The Toowoomba Regional Council (TRC) Street Tree Masterplan project is part of the TRC’s ‘Liveable Streetscapes and Neighbourhoods in Future Climates’ project funded by the Australian Government through the Water for the Future initiative.

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1. EXECUTIVE SUMMARY

The value of trees in the urban environment is widely recognised, not only for their aesthetic value but also for the contribution they provide for our pleasure, comfort and well being. Trees in urban environments provide a variety of benefits and play an important role in providing shade, reducing the urban heat island effect, wind speeds, solar radiation, greenhouse gas emissions and energy use, assist in air purification, provide and improve habitat and human health, and encourage residents to be active outdoors. Also, through shading of paved surfaces i.e. roads they can reduce heat fluctuations and the resulting maintenance requirements. Trees also increase property values, act as landmark features and give character and identity to the landscape. However trees also need space to grow and without this, can cause ongoing costs to Council from their impacts on built infrastructure.

The TRC area is known for its iconic climate and its leafy tree lined streets which provide amenity, attract tourism, and contribute towards local events. To maintain the current ‘Garden City’ image into the future, the multiple benefits and value of street trees needs to be recognised and prioritised. At minimum, the same value in streetscape decision making should be given to street trees as their built infrastructure counterparts. Successful street tree plantings or ‘Green Infrastructure’, (from both a community and council perspective) rely heavily on making the right conditions available. This will ensure long term street tree health and success amongst the competing pressures of both above and below-ground built infrastructure requirements. If designed for and maintained properly, these ‘competing’ elements can be successfully combined to provide both improved amenity and minimise maintenance for the communities they serve.

Street tree selection, planting and streetscape design must now also account for future climate change and the associated tree health impacts. Especially in a climate predicted to be hotter and drier in the TRC area, to achieve the maximum benefit from street trees, they need to be viewed and funded as a key Council asset. To improve future street trees’ ability to cope with changed climatic conditions and deliver the benefits of street trees to the community over the long term, their design, implementation, maintenance and monitoring needs to be prioritised.

This Street Tree Masterplan provides guidance for the selection of street trees in a wide range of towns throughout the Toowoomba Regional Council area. The recommendations provided are based on knowledge of street trees and urban design principles, taking into account particular aspects of the Toowoomba Region. These aspects include biophysical factors that affect trees, both currently and in the future, as well as built infrastructure factors that affect trees, such as road and service networks. The street tree selection process is outlined, including descriptions of the criteria used during this process, and species recommendations are given for each town. A Master Street Tree Species List and Street Tree Matrix are provided, as are relevant technical drawings and standards related to street trees.

The key objectives of the Regional Street Tree Masterplan Project are to:

• Provide a consistent and living Street Tree Masterplan that is easily accessed and understood by a range of users with a planning horizon of 40-50 years (to approximately 2060) that reinforces and enhances the landscape character of TRC towns
• Provide information that can assist in implementation, including the regulation of local laws
• Encourage and facilitate active transport in road reserves through increased shade and improved aesthetic amenity by implementing high quality canopy plantings
• Provide guidance to TRC, community, developers and linear infrastructure providers for urban tree management requirements as part of the Toowoomba Regional Planning Scheme
• Advance TRC’s reputation as custodians and managers of street tree assets for the TRC area into the future.
2. OVERVIEW

For the purpose of this Street Tree Masterplan, street trees have been defined as deliberate plantings in a road reserve within an urban environment. Street trees do not include plantings within a park, garden or vegetation along rural roads outside town boundaries.

This document aims to provide a single point of reference to guide street tree masterplanning until approximately 2060 across the eight former shire council areas now making up the amalgamated TRC area.

The Toowoomba Regional Council Street Tree Masterplan project is part of the Toowoomba Regional Council’s ‘Liveable Streetscapes and Neighbourhoods in Future Climates’ project funded by the Commonwealth Government under its Water for the Future Program. The program provides assistance to local governments in the Murray Darling Basin to systematically assess the risks, opportunities and implications associated with climate change, with a particular focus on water availability. The intent is that the information developed through funded projects is then used in the review of existing plans or the development of new plans to take account of these risks and implications.

This masterplan forms the third and final stage of the ‘Liveable Streetscapes and Neighbourhoods in Future Climates’ project and is preceded by the Stage One climate modelling for the Toowoomba region undertaken by University of Southern Queensland (2010) Future Climate Profile of the Toowoomba Region and the Stage Two climate change risk analysis project undertaken by RPS (2011) Key Climate Change Risks and Opportunities for Street Tree Masterplanning.

2.1 Benefits of Street Trees

The value of trees in the urban environment is widely recognised, not only for their aesthetic value, but also for the contribution they provide for our pleasure, comfort and well being.

Trees in urban environments provide a variety of benefits and play an important role in:

- Providing shade
- Reducing the urban heat island effect
- Helping to reduce wind speeds
- Helping to reduce solar radiation
- Helping to reduce greenhouse gas emissions
- Helping to reduce energy use
- Assist in air purification
- Provide and improve habitat and human health
- Encourage residents to be active outdoors
- Potentially reducing maintenance of road infrastructure

Trees also increase property values, act as landmark features and give character and identity to the landscape. However, trees also need space to grow and without this, can cause ongoing costs to Council from their impacts on built infrastructure.

