Arborist Report

for

City of Moonee Valley

Assessment of a *Eucalyptus camaldulensis* (River Red Gum) at Newmarket Station

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Executive Summary

Homewood Consulting Pty Ltd has been engaged to provide an arborist report on one tree located at Newmarket train station. An inspection of the tree has been requested to assess the health, structure, risk rating and to address concerns raised in relation to potential damage to the existing station from the tree. Concerns have been raised that tree roots may be causing damage to the existing rail line or may grow under the track and subsequently cause damage; and if the whole tree were to fail, that it would cause significant damage to the existing rail infrastructure.

The tree is owned by Victrack and managed by Public Transport Victoria and Metro Trains.

The tree is a mature *Eucalyptus camaldulensis* in good health and has fair structure and a Useful Life Expectancy exceeding 50 years. The tree provides a significant landscape contribution and is a valuable asset to the area.

A Tree Risk Assessment Qualification (TRAQ) has been conducted on the subject tree, assessing the risk of total tree failure over a 12 month period. The tree presents a ‘Low’ risk of harm and no works are recommended to further mitigate risk.

There no visible evidence to suggest roots from the subject tree are currently impacting the existing rail line and given the grade modifications made to construct the station, it is unlikely tree roots will be found within the train track area. There is cosmetic damage to the existing retaining wall; however this is unlikely to have been caused by the subject tree. This wall can be repaired or replaced without compromising tree health or structure providing the recommendations outlined in this report are followed.

A non-destructive root investigation may be undertaken to definitively determine the presence and impact of any tree roots growing beyond the retaining wall.
Recommendations

It is recommended that:

1. The tree is retained in the landscape.

2. A non-destructive root investigation is undertaken along the platform edge, adjacent to the existing rail line, to determine the presence of any tree roots.
   
   2.1 The trench should be a minimum of 1.5m in depth and conducted under the direct supervision of a suitably qualified arborist (minimum AQF Level 5);

   2.2 The trenching must be undertaken utilising a root sensitive excavation technique such as Airspade®, hydrovac or similar;

   2.3 If root activity is present, root samples will need to be taken and sent for laboratory analysis so any roots found can be identified to Genus level to ascertain the source of the roots. There are a number of *Schinus* (Peppercorn trees) along the boundary of the station that will need to be ruled out if root activity is present in the area of concern;

   2.4 If a root barrier is required, the potential loss of root mass resulting from any root severance will need to be considered (number and size of roots) and determine if the tree can remain viable.

3. If the existing retaining wall is to be repaired or replaced, the following is recommended:

   3.1 All works are undertaken under the direct supervision of a suitably qualified Arborist;

   3.2 Trunk protection is installed around the base of the tree to ensure no mechanical damage occurs during construction. Specifications for trunk protection are listed in Appendix 2;

   3.3 Construct the new retaining wall under the direct supervision of a suitably qualified arborist;

   3.4 Screw piles or similar sensitive construction method is utilised in lieu of strip footings;

   3.4.1 If roots greater than 40cm in diameter are encountered these roots must be retained and the footings shifted;

   3.4.2 All roots less than 40cm in diameter be pruned by a suitably qualified Arborist, at right angles with sharp, clean tools.

3.5 The retaining wall must be bridged over the existing root system in between screw piles.
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1. Introduction

Homewood Consulting Pty Ltd has been engaged to provide an assessment of a *Eucalyptus camaldulensis* (River Red Gum) located at Newmarket train station, in Flemington. An inspection and arborist report of the tree has been requested to assess the health, structure and risk that the tree currently presents in the landscape as well as to determine the likelihood as to whether the root system of the tree is currently impacting the existing railway track. Public Transport Victoria and Metro Trains have raised concerns in relation to this tree, specifically that:

- Tree roots may be currently causing damage to the existing rail line;
- Tree roots may grow under the track and then subsequently cause damage; and
- If the whole tree were to fail, this would cause significant damage to the existing rail infrastructure or railway station.

This report also makes comment on the existing retaining wall for the station platform that is in disrepair and is located immediately adjacent to the subject tree.

On Wednesday, 28 November 2018 Tim Oldfield and Ben Kenyon conducted a site inspection. A summary of the assessment can be seen in Section 4.

A Visual Tree Assessment (VTA) was conducted for the tree. A VTA consists of a detailed visual inspection of a tree and its surrounding site, including a complete walk around the tree, looking at the buttress roots, trunk, branches and leaves. The tree is observed from a distance and close up to consider crown shape, landscape context and surroundings.

The assessment was conducted from ground level with no instruments used other than a diameter tape to measure trunk diameter. Any assessments of decay are qualitative only. Tree height and canopy width were estimated.

2. Site Details

The tree is located within McCall Reserve (Figure 1) which is located adjacent to Newmarket Station, in Flemington. The tree is located along the eastern boundary of this reserve, immediately adjacent to the station platform wall (Figure 2). Mature trees surrounding the station include several Peppercorns (*Schinus molle*), Silver or White Poplars (*Populus alba*) and a River Red Gum (*Eucalyptus camaldulensis*), mostly to the south of the buildings.

