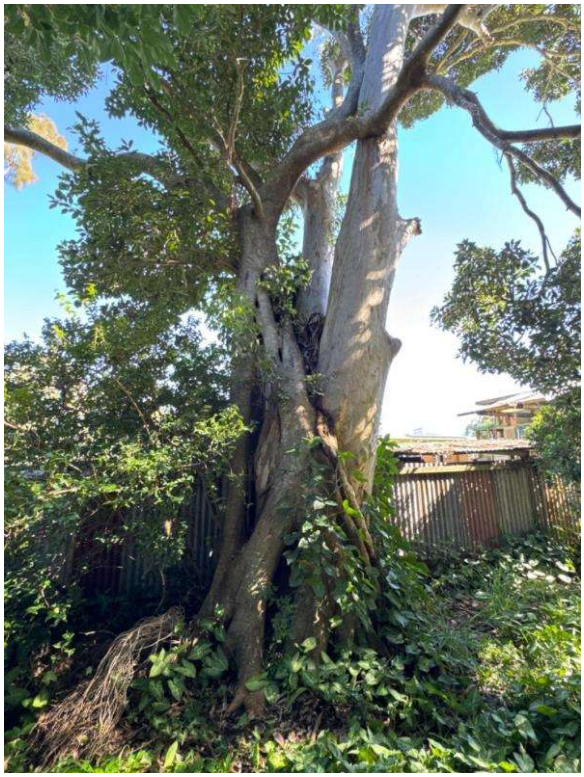
Consequences /Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
	No injuries*	First Aid Treatment*	Medical treatment*	Serious or extensive injuries*	Death or large number of serious injuries*
Almost Certain	Low	Medium	High	High	Extreme
Likely	Low	Medium	Medium	High	High
Possible	Low	Low	Medium	Medium	High
Unlikely	Low	Low	Low	Medium	Medium
Rare	Low	Low	Low	Low	Medium

Prioritising Risks - Table of Management Action

Risk Score	What should I do?
Extreme	Immediate action required
High	Action plan required, senior management attention needed
Medium	Specific monitoring or procedures required, management responsibility must be specified
Low	Manage through routine procedures. Unlikely to need specific application of resources

Subject Tree Photos

Tree 1



Tree 1 - Base

Tree 2

Tree 2 - Base

Appendix 1: Explanation of Terminology

Definition	Process Description
Removal	Complete tree removal leaving stump as close as possible to ground level. Recommended process will include chipping of all foliage limbs and timber and reinstatement of work site. Recommendation typically based on tree being assessed as representing a health and safety concern [Dead, dying, structurally unsound, unstable, poor form]
Remove and Grind	Complete tree removal to include grinding of stump to a depth of 75 millimetres unless otherwise specified. Recommended process will include chipping of all foliage limbs and timber and reinstatement of work site. Stump site will be cleaned of all grinding debris and sawdust and backfilled with premium topsoil free from weeds.
Crown Clean (Deadwood)	Removal of all major/significant deadwood and dead branches up to [and including] 30 millimetres in diameter in trees overhanging pedestrian or vehicular areas or removal of dead branches > 50mm diameter in canopy of trees located in parkland or similar area unless otherwise specified.
Crown Clean (General pruning)	Recommended pruning process will include removal of broken, crossing, rubbing, diseased, stressed or dying branches or limbs with poor attachment. Additional work process may include pruning to define leaders, balance the crown, reduce weight load, or clear the tree from obstructions. In summary, to rectify, as far as is possible, any structural defects and eliminate undesirable growth or deadwood.
Crown Reduction (Canopy reduction)	Recommended pruning process may include light and general pruning typically to encompass removal of up to 15% but no more than 20% of the leaf-bearing crown. By definition, the unique shape and form of the tree will not be altered or compromised by the pruning process. Typically, the consulting arborist will nominate the reduction percentage [%] appropriate to species, condition and assessment.
Crown Raising (Canopy lift)	Pruning processes maybe involve the raising of the tree's lower canopy to a height specified in metres. Typically, the process is performed to provide for pedestrian and or vehicular clearance and unless otherwise specified the default parameters will be to provide 2 metres clearance from ground level or as specified by local or state government regulation. From time to time pruning requirements may be altered to accommodate various site-specific requirements as advised by the consulting arborist accordingly.
Crown Restoration	Pruning process will encompass crown restoration and remedial works where the tree has been previously lopped or otherwise damaged. Not feasible when tree has extensive decay and should only be considered when there is evidence of healthy re- growth. When performed correctly the process of remedial pruning will most likely take several years to complete.
Hanger Limb / Unattached branch	Pruning process may be restricted to the removal of any hanger/s or dangerous/dead/dying limbs and will typically involve the removal of a single limb. In some instances, removal of an individual limb may be necessary to accommodate an obstruction and the consulting arborist will advise accordingly.
Directional Pruning	Pruning process will be restricted to pruning canopy away from buildings/service wires/property boundary and will typically be performed to avoid future growth in these areas. Where appropriate future growth will be directed away from obstruction by selected pruning so as to encourage the development of the growth of new leaders.