The contribution that avenues of street trees make on the overall visual presentation of a city or town can be seen throughout the world. Impressions remembered by visitors to cities are more often than not, images from the street.

From an economic perspective, avenues of street trees promote Toowoomba’s ‘Garden City’ image and improve the liveability of the city for its residents. Other towns in the TRC area also recognise economic benefit from established street tree plantings. Goombungee for example, hosts the Jacaranda Festival based on its street tree plantings. A number of studies (refer Reference list) also show property values are generally higher in streets with established street tree plantings.

Well landscaped commercial districts attract visitors and encourage people to stay longer. One study alone (in Davis, California) showed that “the city’s 24,000 public street trees provided US $1.2 million annually in net environmental and property value benefits” and that “the benefit cost ratio was $3.81 for every $1.00 spent on tree planting and management” (Maco and Macpherson in Ely, 2010).
2. OVERVIEW (continued)

When considering climate change, urban trees are gaining recognition for their ability to reduce greenhouse gas emissions, their role in carbon sequestration and storage and “buffering” the effects of climate change by shading, evapotranspiration, reducing wind speeds and reducing the urban heat island effect in cities and towns. Also both exotic and native tree plantings can provide habitat and food for wildlife, although a lack of biodiversity within urban street tree environments can be an issue if not taken into consideration.

Trees provide a cooling and humidifying effect through evapotranspiration. They help to improve air quality by removing atmospheric pollutants by trapping airborne particles on their surfaces, they oxygenate the air and reduce carbon dioxide through photosynthesis.

Various research (refer References) has also indicated that street trees if given sufficient space, can lengthen the lifespan of road surfaces such as bitumen. This is achieved by shading the paved surface and thereby reducing temperature variations. As a result the need for replacement of paved surfaces is reduced along with the associated costs to council.

In urban design, trees provide character and seasonal interest, structure to the streetscape, help to visually soften the urban environment and can be used for wayfinding and to celebrate town entries and key locations within towns.

For more information on street trees in Australia visit www.treenet.org

2.2 Purpose of the Street Tree Masterplan

The purpose of the STMP is to provide a practical street tree masterplanning guideline for TRC to guide the future street tree planting strategy with a planning horizon of 40-50 years. This guideline is a ‘living document’ and is subject to amendment as required by TRC. These amendments are indicated on the inside front cover.

2.3 Key Objectives and Desired Outcomes

The key objectives of the Street Tree Masterplan Project are to:

- Provide information that can assist in implementation, including the regulation of local laws.
- Encourage and facilitate active transport in road reserves through increased shade and improved aesthetic amenity by implementing high quality canopy plantings.
- Provide guidance to TRC, community, developers and linear infrastructure providers for urban tree management requirements as part of the Toowoomba Regional Planning Scheme.
- Advance TRC’s reputation as custodians and managers of street tree assets for the TRC area into the future.
- Provide a strategy to provide for optimal street tree growing conditions in the TRC area.
- Provide a consistent and living STMP that is easily accessed and understood by a range of users with a planning horizon of 40-50 years (to approximately 2060) that reinforces and enhances the landscape character of TRC towns.

2.4 Public Safety and Risk Management

When designing for street tree plantings, potential risks to public safety need to be taken into account such as:

- Maintaining sight lines at road intersections and driveways
- Leaf, fruit and flower litter resulting in slippery surfaces and increased maintenance requirements
- Trip hazards due to impacts of street trees on built infrastructure
- Crime Prevention through Environmental Design (CPTED)
- Risk of limb drop
- On State controlled roads taking into account Clear Zone requirements

These risks may be mitigated through both species selection and design criteria, although not all potential risks can be completely avoided when dealing with biological assets (or Green Infrastructure), such as trees. Green infrastructure is different from Built Infrastructure as care is needed in applying traditional risk analysis that was developed for Built Infrastructure. Solutions for a balance between risk management and other factors such as cultural heritage will be dealt with on a case by case basis by Council.

Stage Two of this project (A First Pass Assessment of Climate Change Risks and Opportunities in the Toowoomba Regional Council Area, RPS 2011) identified various risks for street trees in the future associated with changing climatic conditions. There are potential risks associated with increased storm events, limb and litter drop. However the largest potential threat is loss of tree vigour and declining health in the long term due to increased heat and reduced water availability. The Stage 2 Report recommended that street trees are monitored to identify potential climate change risks for the health of certain species, as a preventative measure prior to these trees becoming a public safety issue in the future.

Further information on climate change, species selection and risks is provided in the report provided in Section 11.2 ‘Street Tree Selection and Climate Change - Considerations and Strategies for TRC’ by Dr. Jane Tarran.

Shady streets improve amenity and encourage outdoor activity - Toowoomba (TRC 2011)

Ensure street tree planting undertaken after new residential developments are complete to avoid hot streetscapes with limited amenity - Wyreema (RPS 2011)
3. USING THE STREET TREE MASTERPLAN

3.1 Policy Environment and Council Planning Process

The STMP responds directly to Council’s 2010 document Strategic Directions: Planning for our region’s long-term future. Planning for street tree planting can be seen as a direct response to an important tangible outcome of Council’s Corporate plan, in particular the goals of:

- Built Environment
- Natural Environment
- Community

Street tree masterplanning is intrinsically linked to all of the Themes, which are outlined under the Goals. Street tree plantings and streetscape design are directly linked to the Themes of Settlement Pattern, Transport and Mobility, Integrated Infrastructure and Utilities, Natural Environment, Natural Resources and Landscape, Community Identity, Strong Communities, Economy and Governance.