![Figure 1: McCall Reserve and the subject tree along the eastern property boundary](image-url)
3. Site Map

Figure 2: Approximate location of subject tree (Nearmap 2018)
4. Tree Details

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Eucalyptus camaldulensis</th>
<th>Health</th>
<th>Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Name</td>
<td>River Red Gum</td>
<td>Structure</td>
<td>Fair</td>
</tr>
<tr>
<td>Origin</td>
<td>Indigenous</td>
<td>ULE</td>
<td>50+ years</td>
</tr>
<tr>
<td>Height x Width</td>
<td>28m x 27m</td>
<td>Individual Significance</td>
<td>Outstanding</td>
</tr>
<tr>
<td>DBH</td>
<td>138cm</td>
<td>Retention Value</td>
<td>Very High</td>
</tr>
<tr>
<td>Age Class</td>
<td>Mature</td>
<td>TPZ radius</td>
<td>15m</td>
</tr>
<tr>
<td>Landscape Contribution</td>
<td>Very High</td>
<td>SRZ radius</td>
<td>4.1m</td>
</tr>
</tbody>
</table>

| Figure 3: The subject tree – *Eucalyptus camaldulensis* |

4.1 Tree Condition

Overall the tree has good health with no obvious evidence of pest and disease. There is minor deadwood throughout the canopy however this is not uncommon (and quite normal) for this species at maturity. It displays a full canopy of foliage with good extension growth and no crown thinning evident (Figure 3).

The tree has fair structure with a slight lean to the west and some codominant unions within the canopy, none of which have bark inclusions. The tree has good basal trunk flare, good flexure wood at the base and appears stable in the ground.
4.2 Tree Significance

The subject tree is in excess of 100 years old and was an established and significant landscape feature that potentially existed prior to the current station being constructed. The tree is afforded a number of protection measures under the Moonee Valley Planning Scheme.

The subject tree is registered in the Moonee Valley City Council Significant Tree Register 2017 (Tree 309) with the Planning Scheme overlay shown in grey in Figure 4. The Significant Tree Register identifies trees on public and private land which contribute substantially to the amenity of the Municipality and trees have been selected based on the National Trust’s Register of Significant Trees significance criteria, including:

- horticultural or genetic value;
- unique location or context;
- rare or localised distribution;
- particularly old specimen;
- outstanding size, aesthetic value;
- curious growth habit;
- historical significance;
- connection to Aboriginal culture;
- outstanding example of species;
- remnant vegetation; or
- outstanding habitat.

The tree has been registered due to it being an old remnant specimen with outstanding size and aesthetic value.

The tree is also afforded State heritage significance and is listed for protection under the Moonee Valley Planning Scheme Heritage Overlay (HO380), shown in pink in Figure 4. The citation for the heritage significance of the precinct, which includes surrounding vegetation, is located on the Victorian Heritage Database. Overall the tree is highly significant to the surrounding landscape and all efforts should be made for its retention.

Figure 4: Image showing both Heritage and Significant Tree controls (Landchecker, 2018)
5. Discussion

Public Transport Victoria and Metro Trains have raised concerns in relation to this tree, specifically that:

- Tree roots may be currently causing damage to the existing rail line;
- Tree roots may grow under the track and then subsequently cause damage; and
- If the whole tree were to fail, it would cause significant damage to the existing rail infrastructure of railway station.

5.1 Root damage to existing infrastructure

The soil grade at the base of the tree is substantially different to soil grade at the train tracks. The station was likely constructed above existing grade with the use of retaining walls which were then infilled to achieve the current rail alignment.

The station platform sits 2.3m above natural ground level (at the base of the tree) and the rail track is 1.2m above ground level (1.1m below platform level). Therefore the railway itself is potentially sitting on 1.2m of fill soil (Figure 5 and Figure 7). It is also likely that the footings for the platform go down into the fill soil by at least 600mm, which would create a root barrier along this façade, further preventing root activity from encroaching into the train track area.

![Figure 5: Station cross-section showing grade changes (not to scale)](image)

Tree roots are opportunistic and will grow where soil conditions, such as low bulk density and supplies of oxygen and nutrients, are best (Perry 1982). They will always grow through soil in the path of least resistance and they will only continue to grow if soil conditions are favourable. If soil conditions are unfavourable root growth will be reduced and may even completely stop (Raven and Johnson 1992).

The fill soil placed for the existing railway station would be heavily compacted, limiting gas exchange and access to water and would inhibit root growth through this area.

Furthermore, root growth is highly influenced by geotropism. Geotropism is the growth of the parts of plants in response to the force of gravity. The upward growth of plant shoots is an
example of ‘negative geotropism’ while the downward growth of roots is known as ‘positive geotropism’ (Roberts et al, 2006; Raven, 1992).