Habitat Pruning	When pruning deadwood from trees, simple techniques and methods can be employed to achieve hazard reduction whilst leaving food and habitat for tree dwelling fauna. Long pieces of deadwood can be reduced in length to limit potential hazard but still retain food for the insects and microorganisms. Stubs that have been left by old pruning or previous branch failure can be retained, and with the use of a hole-saw or chainsaw they may also be bored out to create a nesting hollow for native birds or small mammals. Source: Mosman Council
Deadwood	Dead branches within canopy of tree.. Deadwood is a naturally occurring feature of most tree species and comprises dead or decaying branches within the canopy of a tree. Deadwood may have habitat value and require removal only according to the considered risk of its location, i.e., high use pedestrian area or damage to adjacent infrastructure.
Decay	The process of degradation of woody tissues by micro-organisms.
Compaction	Results from loads or stress forces applied to the soil as well as shear forces. Both foot traffic and vehicle traffic exert both forces on soils. Vehicle traffic may cause significant compaction at depths of 150–200 mm (the area in which most absorbing roots are located). The degree of compaction will depend on weight of vehicles, number of movements, soil moisture levels and clay content. Soil handling, stockpiling and transporting also tend to lead to the breakdown of soil structure and thus to compaction. Vibration as a result of frequent traffic or adjacent construction activities will also compact soils.
Codominant Structure:	Stems or trunks of about the same size originating from the same position from the main stem.. When the stem bark ridge turns upward the union is strong; when the ridge turns inward the union is weak, a likely point of failure in storm or windy weather conditions or where increasing weight causes undue stress on the defective union.

Source: AS4373-2003 Pruning of Amenity Trees & AS 4970-2009 Protection of Tree on Development Sites & Habitat Creation By Kieran O'Neill, Mosman Council.

Appendix 2: Normal Function of a Tree

Background Note: The following diagrams and explanatory notes are useful to illustrate the structure of a tree in a normal growing environment. This information is taken from AS4970-2009 Protection of trees on development sites which has been released subsequently to AS4373-2007 Pruning of amenity trees.

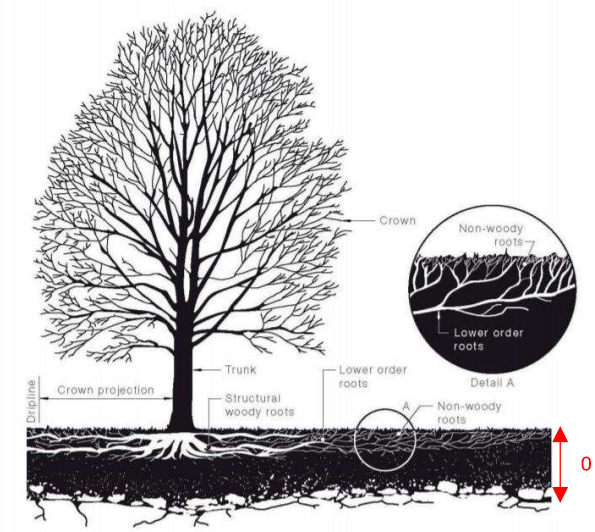


Figure 7: Structure of a tree in a normal growing environment

Leaves
The main function of leaves is photosynthesis, that is, the production of sugars. The sugars produced by the leaves (and any other green tissue) are the source of chemical energy for all living cells in the entire plant and as such are essential for the normal functioning and survival of the tree. Anything that directly or indirectly damages the leaves will interfere with photosynthesis.

Trunks and branches
Branches and trunks are composed of many tissues with specialized functions including the bark (protection), phloem (transport of sugars from the leaves), vascular cambium (growth of new transport tissues), sapwood (transport of water and nutrients from the roots), heartwood (strength and structural support) and rays (internal transport and storage of sugars). Damage to branches or trunks may allow infection by plant pathogens (disease causing organisms), disrupt the movement of vital materials and structurally weaken the tree.

Roots
The main functions of roots include the uptake of water and nutrients, anchorage, storage of sugar reserves and the production of some plant hormones required by the shoots. For roots to function, they must be supplied with oxygen from the soil. The root system of trees consists of several 'types' of roots found in different parts of the soil and is generally much more extensive than commonly thought. The importance of roots is easily overlooked because they are not visible, that is 'out of sight, out of mind'. Damage to the root system is a common cause of tree decline and death and is the most common form of damage associated with development sites.