The STMP has also been informed by the Toowoomba Regional Councils’ Policy Framework. This Framework is overviewed by Strategic Directions the Community Plan, the Corporate Plan and the Operational Plan. The Street Tree Masterplan sits outside the Toowoomba Regional Planning Scheme but is referred to via the Scheme’s Street Tree Policy and also via TRC development application requirements and processes.

3.2 Other Policies and Strategies Related To This Masterplan

Other documents which need to be considered when reviewing and working with this STMP include:

- Toowoomba Regional Planning Scheme
- Toowoomba City Centre Masterplan (Urbis, 2010)
- Toowoomba Active Transport Strategy
- Former Toowoomba City Council Planning Scheme Policy No 3
- Toowoomba Transport Strategy Proposals to 2031 (report).
- Department of Transport and Main Roads (DTMR) Road Landscape Policy
- DTMR Road Landscape Manual
- Austroads Guide to Road Design
  - Part 6 Roadside Design Safety and Barriers
  - Part 6B Roadside Environment

3.3 Who will use this Masterplan?

It is anticipated that the Masterplan will be used by:

- TRC staff for ongoing planning and management of trees in road reserve land;
- TRC staff for establishing future capital works and planting/removal program budgets
- Developers and their consultants when undertaking factors to be considered, selection and planting of street trees
- The broader TRC community (i.e. government agencies and communities) to increase their understanding of the processes used to plan and manage street tree assets in the TRC area.

3.4 How to use this Masterplan

The STMP document is divided into a number of sections.

Section 4: Urban Design Principles deal with higher level principles and issues including matters to consider in overall streetscape design that directly affect decision making about street trees.

Sections 5 and 6: The Biophysical Factors Affecting Green Infrastructure and Built Infrastructure Factors deal with issues affecting outcomes at the site scale, with a focus on either the living or built urban environment.

Section 7: The Street Tree Selection Process and Town Masterplans section outlines the process to be undertaken when choosing street trees within the towns outlined in this STMP. It provides information on what species to plant where on which street and strategies for selection in cases where species are not specifically identified to be planted on your street.

Section 8: This section features the Master Street Tree Species List or “Street Tree Matrix” which gives information on individual species and how they are categorised to fit within the TRC street types to help with species selection.

Section 9: This section provides a series of standard technical drawings to be used when planting and doing work around street trees. These will be updated from time to time as required.

3.5 Roles and Responsibilities of Stakeholders

3.5.1 TRC Responsibilities

TRC’s responsibilities in relation to implementation of the STMP include:

- Liaising with other agencies, developers and community to ensure the aims of the plan are taken into account with any new streetscape works
- For State controlled roads, liaising with DTMR as a key stakeholder
- Ensuring compliance with the STMP
- Monitoring of street tree strategies and tree health
- Identifying and undertaking street tree maintenance as required
- Responding to public enquiries regarding street trees
- Reviewing Property Clearance Requests which impact on adjacent street tree plantings
- Undertaking street tree planting programs as required
- Mow land that adjoin Council property such as parks and sporting fields and roadsides that are not kerbed and channelled

3.5.2 Role of the Community

The community plays an important role in the ongoing health and wellbeing of street trees. TRC encourages the community to participate in street tree planting programs. By maintaining street trees outside their residences the community can take great pride in fostering a community asset that all can enjoy now and for generations to come.

The community can help to achieve the vision for the STMP by:

- Maintaining roadside verges including caring for and watering street trees planted outside individual properties (Note: this is not encouraged on State controlled roads or TRC roads where community safety may be at risk due to exposure to high speed, high volume roads).
- Understanding the legal obligations regarding street trees i.e. it is illegal to interfere with, prune, damage or remove street trees without prior TRC approval.
- Care needs to be taken not to damage street trees by mowers and whipper-snippers, the long-term use of residual herbicides or by the use of mulch placed up against the trunk of the tree. Protect the mulched area with stakes.
- Trial not mowing close to mature trees, leaving an area of longer grass around the base of each tree. This area may be slashed twice a year to prevent excessive grass growth.
- Refer to Council publications and website on the proper care of trees.

3.5.3 Other Agencies Roles and Responsibilities

Other Agencies involved in consultation as part of the street tree masterplanning process include:

- Energy and telecommunications providers who need to inform TRC of any impact to street trees as part of their maintenance and installation works
- Department of Transport and Main Roads who need to liaise with TRC regarding upgrading and installation of transport networks under their control within the TRC area.

3.5.4 Provisos about the Masterplan

It is acknowledged that not every settlement in the TRC area is included and these will be subject to future recommendations by Council as the need arises.

Likewise not every street has specific species allocated to it. In these instances it is assumed that any species on the Street Tree Matrix in Section 8 that can be shown to be suitable for planting on that street when local conditions are taken into account is suitable. This is to encourage diversity of street tree species on streets that are not of higher order street hierarchy within settlements.