Roots are sensitive to the hormone Auxin which concentrates on the lower side of the root during growth/elongation. This hormone inhibits cell expansion which in turn causes the root to bend downwards due to increased elongation on the top side of the root (Raven, 1992). Given this general growth nature of roots, it is highly unlikely tree roots would have grown upwards through 1.2m of heavily compacted soil to impact the existing rail line.

Figure 6: Diagram showing Auxin (IAA) transport & its effect on root growth (taken from Raven, 1992)
The railway line itself shows no obvious signs of damage or lifting from tree roots (Figure 8). Rail spikes within close proximity to the tree do not appear to have moved; no timber sleepers appear to have been displaced and the rail line itself does not appear to be in disrepair compared to other sections of the rail line that are well setback from the subject tree.

Figure 7: Looking west at subject tree and railway line, showing the difference in grade

Figure 8: No clear evidence of damage to the existing track
No evidence of track damage or tree root activity has been provided by Metro Trains or PTV. Further investigation must be undertaken within the area of concern to definitively determine if tree roots are located within this area and, if roots are present, whether they are impacting the existing rail line. This should be done via non-destructive excavation along the platform edge, and specifications are provided in the report recommendations.

If tree roots are present, complete tree removal is unlikely to be required. There is ample space between the subject tree and the rail tracks to install a tree root barrier.

In short, there is currently no evidence of tree roots in the vicinity of the rail tracks, this should be investigated further. If there are roots present, then there are alternatives to managing root growth that successfully retain the subject tree.

5.2 Whole Tree Failure

Another concern raised is related to whole tree failure and the impact this would have on the existing rail infrastructure (from root and soil upheaval).

The tree has a lean towards the west, away from the existing station, however it shows no signs of root plate instability with no visible cracks, basal trunk decay or ground heave noted during the site inspection.

Furthermore, the crown of the subject tree is well balanced and not over extended. There are no signs that the tree has a compromised root system or that complete tree failure is probable.

5.2.1 Risk Assessment

The risk assessment method utilised is Tree Risk Assessment Qualification (TRAQ). This method was developed by the International Society of Arboriculture (ISA - Dunster, Smiley, Matheny and Lilly, 2017).

The TRAQ method uses a qualitative approach to tree risk assessment and consists of the following main components:

- Likelihood of failure
- Likelihood of impact
- Consequences of failure

These components are used to determine the likelihood and consequences of an event occurring to determine a risk rating. The risk components and definitions are listed in Appendix 1. This tree presents a ‘Low’ risk rating of whole tree failure in its current environment.

While the crown could benefit from some minor deadwood removal, this is general maintenance works and would have no influence on reducing the risk of whole tree failure.

<table>
<thead>
<tr>
<th>Likelihood Of failure</th>
<th>Likelihood Of Impact</th>
<th>Likelihood of Failure and Impact</th>
<th>Consequences To Target</th>
<th>Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improbable</td>
<td>Low</td>
<td>Unlikely</td>
<td>Severe (persons)</td>
<td>Low</td>
</tr>
</tbody>
</table>
5.3 Damage to the existing Retaining Wall

The subject tree is located adjacent to an existing retaining wall that supports the station platform (Figure 9). There is some cosmetic damage to this wall, with small cracks, scuffs and general disrepair observed.

It is noted that a large portion of the wall (not just the sections immediately within proximity to the subject tree) has similar damage (Figure 10). The damage to the retaining cannot be solely attributed to the growth of the subject tree, it is more likely attributed to the age of the wall. There is no visible structural damage to the wall resulting from the subject tree.

![Figure 9: Retaining wall next to the subject tree](image)

The retaining wall can be repaired or replaced without compromising the health or structure of the subject tree providing works are undertaken in a sensitive manner.

One option would be to use screw pile footings in lieu of a strip footings. ‘Screw Pile’ or similar footings generally have a lower impact on root systems because soil excavations are kept to a minimum, with individual holes for each pile far less likely to damage tree roots compared with a continual open trench as for strip footings.

Using screw piles while bridging the retaining wall over existing roots to construct the retaining wall would ensure that very few roots are impacted. It is important to allow some flexibility in the placement of the footings to ensure that if any major roots are discovered, the footings can be moved to avoid the root. If stump/pier holes are excavated manually and significant tree roots are not severed, it is unlikely that the construction of any proposed replacement retaining will impact on the health and structure of the subject tree.
6. Conclusions

The tree is a remnant, indigenous specimen that is very significant in the landscape. It is listed on the Moonee Valley Significant Tree Register and is also protected by a Heritage Overlay.

There are no obvious signs of tree roots located within the rail line corridor and there are no obvious signs of damage to infrastructure from tree roots.

The likelihood of complete tree failure at the root plate is considered improbable and the resultant risk assessment places the tree at a ‘Low’ level of risk.