Root systems consist of three main parts:

1. The structural woody roots (anchorage, storage and transport);
2. Lower order roots (anchorage, storage and transport); and
3. Non-woody roots (absorption of water and nutrients, extension, synthesis of amino acids and growth regulators) (see Figure).

In addition to lateral root spread being underestimated, root depth in trees has also been grossly exaggerated. Deep root systems or taproots are the exception rather than the rule. Most roots of most trees are found in the very top of the soil. The vast majority of these roots are small non-woody absorbing roots which grow upward into the very surface layers of the soil and leaf litter. This delicate, non-woody system, because of its proximity to the surface, is very vulnerable to injury."

Explanatory Note: The importance of gas exchange in soils
The fact that tree roots require oxygen to function is often misunderstood. Accessibility to available oxygen and water within the soil structure is dependent on the integrity of soil structure within their surrounds; when soils are compacted there is little space between soil aggregates with soil volume and total pore space, especially macropore space diminished. In turn, good soil oxygenation and gas exchange (Lonsdale) levels allow for successful function of tree roots. Oxygen levels in soils will typically decrease as soil depth increases and /or soils are heavily compacted.

Macropore is the term used to describe the relatively large space between soil particles that is usually air filled and allows for water movement and root penetration. Micropore is the term used to describe the space between soil particles that is relatively small and likely to be water filled.

Compaction results from loads or stress forces applied to the soil as well as shear forces. When soil within the root zone of a plant, including a tree, is compacted through either pedestrian or vehicular traffic, or by the heavy weight of stored materials or machinery, the ability of water and oxygen to penetrate the soil around the roots of living plants is compromised. Whilst tree roots are typically found in the top 600mm of the soil horizon, vehicle traffic, in particular may cause significant compaction at depths of 150–200 mm (the area in which most absorbing roots are located). (Refer Tree Function Note above).

The degree of soil compaction will depend on weight of vehicles, number of movements, soil moisture levels and clay content. Soil handling, stockpiling and transporting also tend to lead to the breakdown of soil structure and thus to soil compaction. Vibration, as a result of frequent traffic or adjacent construction activities, will also cause compaction of soil.

Contrary to the commonly held myth that all trees have tap roots, tree roots are typically located within the top 600mm of soil. Just as leaves perform the vital function of photosynthesis, tree roots are vital for the primary functions of anchorage, storage, absorption and conduction. Larger tree roots fulfil the main functions of anchorage, storage and conduction and smaller more fibrous tree roots, which grow primarily at the end of the main woody roots, fulfil a vital role in absorbing oxygen, essential mineral elements and moisture from the soil, often through a symbiotic relationship with soil borne fungi referred to as Mycorrhizae; the extent of root loss has the potential to jeopardise any or all of these main functions and most importantly may compromise the structural integrity of an established tree and its associated potential OH&S risk of failure occurring; any OH&S risk of potential failure in a high use area such as public roads, is noteworthy for all the wrong reasons and should be of major concern and avoided at all times. (Refer Appendix 2, Tree Function Note).

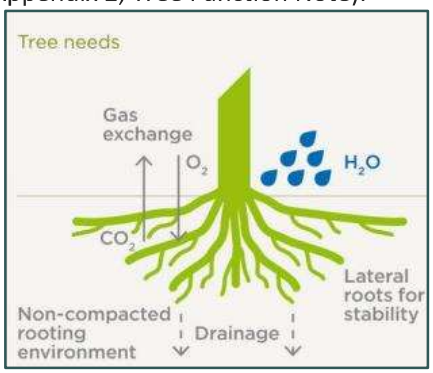


Figure 8: Gas exchange in woody tissues: the diffusion of gases into and out of a particular region (Jaluzot)