This document is a “living” document, it will be updated as required and the date and nature of these amendments are recorded on the inside front cover. It is recommended this document be reviewed every five years.
4. URBAN DESIGN PRINCIPLES

Urban Design “seeks to ensure that the design of buildings, places, spaces and networks that make up our towns and cities, work for all of us, both now and in the future”. (Ministry for the Environment, 2005). Urban design also “establishes the balance between natural ecosystems and the built environment” (Major Cities Unit, 2011). Therefore streetscapes and street trees have a fundamental role to play in how we move around and experience our towns and cities.

The Australian Government - Major Cities Unit’s Urban Design Protocol Places for People identifies the following urban design goals and principles:

Goals:

- Prosperity – enhances economic prosperity and living affordability
- Sustainability – fosters environmental responsibility
- Liveability – cultivates healthy and cohesive communities
- Leadership – demonstrates visionary leadership and strong governance
- Design – Integrates design processes and embraces design excellence.

Leadership and Governance Principles:

- Works within the strategic planning and physical context
- Considers the whole life cycle of a place and improves over time
- Fosters a culture of excellence, innovation and leadership in design and management
- Engages with relevant stakeholders.

Design Principles for People:

- Makes people feel comfortable and welcome in that place
- Creates places that are vibrant and where there are people around
- Makes people feel safe in that place
- Creates places that are enjoyable and easy to walk and cycle around.

Design Principles about Place:

- Creates places that are connected
- Offers a diversity of experiences to choose from
- Makes places that endure and are of quality
- Enhances the local economy, environment and community.

Street Tree Design, Planning and Management Addresses the Above Principles by:

- Providing visual cues for wayfinding and circulation patterns
- Celebrating town entries and key focal areas through feature tree planting
- Adding character to streetscapes through species selection, planting spacing and formal or informal planting layouts
- Emphasising the seasons with changing of leaf colour and flowers
- Reducing the urban heat island effect through shading hot pavements
- Helping to reduce wind speeds
- Reducing greenhouse gas emissions and assisting in air purification through capture of particles on their leaves
- Providing and improving habitat and human health
- Potentially reducing road infrastructure maintenance through shading of road surfaces thus lowering temperature fluctuations
- Giving a sense of safety to pedestrians when planted between road and footpath.

4.1 Streetscape Design and Street Trees

The over-arching factor affecting street tree health and vitality is lack of space provided for adequate tree growth within road reserves. The fundamental horticultural requirements for tree health are the same as those for trees in a forest environment. It is imperative they have sufficient room for root growth, access to aerated soils, water and healthy soil conditions to optimise their life span and provide the most long term benefits to our communities.

To provide for best practice outcomes and to achieve the urban design principles, designing for street trees needs to be considered at the planning stages of new streets. As living biological assets, tree space requirements increase over time and can be underestimated if not taken into consideration at the time of designing for urban growth. In long lived species, some trees may in fact outlast the design life of adjacent built infrastructure. However, it is generally accepted that the advantages of having trees in urban areas outweigh the disadvantages.

Strategies to maximise tree health and minimise disturbance to built infrastructure need to be considered for both existing and new streetscape environments.

Street trees make a significant contribution to a town’s streetscape character and amenity - Millmerran

Street trees can provide a visual and physical separation and sense of safety for active transport network users - Peregian Springs, QLD
4.1.1 Existing Streetscapes

Existing streetscapes in the TRC area are an amalgamation of the eight previous shire council area’s management regimes, with their differing standard road, tree design and service layouts. Dimensions of existing road reserves and their layouts provide a great challenge for management of existing street tree health due to:

- Increased pressure on existing street corridors to provide a higher level of amenity due to implementation of new planning strategies such as - The Active Transport Strategy (e.g. requirement for wider footpaths in limited road corridors)
- Increased urban densities resulting in reduced lot frontages and therefore reduced ability to retain and/or plant replacement street trees
- Pressure from development to remove large established trees which provide street and town amenity and character
- Changes to pruning envelope requirements on DTMR controlled roads
- Requirements outside Council’s control to accommodate more services and install additional built infrastructure in a fixed road corridor width
- Requirements to undertake tree work to maintain clear distances from services above and below ground
- Lack of budgets for maintenance
- Historic poor pruning practices resulting in reduced long term tree health in existing trees

Due to the variable conditions on existing streetscapes, solutions to accommodate existing trees and streetscapes need to be explored on a case by case basis. When designing for and working around existing trees the following requirements apply:

- All construction works around existing trees are to be carried out in accordance with the standard drawings herein Section 9 and should consider the current version Australian Standard AS4970 - Protection Of Trees On Development Sites.
- Where built infrastructure is being replaced near street trees, consider tree sensitive and more robust engineering solutions to accommodate the continued growth and health needs of the existing adjacent trees.
- Consult with TRC Landscape Architects to explore alternative solutions such as deviations from standard alignments e.g. of paths or services to accommodate existing trees, including potentially moving pathways across the street if practical to maintain existing significant street tree vegetation.
- Identify opportunities to underground power lines on key avenues to prevent ongoing pruning and potential loss of large ‘structural’ trees, using pipe boring techniques (tunneling), rather than trenching to avoid damage to existing tree roots. Trenching close to tree roots can lead to faster tree death.
- Refer to the tree avenue species selection required in the masterplans to supplement existing plantings with a long term view of eventual replacement of existing trees.