Based on the observations on site and the evidence provided to date, the recommendation/request for complete tree removal appears to be based on supposition rather than a considered response.
7. Recommendations

The following is recommended:

4. The tree is retained in the landscape

5. A non-destructive root investigation is undertaken along the platform edge, adjacent to the existing rail line, to determine the presence of any tree roots.
   5.1 The trench should be a minimum of 1.5m in depth and conducted under the direct supervision of a suitably qualified arborist (minimum AQF Level 5);
   5.2 The trenching must be undertaken utilising a root sensitive excavation technique such as Airspade®, hydrovac or similar;
   5.3 If root activity is present, root samples will need to be taken and sent for laboratory analysis so any roots found can be identified to Genus level to ascertain the source of the roots. There are a number of *Schinus* (Peppercorn trees) along the boundary of the station that will need to be ruled out if root activity is present in the area of concern;
   5.4 If a root barrier is required, the potential loss of root mass resulting from any root severance will need to be considered (number and size of roots) and determine if the tree can remain viable.

6. If the existing retaining wall is to be repaired or replaced, the following is recommended:
   6.1 All works are undertaken under the direct supervision of a suitably qualified Arborist;
   6.2 Trunk protection is installed around the base of the tree to ensure no mechanical damage occurs during construction. Specifications for trunk protection are listed in Appendix 2;
   6.3 Construct the new retaining wall under the direct supervision of a suitably qualified arborist;
   6.4 Screw piles or similar sensitive construction method is utilised in lieu of strip footings;
      6.4.1 If roots greater than 40cm in diameter are encountered these roots must be retained and the footings shifted;
      6.4.2 All roots less than 40cm in diameter be pruned by a suitably qualified Arborist, at right angles with sharp, clean tools.
   6.5 The retaining wall must be bridged over the existing root system in between screw piles.
8. References


Roberts, J. Jackson, N & Smith, M, ‘*Tree Roots in the Built Environment*’, TSO Publishing, UK.
Appendix 1. Data Collection Definitions & Descriptors

Tree assessments are based on the assessor’s experience and opinion of the tree.

1.1 Botanical name
The scientific name identifying the genus and species of the tree. Each species has only one scientific name.

1.2 Common Name
The colloquial name for a tree species, usually in plain English. Common names for a species are often local or regional and each species can have multiple common names.

1.3 Tree dimensions
Tree height and canopy width in metres (estimated unless stated otherwise).

1.4 DBH
Diameter of the trunk at breast height (1.4m above ground level) measured using a diameter tape. Used to calculate the Tree Protection Zone radius.

1.5 Basal diameter
Diameter of the trunk above the root buttress, measured using a diameter tape. Used to calculate the Structural Root Zone radius.

1.6 Health

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>The tree is demonstrating excellent or exceptional growth. The tree exhibits a full canopy of foliage and is free of pest and disease problems.</td>
</tr>
<tr>
<td>Good</td>
<td>The tree is demonstrating good or exceptional growth. The tree exhibits a full canopy of foliage, and has only minor pest or diseases problems.</td>
</tr>
<tr>
<td>Fair</td>
<td>The tree is in reasonable condition and growing well. The tree exhibits an adequate canopy of foliage. There may be some deadwood present in the crown. Some grazing by insects or possums may be evident.</td>
</tr>
<tr>
<td>Poor</td>
<td>The tree is not growing to its full capacity; extension growth of the laterals is minimal. The canopy may be thinning or sparse. Large amounts of deadwood may be evident throughout the crown. Significant pest and disease problems may be evident or there may be symptoms of stress indicating tree decline.</td>
</tr>
<tr>
<td>Very Poor</td>
<td>The tree appears to be in a state of decline. The tree is not growing to its full capacity. The canopy may be very thin and sparse. A significant volume of deadwood may be present in the canopy or pest and disease problems may be causing a severe decline in tree health.</td>
</tr>
<tr>
<td>Dead</td>
<td>The tree is dead.</td>
</tr>
</tbody>
</table>
### 1.7 Structure

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>The tree has a well-defined and balanced crown. Branch unions appear to be sound, with no significant defects evident in the trunk or the branches. Major limbs are well defined. The tree is considered a good example of the species.</td>
</tr>
<tr>
<td>Fair</td>
<td>The tree has some minor problems in the structure of the crown. The crown may be slightly out of balance, and some branch unions may be exhibiting minor structural faults. If the tree has a single trunk, it may be on a slight lean or exhibiting minor defects.</td>
</tr>
<tr>
<td>Poor</td>
<td>The tree may have a poorly structured crown. The crown may be unbalanced or exhibit large gaps. Major limbs may not be well defined. Branches may be rubbing or crossing over. Branch unions may be poor or faulty at the point of attachment. The tree may have suffered root damage.</td>
</tr>
<tr>
<td>Very Poor</td>
<td>The tree has a poorly structured crown. The crown is unbalanced or exhibits large gaps with possibly large sections of deadwood. Major limbs may not be well defined. Branches may be rubbing or crossing over. Branch unions may be poor or faulty at the point of attachment. Branches may exhibit large cracks that are likely to fail in the future. The tree may have suffered major root damage.</td>
</tr>
<tr>
<td>Has Failed</td>
<td>A section of the tree has failed or is in imminent danger of failure and the tree is no longer a viable specimen.</td>
</tr>
</tbody>
</table>