Reference Page

1. Standards Australia (2007): AS 4737-2007 Pruning of Amenity Trees. SAI Global
2. Standards Australia (2009): AS 4970-2009 Protection of Trees on Development Sites. SAI Global
3. Standards Australia (2012): AS4454-2012 Composts, Soil Conditioners and Mulches. SAI Global
4. Standards Australia (2018): AS4419:2018 Soils for Landscaping and Garden Use. SAI Global
5. Standards Australia (2018): AS2303: 2018 Tree Stock for Landscape Use. SAI Global
6. Shigo, A.L. (1986): *A New Tree Biology.* Shigo & Trees, Associates, Durham, New Hampshire.
7. Mattheck K, Breloer H. (1994): *The body language of trees, a handbook for failure analysis*, London, England.
8. Shigo, A.L. (1991): *Modern Arboriculture.* Shigo & Trees, Associates, Durham, New Hampshire.
9. Bassuk, N., Grabosky, J., Trowbridge, P., & Urban, J. (1996): *Structural Soil*. Urban Horticulture Institute, Cornell University.
10. Matheny, N. & Clark, J. R. (1998): *Trees and Development, A Technical Guide to Preservation of Trees During Land Development*. ISA
11. Lonsdale, D. (1999): *Principles of Tree Hazard Assessment and Management, 5th Impression*. Stationery Office Books.
12. Costello, L. R., & Jones, K. S. (2003): *Reducing Infrastructure Damage by Tree Roots, A Compendium of Strategies*. ISA
13. Costello, L. R., Perry, E. J., Matheny, N. P., Henry, J. M., & Geisel, P. M. (2003): *Abiotic Disorders of Landscape Plants, A Diagnostic Guide*. ISA
14. Clark, R. (2003): *Specifying Trees, A Guide to Assessment of Tree Quality*. NATSPEC
15. Harris, R. W., Clark, J. R., Matheny, N. P. (2004): *Arboriculture, Integrated Management of Landscape Trees, Shrubs, and Vines. 4th Edition*. Prentice Hall
16. Jol, H. M. (2008*): Ground Penetrating Radar Theory and Application 1st Edition*. Elsevier
17. Urban, J. (2008): *Up by Roots, Healthy Soils and Trees in the Built Environment*. ISA
18. Pallardy, S. G. (2010): *Physiology of Woody Plants, 3rd Edition*. Elsevier
19. Strouts, R.G., & Winter T.G. (2013): *Diagnosis of Ill-Health in Trees, 7th Impression*. Stationery Office Books.
20. Leake, S., & Haege, E. (2014): *Soils for Landscape Development. Selection, Specification, and Validation.* CSIRO
21. Roberts, J., Jackson, N., & Smith, M. (2015): *Tree Roots in the Built Environment, 2nd Impression*. Stationery Office Books.
22. Slater, D. (2017): *Assessment of Tree Forks Course Notes*. Arboriculture Association
23. Hirons, A. & Thomas, P. A. (2018): *Applied Tree Biology*. Wiley Blackwell
24. International Society of Arboriculture (2017): *Tree Risk Assessment Manual, 2nd Edition*. ISA
25. Bond, J. (2020): *Urban Tree Health*. Urban Forest Analytics LLC
26. Nearmap. (www.nearmap.com.au); accessed 2024.

Company Details

Independent Arboricultural Services

Independent Arboricultural Services, incorporated in May 2007, offers a completely independent arborist consulting and reporting service. Its directors and associated consultants bring extensive arboricultural knowledge gained over many years to this company. All consulting staff hold AQF Level 5 (Diploma of Arboriculture). Specialised advice when required, such as provision of survey mapping or engineering advice and certification is sourced from reputable professional providers according to site requirements as per Australian Standard 4970-2009.

Statement of Goal

To deliver continual improvement through the use of world's best arboricultural practices, supported by ongoing education and exposure to leading industry experts and research throughout the world.

Mission Statement

To provide timely, relevant and actionable consulting advice and practice based on the latest available and best scientific arboricultural knowledge.

Environmental Statement

Independent Arboricultural Services supports long term environmental sustainability sustainable sourced paper and ensuring all inks cartridges are recycled where possible.

Independent Arboricultural Services actively seeks to maintain a positive carbon footprint status and to that end is committed to protecting and preserving the environment, continuing to carry out tree planting, transplanting and replacement planting where practical, having planted in excess of 4000 trees in the first 2 years after its inception in May 2007 alone. Arboricultural recommendations involving the removal of tree/s will include replanting at a minimum ratio of 2 trees for any tree removed where possible. All arboricultural recommendations are made in accordance with world's best arboricultural practice and within the Australian Standards AS 4373-2007 Pruning of amenity trees and AS 4970-2009 Protection of trees on development sites so as to ensure optimal outcomes for all living trees.

Independent Arboricultural Services acknowledges the benefits of healthy trees with good vigour and vitality and actively promotes better understanding in the general community of the contribution that trees make to reducing greenhouse gasses, the contribution of trees to better water retention and the prevention of soil erosion, the ability of trees to provide protection to infrastructure by diffusing strong winds in weather events and the contribution of trees to general liveability within the urban environment.

It is an acknowledged fact that air temperature beneath a tree canopy can be in excess of 5^{o} Celsius lower than the surrounding ambient air temperature thereby reducing reliance on greenhouse gas producing air conditioners and coal fired power sources.