4.1.2 New Streetscapes

The Toowoomba Regional Planning Scheme aims to help achieve the urban design principles by providing wider road reserves and space allocation for street tree plantings than previously allowed. For more information refer to the:

- Schedule 4 - Planning Scheme Policy 2 Table 4.2.11 ‘Design Criteria Characteristics For Urban, Rural Residential and Industrial Street Tree Planting
- Toowoomba Regional Planning Scheme - Typical Cross Sections for Urban and Rural Roads - these indicate clear zones and planting widths for trees in different types of streets
- Standard TRC drawings supplied in Section 9 Technical Drawings and Standards, of this Masterplan

To help improve tree viability and to implement a consistent streetscape strategy, the Toowoomba Regional Planning Scheme and TRC STMP aims to:

- Wherever possible ensure a minimum of 2m x 2m ground space available for the sole purpose of tree planting and root growth, but do not set this as the default tree pit size; wherever possible, increase the amount of ground space available in either direction (e.g 2m x 4m out to or along the kerb) to provide a larger mulched area for optimum root growth and root expansion over time.
- Provide mechanisms to ensure trees in new residential streets are planted after development completion
- Encourage more robust engineering solutions (in consultation with Council engineers), around street tree plantings to minimise potential future damage infrastructure e.g. no cold joints (refer glossary) near street tree pits that act as future potential weak points.
- On State controlled roads, comply with DTMR clear zone, sight distance, setback and clearance requirements.
- Tree species appropriate for the streetscape conditions (e.g. under powerlines, those that will grow to a height no greater than 4m).
- Ensure protection for existing trees to be retained by applying the current version of Australian Standard AS4970 - Protection Of Trees On Development Sites and AS 4373 Pruning of Amenity Trees when undertaking new works around existing trees.
- Ensure all Council construction works and works by other service providers are carried out in accordance with the standard drawings herein.

4.1.3 Tree Removal and Value of Trees to the Wider Community

Incremental tree removal over time without replacement can lead to a long term loss of streetscape character and amenity and compromise urban design principles for the wider community. Where a development is likely to impact existing trees within the streetscape, it is recommended a qualified arborist be engaged to assess the health of the tree/s in question. The arborist’s report will then inform any decisions for design and/or potential removal of street trees.

When assessing trees for removal, consideration needs to be given to the:

- Age of the tree
- Health of the tree
- Replacement value
- Time it will take to grow a replacement tree to a semi-mature size/same size of that being removed

Prior to removal, the wider value of trees to the community needs to be calculated and not be limited to a simple cost for removal and replacement (often with smaller size). Studies have shown (Ely 2010) that the monetary value of street trees in terms of increased revenue due to tourism and amenity benefits are often underestimated.

Informal tree planting layouts allows for provision of trees that can compensate for inability to plant trees elsewhere in the street due to increased densities and other factors - Pittsworth (RPS 2011)

Large trees of significant cultural and natural value to the community can be preserved and accommodated - Adelaide (TRC 2011)
4.2 Water Sensitive Urban Design

Water sensitive urban design (WSUD) is an approach to the planning and design of urban environments that supports healthy ecosystems, lifestyles and livelihoods through smart management of all our waters. (www.waterbydesign.com.au, 2011)

The National Water Commission defines water sensitive urban design as ensuring “…that urban water management is sensitive to natural hydrological and ecological cycles. It integrates urban planning with the management, protection and conservation of the urban water cycle”.

The provision of guidelines for streetscape design and hence Water Sensitive Urban Design (WSUD) solutions are outside the scope of this document. However streetscape design and street tree masterplanning are unavoidably linked at all levels by design outcomes in the street both above and below ground.

This section aims only to ensure WSUD principles in street tree masterplanning are considered as part of the overall design solution and are investigated wherever possible. It is ideal to consider WSUD at the early planning stages of a project as space requirements and other factors can mean that it can be difficult to retrofit later. Refer Council’s Standard Road sections in Section 9 and consider stormwater requirements and opportunities.

With the likelihood of the TRC area being hotter and drier in future (USQ, 2010), by 2100 approximately half the rainfall than 2011 levels will be available to sustain street trees. It is therefore imperative that WSUD solutions be considered to help supplement other watering regimes when developing new streetscapes.

TRC also has requirements under the Queensland State Government’s Department Of Environment And Resource Management State Planning Policy for Healthy Waterways (2009) to comply with water quality management requirements for storm water runoff prior to discharge into waterways.

More information on these requirements and WSUD design solutions can be found on the Healthy Waterways website at http://www.healthywaterways.org/HealthyWaterways/Resources/Reports.aspx

WSUD solutions not only improve water quality, but can also be an effective way to provide “self watering” solutions for street trees in our urban centres. This can be achieved through the use of specialised tree pit details in town centres or for example small biopods along the stormwater catchment in residential areas. Water sensitive urban design solutions can be very cost effective compared to piping. WSUD solutions can help reduce costs to Council by naturally helping to supplement street tree watering requirements.