### 1.8 Age Class

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature</td>
<td>Tree has reached the expected size for the species at the site.</td>
</tr>
<tr>
<td>Semi-mature</td>
<td>Established tree that has not yet reach the expected size for the species at the site.</td>
</tr>
<tr>
<td>Young</td>
<td>Recently planted tree or juvenile self-sown tree (generally less than 5 years old).</td>
</tr>
</tbody>
</table>

### 1.9 Useful Life Expectancy (ULE)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>40+ years</td>
<td>The tree is in excellent condition and under normal conditions and with appropriate management is expected to continue as a viable landscape component in excess of 40 years.</td>
</tr>
<tr>
<td>20 - 40 years</td>
<td>The tree is in good condition and under normal conditions and with appropriate management is expected to continue as a viable landscape component for 20-40 years.</td>
</tr>
<tr>
<td>10 - 20 years</td>
<td>The tree is in fair condition and under normal conditions and with appropriate management is expected to continue as a viable landscape component for 10-20 years.</td>
</tr>
<tr>
<td>5 - 10 years</td>
<td>The tree is in fair to poor condition or it is not a long lived species. Removal and replacement may be required within the next 10 years.</td>
</tr>
<tr>
<td>1 - 5 years</td>
<td>The tree is in poor condition due to advanced decline or structural defect. Removal and replacement may be required within the next 5 years.</td>
</tr>
<tr>
<td>0 years</td>
<td>The tree is dead, or is considered hazardous in the location. Removal may be required.</td>
</tr>
</tbody>
</table>
1.10 Tree Origin

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exotic</td>
<td>The species originates in a country other than Australia.</td>
</tr>
<tr>
<td>Australian Native</td>
<td>The species originates within Australia.</td>
</tr>
<tr>
<td>Indigenous</td>
<td>The species originates within the local environs.</td>
</tr>
</tbody>
</table>

1.11 Contribution to the Landscape

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Generally a large tree which is a significant component of the local landscape and provides canopy cover to the site. May offer shade and other amenities such as screening. The tree may assist with erosion control, offer a windbreak or perform a vital function in the location (e.g.: Habitat, shade, flowers or fruit).</td>
</tr>
<tr>
<td>Medium</td>
<td>Generally a medium sized tree or group of small-medium trees which provide a moderate contribution to the local landscape and canopy cover. The tree may offer screening in the landscape or serve a particular function in the location.</td>
</tr>
<tr>
<td>Low</td>
<td>The tree offers little in the way of screening, amenity or canopy cover.</td>
</tr>
<tr>
<td>Negligible</td>
<td>The tree offers extremely little to nothing in the way of screening, amenity or canopy cover.</td>
</tr>
</tbody>
</table>

1.12 Tree Significance Rating

This rating system is used to rate the significance of trees in a local area. Some trees identified in local areas may be suitable for National or State registration. Trees that have State or National significance would normally be registered by The National Trust and identified as such. This system of rating and any values expressed represents the opinion of the consultant.

Trees may be considered significant in a local area if they fit into one or more of the following categories.

- Exceptional size
- Rare
- Very old
- Unusual shape or form
- Aboriginal cultural value
- Historic value
- Exceptional example of a species
- Economic, genetic
- Outstanding feature in the landscape
- Habitat value
- Erosion control
Table 2. Tree Significance Rating Definition

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptional</td>
<td>A tree is considered exceptional because several of the preceding categories apply to the specimen. This tree is normally one that creates a profound effect on the local area and has an exceptional impact on the tree surveyor.</td>
</tr>
<tr>
<td>Outstanding</td>
<td>A tree is considered outstanding because one or several of the preceding categories apply to the specimen. This tree is normally one that attracts attention and has a noticeable impact on the area and the tree surveyor.</td>
</tr>
<tr>
<td>Valuable</td>
<td>A tree is considered valuable because at least one of the preceding categories may be applicable or partially to the specimen. This tree is normally one that is a reasonable specimen without any particular outstanding features. It normally has a diameter at breast height over 1000mm and has good to average health and structure.</td>
</tr>
<tr>
<td>Moderate</td>
<td>A tree is considered to have moderate value because it may be in reasonable condition but may only partially fulfill any one factor. It generally has a diameter at breast height of less than 1000mm and an average or poor health and structure.</td>
</tr>
<tr>
<td>Low value</td>
<td>As an individual specimen, the tree is not considered significant. This may be a small specimen, with poor health or structure and be common in occurrence or possibly a weed species. This tree has no impact on the tree surveyor.</td>
</tr>
<tr>
<td>Negligible</td>
<td>As an individual specimen, the tree is not considered significant. This may be a very small specimen with very poor health and structure and may be common in occurrence or a weed species. This tree has no impact on the tree surveyor.</td>
</tr>
</tbody>
</table>