4.3 Crime Prevention Through Environmental Design

Crime Prevention Through Environmental Design (CPTED) principles need to be applied when designing in the public realm to ensure public personal safety is taken into account. This has particular relevance to species selection as vegetation can potentially impact sight lines. Consideration to maintaining a clear bole height (refer glossary) for trees and avoiding overuse of tall shrubby species will minimise vehicle/ pedestrian conflicts and opportunities for potential criminal activity.
5. BIOPHYSICAL FACTORS AFFECTING GREEN INFRASTRUCTURE

As living assets, Green Infrastructure, including street trees, is affected by local physical and climatic conditions. These conditions have a fundamental role to play in street tree selection. Local climate and soils vary across the TRC area and it is important to confirm species selections are suitable for the area. TRC’s preferred list of tree species contains information on tree habit and preferences; this information is outlined in the Street Tree Matrix in Section 8.

Observations of locally growing species in an area are also a good indication of the success of different species. It is advisable to obtain local knowledge where possible on local conditions as detailed mapping and other climatic information can be limited or difficult to source.

5.1 Local Soils

Soil types vary widely across the TRC area and even within townships. This can make it difficult to specify plantings according to a tolerance for certain soil types without highly detailed soil maps and local knowledge. Tree selection with a preference or tolerance for local site conditions is an important factor in determining the ongoing health and vitality of the trees.

The local soil types across the TRC area can be found on various soil maps of the area (refer to Appendices). They range from well-drained, red-brown loams in Toowoomba to deep cracking black clays to the west and south. The soils found within the TRC area fall into the following groups:

- Ferrosol - mostly neutral to slightly acidic - red
- Dermosol - red brown to black, mostly neutral to slightly alkaline
- Upland Vertosol - neutral to alkaline, heavy black cracking clays
- Alluvial Vertosol - neutral to alkaline, heavy black cracking clays
- Sodosol - acidic topsoil, alkaline subsoil; sandy loam over clay e.g. Oaky

(Prentice 2006)

More information about the physical characteristics of the above soil types is included in the Appendices.

There is no single soil map for the TRC area available in 2011. The soil maps available vary in scale and information for different regions within the TRC area. A list of these maps is in the Appendices.

5.2 TRC Area Climate

Climatic conditions vary widely across the TRC area. To illustrate this, the 30 year average (1971-2000) climate statistics from the Bureau of Meteorology (2011) for Oaky (located in the west of the TRC area) and Toowoomba (located in the east of the TRC area) are as follows:

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Oaky</th>
<th>Toowoomba</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean max summer temperature</td>
<td>30.3°C</td>
<td>27.6°C</td>
</tr>
<tr>
<td>Mean min winter temperature</td>
<td>3.5°C</td>
<td>17.0°C</td>
</tr>
<tr>
<td>Annual mean max temperature</td>
<td>30.8°C</td>
<td>22.7°C</td>
</tr>
<tr>
<td>Annual mean min temperature</td>
<td>2.8°C</td>
<td>12.0°C</td>
</tr>
<tr>
<td>Highest max summer temperature</td>
<td>41.8°C (Jan1994)</td>
<td>39.4°C (Jan1994)</td>
</tr>
<tr>
<td>Lowest min winter temperature</td>
<td>-7.5°C (Aug1982)</td>
<td>-2.3°C (July 1971)</td>
</tr>
<tr>
<td>Mean annual total no. of days above 35°C</td>
<td>9.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Mean annual total no. of days below 2°C</td>
<td>43</td>
<td>7.4 (frost days)</td>
</tr>
</tbody>
</table>

Rainfall

Wet season is from November to February
Dry season is from April to September

Mean annual rainfall | 636.5mm | 963.1mm

The 30-year average (1971-2000) data is the same baseline period used by the Queensland Government in developing regional climate change projections for the Eastern Downs region and therefore provides a useful comparison (Queensland Government in AECOM, 2010).

5.2.1 Toowoomba City

As illustrated above, due to Toowoomba City’s elevation, local climate data is not necessarily indicative of climatic conditions across the TRC area.

With an altitude of 675m above sea level, the climate of Toowoomba is warm temperate, characterised by cool dry winters and warm wet summers. Rainfall is variable across the city, with the western suburbs receiving markedly lower rainfall than suburbs along the escarpment. (TCC 2003)

Winds are largely from the east except during the months of July and August, when strong westerly and south westerly winds dominate.

5.2.2 Recent Climate Events

The TRC area has experienced severe drought conditions for a number of years. As at 18 May 2010, the TRC area was the only area still formally drought declared in Queensland, having originally been declared in October 2000 (Department of Employment, Economic Development and Innovation, in AECOM 2010). The lower plainlands to the west of the region are often subject to inundation and flooding.

The drought has lead to severe water shortages in Toowoomba. The response to the drought had severe implications for TRC’s street tree planting regimes and maintenance. Tree planting programs were halted and any tree watering regimes ceased. In many areas, trees were only planted on request for residents who were interested in their establishment and maintenance, which is not conducive to achieving an overall consistent outcome across the TRC area.

5.2.4 Bushfire Risk

As illustrated above, due to Toowoomba City’s elevation, local climate data is not necessarily indicative of climatic conditions across the TRC area.

In the townships to the north east of the region, there is likely to be an increased risk of bushfires due to the existing vegetation profile, slope and aspect of the area (RPS 2010).

Generally speaking, downhill movement on hillytops and ridges discourages frost settlement and plants less tolerant of frost are able to be planted in these locations. Flat lowland areas and creek margins can receive quite severe frosts of minus 6 to minus 10 degrees Celsius which can occur from as early as mid April and as late as October. Trees in these areas may need protection when young as part of planting maintenance regimes until they are well enough established which will be location dependent. (Prentice 2006).

TRC’s Bushfire Management Plan needs to be taken into account (in terms of siting, design and species selection) when planning street trees in this region.
5.3 Climate Change and Street Trees

5.3.1 Future climate

There are a number of factors affecting street trees which have been identified in the climate modelling report undertaken for the TRC area which are listed below (USQ 2010). These predicted changes potentially have a large impact on street tree health and vitality, as well as implications for disease and pest control.

Temperature

Substantial increases in mean monthly temperatures, averaged across a season can be anticipated from 2070 onwards. Most models depict a +0.7°C to +2.0°C increase depending on the month but with a tendency for highest increases in late winter (USQ, 2010).

Extreme Temperature

In addition to higher temperatures on average, it is likely that there will be a significant increase in the number of days per year above 35°C during summer, especially towards the latter part of the century (USQ, 2010).

Solar Radiation

Increases in solar radiation will mainly occur during autumn and winter with little or decreased solar radiation in summer, possibly associated with precipitation changes in those periods (USQ, 2010).

Humidity

The relative humidity is projected to decrease within the TRC area during most months with the exception of December and January where a small increase is more likely (USQ, 2010).

Wind speed

Generally, mean wind speeds are expected to decrease, especially in autumn/winter however; increase in spring/early summer (possibly associated with changes to convective activity) are likely (USQ, 2010).

Frost and Growing Days

A slight decrease in the number of growing days is projected during autumn and spring however; the winter months are expected to have a significant increase in days above 15°C. As the temperatures increase, the number of frosts is also expected to decrease as the frost season shortens (USQ, 2010).

Rainfall

The overall rainfall trend is towards lower annual rainfalls with precipitation predicted to drop from 1004mm to 673mm by 2100. Mixed outcomes are depicted for ‘summer’ rainfall; however three out of five models depict an increase, especially for the period 2040- 2069. For late autumn through winter and mid spring, most models depict a major decrease (10% to 60% decrease depending on month) (USQ, 2010).

5.3.2 Potential Impact of Climate Change Issues on Street Trees

The following information is derived from the Tarran report 2011, a full version of which can be found in the Appendices.

A street tree planted in 2011 will potentially be part of TRC’s street tree population in 2099, with an age of eighty eight. It will be expected to cope with a rainfall that is only 673mm (rather than the 1004mm of today), with mean temperatures that are 21°C (rather than 17°C), and with more than 6 days over 35°C in each of January and February, when there is currently about one such day in each of those months. The implications of these changing climatic conditions on species selection need to be considered in order to maintain resilience in the regions’ street trees. The loss of benefits (value) from their deaths, combined with removal and replacement costs, plus time lost waiting for the replacements to grow to full value, represents a major, if not catastrophic consequence.

Many of the current street tree species selections could survive climate change projections in the areas where they currently occur; during the expected life-spans of these trees, provided the trees are not already at the extremes of their environmental tolerances. However, as replacement and new tree planting opportunities occur; best practice recommends to use species that may be better suited to the projected, new climate, on a trial basis. Some Urban Forest Management Plans have suggested that 5% of municipal plantings be “experimental” species (McPherson 1998, referring to a plan from 1992), to evaluate potential additional tree species for species lists. This recommendation was made before the challenges of climate change were fully recognised and is even more important now.

Trees can be adaptable to conditions beyond their preferred ranges although tree species growing in urban areas may have different physiology and morphology from the same tree species in natural forests (McCarthy & Pataki 2010), so a preferred natural environmental range may underestimate an acceptable urban environmental range.

Particular species that demonstrate resilience to a range of conditions should be considered for planting in an area that is expected to experience a changed climate in the future. For example the TRC area in expected to become hotter and drier so species that are known to adapt to those conditions should be selected. (Tarran 2011)
5.4 Tree Replacement

There are many trees in the TRC towns which are reaching maturity and a replacement strategy for these trees is required over the next 50 years.

5.4.1 Iconic Avenues

Toowoomba’s Camphor Laurels (Cinnamomum camphora) have helped to define the city’s heritage areas and contribute to the current green leafy character of the city. The Camphor laurel size has also contributed to the iconic and much loved ‘tunnels of green’ around the city, despite there being other issues with ongoing maintenance due to size of the maturing trunks and pruning around overhead powerlines. With the declaration of Camphor laurels as weeds, it is recommended an alternative species be used.

Likewise in the other towns in the TRC area there are some large tree specimens which contribute greatly to the character of the towns. Their preservation or replacement needs consideration when undertaking future road works as communities grow and traffic requirements change.