1.13 Tree Retention Value

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>Tree of exceptional quality in good condition. A prominent landscape feature and/or of historic, cultural, ecological or other significance. Has the potential to be a medium to long-term landscape component where managed appropriately. All efforts should be made to retain the tree and protect from construction impact.</td>
</tr>
<tr>
<td>High</td>
<td>Tree of high quality in good to fair condition. Generally a prominent landscape feature. Has the potential to be a medium to long-term landscape component where managed appropriately. All efforts should be made to retain the tree and protect from construction impact.</td>
</tr>
<tr>
<td>Medium</td>
<td>Tree of moderate quality in fair condition. Generally a modest landscape feature. May have a health or structural issue that can be resolved with arboricultural input, or may refer to a medium to small tree in good condition. Has the potential to be a medium to long-term landscape component where managed appropriately. Where practical, design modifications should be considered in order to retain and protect from construction impact.</td>
</tr>
<tr>
<td>Low</td>
<td>Either: Tree of low quality in poor condition. Generally provides little amenity value..Unlikely to be a long or medium term landscape component. The tree may be considered a weed species, structurally unsound, dead/dying/diseased, nearing the end of its ULE or may not be suitable for the site. Or: small tree of good or fair condition which is easily replaced in the landscape through planting of advanced stock.</td>
</tr>
<tr>
<td>Third party ownership</td>
<td>The tree is located outside of the subject site and is owned by a third party. It may be owned by a private entity (residential) or public body (council).</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td>Third party owned trees must be retained and protected from construction impact, unless a mutually acceptable outcome is negotiated with the tree owner and relevant authorities.</td>
</tr>
</tbody>
</table>
Appendix 2. Tree Risk Assessment Qualification (TRAQ)

A risk assessment using the International Society of Arboriculture's (ISA) Tree Risk Assessment Qualification (TRAQ) method has been conducted.

This method of risk assessment uses a qualitative approach to tree risk assessment and consists of the following main components:

- Likelihood of Failure
- Likelihood of Impact
- Consequences of Failure

Before making any assessment of these components, a timeframe must be established for the risk assessment. A timeframe is essential as it provides a point of reference for the level of risk determination. All trees could fail eventually, so risk ratings must be associated with a time frame. The time frame is the length of time within which the assessor is deciding whether a specific failure is likely to occur.

For this report the timeframe considered is 12 months.

It is important to note that the timeframe should not be considered a ‘guarantee period’ for the risk assessment.

The likelihood of failure is the chance of a tree or tree part failure occurring within the specified time frame. The likelihood of failure will fall within one of 4 categories (see Table 3) as determined by the following considerations:

- Site factors
- Response growth
- Tree health
- Tree species
- Load
- Defects and conditions

Table 3

<table>
<thead>
<tr>
<th>Likelihood of Failure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imminent</td>
<td>Failure has started or is most likely to occur soon, even if there is no significant wind or increased load. The imminent category overrides the time frame stated in the scope of work.</td>
</tr>
<tr>
<td>Probable</td>
<td>Failure may be expected under normal weather conditions within the specified time frame.</td>
</tr>
<tr>
<td>Possible</td>
<td>Failure may be expected in extreme weather conditions, but it is unlikely during normal weather conditions within the specified time frame.</td>
</tr>
<tr>
<td>Improbable</td>
<td>The tree or tree part is not likely to fail during normal weather conditions and may not fail in extreme weather conditions within the specified time frame.</td>
</tr>
</tbody>
</table>
The likelihood of impact is the chance of a tree failure impacting a target during the specified timeframe. Likelihood of impact will fall within one of 4 categories (see Table 4) and is determined by considering the following:

- Occupancy rates
- Location within the target zone
- Protection factors
- Direction of fall

### Table 4

<table>
<thead>
<tr>
<th>Likelihood of Impact</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>The chance of the failed tree or tree part impacting the specified target is remote. Considers rarely used areas.</td>
</tr>
<tr>
<td>Low</td>
<td>There is a slight chance that the failed tree or tree part will impact the target. Considers occasionally used areas with no protection factors.</td>
</tr>
<tr>
<td>Medium</td>
<td>The failed tree or tree part could impact the target but is not expected to do so. Considers frequently used areas where the direction of fall may or may not be towards the target.</td>
</tr>
<tr>
<td>High</td>
<td>The failed tree or tree part is likely to impact the target. Considers constant targets with no protection factors, where direction of fall is towards the target.</td>
</tr>
</tbody>
</table>

The consequences of failure are the level of personal injury, property damage, or disruption of activities due to the failure of a tree or tree part. The consequences of failure are placed within one of 4 categories (see Table 5) as determined by considerations of:

- Tree or tree part size
- Fall distance of tree or tree part
- Protection factors
- Target value/damage

### Table 5

<table>
<thead>
<tr>
<th>Consequences of Failure</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>Consequences that do not result in personal injury, involve low-value property damage, or disruptions that can be replaced or repaired.</td>
</tr>
<tr>
<td>Minor</td>
<td>Consequences that involve minor personal injury, low- to moderate-value property damage, or small disruption of activities.</td>
</tr>
<tr>
<td>Significant</td>
<td>Consequences that involve substantial personal injury (requiring professional medical care), moderate- to high-value property damage, or considerable disruption of activities.</td>
</tr>
<tr>
<td>Severe</td>
<td>Consequences that could involve serious personal injury or death, high-value property damage, or major disruption of important activities.</td>
</tr>
</tbody>
</table>
Once the likelihood of failure and the likelihood of impact have been categorised then TRAQ requires that the combined likelihood of a failure impacting a target be categorised. This is done using Matrix 1 which gives the likelihood of failure and impact as either Unlikely, Somewhat likely, Likely, or Very Likely.

**Matrix 1: used to estimate the likelihood of a tree failure impacting a specified target.**

<table>
<thead>
<tr>
<th>Likelihood of Failure</th>
<th>Likelihood of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Low</td>
</tr>
<tr>
<td>Imminent</td>
<td>Unlikely</td>
</tr>
<tr>
<td>Probable</td>
<td>Unlikely</td>
</tr>
<tr>
<td>Possible</td>
<td>Unlikely</td>
</tr>
<tr>
<td>Improbable</td>
<td>Unlikely</td>
</tr>
</tbody>
</table>

The result from Matrix 1 is then combined with the Consequences of failure in Matrix 2, the result of which categorises the tree risk rating as either Low, Moderate, High, or Extreme.

**Matrix 2: risk rating as the combination of likelihood of a tree failing and impacting a specified target, and the severity of the associated consequences.**

<table>
<thead>
<tr>
<th>Likelihood of Failure &amp; Impact</th>
<th>Consequences of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negligible</td>
</tr>
<tr>
<td>Very likely</td>
<td>Low</td>
</tr>
<tr>
<td>Likely</td>
<td>Low</td>
</tr>
<tr>
<td>Somewhat likely</td>
<td>Low</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Low</td>
</tr>
</tbody>
</table>

Once the risk rating has been established then mitigation options should be considered if the risk rating exceeds the level of acceptable risk.

**A hypothetical example of TRAQ application follows:**

A mature tree with a large dead branch is growing next to a one-storey house. The dead branch is on the side of the tree away from the house. The likelihood of this dead branch failure within the next year was classified by a tree risk assessor as probable. The house is a static target with a constant occupancy rate. However, the likelihood of the branch falling from the opposite side of the tree through the rest of the tree to the house is very low. This results in a likelihood of failure and impact rating of unlikely.

Consider now that there is a parking area located partially under the branch and there are no lower branches that would mitigate the fall of the branch. A car is parked under the tree for 14 hours per day, and the driver is present for a minute or two each day as she walks...
between the house and the car. Thus the human occupancy rate in the target zone is rare, and the car occupancy rate is frequent. This leaves two scenarios to judge:

1. The rare human occupancy rate translates to a very low likelihood of impacting the driver. When that is combined with a probable failure likelihood, the combination results in the likelihood of failure impacting the driver of unlikely.

2. The car occupancy rate is frequent, and there are no structures or tree parts that would deflect or impede the fall of the branch on this side of the tree. You rate the likelihood of impact medium. Combining the medium likelihood of impact with the probable likelihood of failure of the branch, the likelihood of failure and impact for the car becomes somewhat likely.

The consequences of a medium-sized dead branch striking a house would be minor, the consequences of that branch striking an unoccupied, new car could be significant, and the consequences of its impacting a person would be severe. These consequences are combined with the likelihood of failure and impact to determine risk ratings as follows:

- For the house, the risk of a medium-sized, dead branch with a likelihood of failure and impact rating of unlikely and consequences rating of minor would result in a risk rating of low.
- For the parked car, the likelihood of failure and impact is somewhat likely and the consequences are significant, so the risk is moderate.
- For the driver of the car, the likelihood of failure and impact is unlikely and the consequences severe, so the risk is low.

The highest of these three individual ratings is moderate, thus the overall tree risk rating would be moderate. Whether the clients choose to mitigate the risk depends upon their perception of risk and what level of risk they find acceptable, as well as the cost, aesthetics, and inconvenience of mitigation.

The above information regarding TRAQ has been taken directly from Dunster, JA, Smiley, ET, Matheny, N, & Lilly, S 2017, Tree Risk Assessment Manual (Second Edition), Champaign, Illinois, International Society of Arboriculture.
All parts of the tree may be damaged by development and damage to any one part of the tree will affect its functioning as a whole.

Root damage is the most common cause of damage to trees on development sites. Roots may be removed, wounded, crushed or torn during grading, excavation or trenching. Soil compaction from foot traffic and vehicle traffic results in loss of pore space within the soil which is essential for the exchange of gases between the soil and atmosphere and soil drainage.

Trunks of trees may be wounded mechanically during demolition and construction work. This not only predisposes a tree to potential decay but it also interferes with the transport of water, nutrients and sugars throughout the tree. Serious impacts may structurally weaken the tree.

The canopy of trees can be damaged through incorrect pruning techniques or mechanical injury by trucks, cranes, excavators etc. The removal of leaves reduces the level of photosynthesis and reduces the tree’s capacity to function normally and to withstand stresses. Incorrect pruning and mechanical damage can produce wounds that are susceptible to infection by wood decay organisms.

For trees to be retained and their requirements met, procedures have to be in place to protect trees at every stage of the development process. This needs to be taken into account at the earliest planning stage of any outdoor event or design of a development project where trees are involved.

### 3.1 Tree Protection Zones

The most common method of protecting trees during construction is by setting up a Tree Protection Zone (TPZ). The TPZ is an area isolated from construction disturbance area, so that the tree remains viable. The TPZ has been calculated according to the Australian Standard (AS 4970-2009) for the subject trees. This method calculates the TPZ as 12 times the trunk diameter at 1.4m above ground level (DBH).

A TPZ should not be less than 2m nor greater than 15m, except where additional crown protection is required. The TPZ of palms, other monocots, cycads and tree ferns should not be less than 1m outside of the crown projection.

### 3.2 Structural Root Zones

The Structural Root Zone (SRZ) is the minimum volume of roots required by the tree to remain stable in the ground. If the SRZ is breached the chances of windthrow are significantly increased. Windthrow is an event where the entire tree fails/falls over.

It is important to note that the SRZ is not related to tree health. It refers to the physical volume of roots required for the tree to remain stable in the ground (Figure 11). It is in no way related to the physiological requirements of the tree, but is the minimum volume of roots required for the tree to remain standing (Mattheck and Breloer 1994).

According to AS4970-2009 the SRZ of the trees has been calculated using the equation:

$$ R_{SRZ} = (D \times 50)^{0.42} \times 0.64 $$
Figure 11: The SRZ = minimum volume of roots required for tree stability. Image from Biddle 1998.
Appendix 4. Tree Protection Measures

4.1 Tree Protection Fencing

The TPZ acts as a physical barrier of protective fencing that is a minimum of 1.8m high. It is installed around retained trees prior to site establishment and retained intact until completion of the works (Figure 12). Once erected, protective fencing must not be removed or altered without approval by the project arborist. The TPZ fence should be secured to restrict access.

![Figure 12: TPZ fencing is erected around retained trees prior to site works.](image)

4.2 Signs

Signs identifying the TPZ should be placed around the edge of the TPZ and be visible from within the development site (Figure 13).
Figure 13: Example of a TPZ warning sign clearly displayed on TPZ fencing.
4.3 Activities restricted within the TPZ

Activities restricted within the TPZ are included but are not limited to:

- machine excavation including trenching
- excavation for silt fencing
- cultivation
- storage
- preparation of chemicals, including preparation of cement products
- parking of vehicles and plant
- refuelling
- dumping of waste
- wash down and cleaning of equipment
- placement of fill
- lighting of fires
- soil level changes
- temporary or permanent installation of utilities and signs
- physical damage to the tree.

4.4 TPZ Maintenance

The area within the TPZ should be mulched. The mulch must be maintained to a depth of 50-100 mm. Where the existing landscape within the TPZ is to remain unaltered (e.g. garden beds or turf) mulch may not be required.

Soil moisture levels should be regularly monitored by the project arborist. Temporary irrigation or watering may be required within the TPZ. An above-ground irrigation system should be installed and maintained by a competent individual.

All weeds should be removed by hand without soil disturbance or should be controlled with appropriate use of herbicide.

4.5 Working within the TPZ

Some works and activities within the TPZ may be authorized by the determining authority. These must be supervised by the project arborist. Any additional encroachment that becomes necessary as the site works progress must be reviewed by the project arborist and be acceptable to the determining authority before being carried out.

Where TPZ fencing is impractical - e.g. if site access is required through the TPZ, other tree protection measures should be used, including trunk and branch protection and/or ground protection.

4.6 Ground Protection

If temporary access for machinery is required within the TPZ ground protection measures will be required. The purpose of ground protection is to prevent root damage and soil compaction within the TPZ. Measures may include a permeable membrane such as geotextile fabric beneath a layer of mulch or crushed rock below rumble boards (Figure 14).
4.7 Trunk and Branch Protection

Where trees cannot be isolated from vehicles or machinery by TPZ fencing, trunk and branch protection may be required to prevent mechanical damage. Protection may consist of padding surrounding the trunk or branch, held in place with batons strapped together, or similar (Figure 14). Boards are to be strapped to trees, not nailed or screwed.

Crown protection may also include pruning, tying-back of branches or other measures. If pruning is required, it must be undertaken as per the specifications of AS 4373-2007 *Pruning of Amenity Trees* and should be undertaken before the establishment of the TPZ.

Figure 14: Example of trunk, branch and ground protection (Source: AS 4970-2009).

4.8 Scaffolding

Where scaffolding is required it should be erected outside the TPZ. Where it is essential for scaffolding to be erected within the TPZ, branch removal should be minimised. Ground below the scaffolding should be protected by boarding (e.g. scaffold board or plywood sheeting). Where access is required, a board walk or other surface material should be installed to minimize soil compaction. Boarding should be placed over a layer of mulch and impervious sheeting to prevent soil contamination. The boarding should be left in place until the scaffolding is removed.