5.4.2 Replacement Guidelines

The following criteria need to be applied to the decision making process during tree replacement:

• If the trees are actively causing problems (such as lifting road surfaces or becoming an environmental nuisance) replacement becomes a priority and needs to take place on a block by block or street by street basis
• If the trees requiring replacement have a strong heritage or community value then replacement will need to be made incrementally so that any negative impacts on the community are minimised
• If the tree replacement is aimed at consolidating avenues then any gaps should be targeted using trees as specified in the relevant masterplan (refer section 7)
• Replacement trees need to be of a similar character and form to the specimens being replaced to maintain consistency in the streetscape (refer to section 5.5.3 for replacement of large trees)
• Space requirements of the adjacent land uses need to be allowed for (eg awnings on shopfronts impeding tree crown space; industrial sites requiring larger setbacks from driveways to allow for truck movement etc)
• Road ownership needs to be considered as it will dictate planting setbacks and maintenance regimes
• Existing site conditions such as current road and parking widths as well as kerbing alignments need to be sufficient to sustain healthy growth of the trees

5.4.3 Replacement Species List

Also refer to Section 7- Street Tree Masterplans for suggested Camphor laurel replacements on specific streets.

Generally, appropriate replacements for large spreading shady street trees include:

- Magnolia grandiflora – Bull Bay magnolia
- Calodendron capense – Cape chestnut
- Findelia collina – Leopard ash
- Platanus × acerifolia – smaller hybrids – London plane tree
- Platanus occidentalis ‘Autumn Glory’ - Sycamore

During replacement other measures will need to be undertaken to minimise ongoing maintenance to built infrastructure. For example:

• The provision of sufficient planting space
• Reinforcing pavements and kerbs where necessary,
• Installing tree trenching (such as can be seen in Adelaide St., Brisbane, allowing growth of large tree avenue)
• Underground structural solutions allowing healthy tree growth, such as use of structural soil in trenches or pits, modular soil cell systems, water harvesting and WSUD applied to tree pit design and potentially undergrounding of powerlines.

5.5 Connections to other Vegetation

5.5.1 Rural Vegetation Connections

The rural nature of the TRC area results in the occurrence of large tracts of vegetation at the fringes of the urban footprint and in some cases well into town boundaries. These tracts of remnant vegetation form part of the character and experience when journeying through the TRC area and help provide a sense of transition from town to country landscapes. They are also reflective of the different historical settlement patterns across the TRC area.

These vegetated linking elements and transitions into urbanised areas are important to the iconic character of the TRC area and provide both scenic amenity and wildlife habitat.

The TRC 2050 Placemaking maps were reviewed as part of this project. It is clear that if these remnant corridors are to be maintained in future with urban expansion, planning provisions will need to be made to allow them to be retained, in discussion with DTMR which controls the road corridor.

Preserving locally native (indigenous) trees in bushland and forest remnants adds to the sustainability of the urban forest overall. Tree planting using locally native stock (local provenance) and/or from stock in other areas (e.g. hotter and drier areas, as discussed previously), may be undertaken along streets and other corridors to connect remnants and provide wildlife corridors.

Equally significant, however, is the possibility that current non-invasive ornamental urban tree species could become invasive if the climate changes in their favour. In addition urban areas could facilitate non-native tree invasion beyond that which is currently experienced. Due to projected climate change, it has been suggested that, in some cases, native tree species in urban forests, including as street trees, may serve as a seed source and refuge to facilitate latitudinal tree migration (towards the poles) (Woodall et al. 2010 in Tarran 2011).

For vegetation management requirements near urbanised areas, refer TRC’s Bushfire Management Plan and the Department of Environment and Resource Management.

5.5.2 Parkland Vegetation Connections

Site context and conditions need to be considered when the streetscape interfaces with a parkland. Cohesion as well as visual and physical access across the boundary are important considerations for a successful design. In some cases, formalised street tree planting may not be required along park boundaries, depending on the local conditions and existing vegetation in the parkland to be retained.
6. BUILT INFRASTRUCTURE FACTORS

6.1 Road Transport Networks - Hierarchy, Roles and Responsibilities

The towns and city within the TRC area have important links with inland southeast Queensland and northern New South Wales. Toowoomba city is also the junction of three main Highway systems - the Warrego Highway, New England Highway and Gore Highway.

Roads in Toowoomba and the regional towns are under the jurisdiction of two authorities. The Queensland (DTMR) is responsible for declared roads’ (National or State Highways), and TRC is responsible for all other roads in the local government area.

The road hierarchy in the TRC area is divided into four broad categories, namely:

- Arterial Roads: metropolitan or regional roads
- Sub-arterial Roads: Roads / Street to circulate traffic between regionally significant activities (airport, base hospital, USQ)
- Distributor / Collector: Collects local traffic to move through a district using a distributor.
- Local access (Urban, Industrial and Rural)

Although there is a hierarchy of roads in the TRC area, large vehicles are not restricted to the arterial or sub-arterial roads. All types of roads throughout Toowoomba are variable in width, length and configuration and have street trees planted at different distances from the kerb line and also vary considerably in traffic use and type. This not only presents issues for transport management but also for street trees.

DTMR roads also have specific requirements for vegetation planting and management in line with their focus on road safety. These requirements dictate clear zones dependent on road design speeds, frangible vegetation and large pruning requirements. These have the potential to negatively affect streetscape character and amenity where the main commercial street is also a designated highway.

For requirements for new TRC controlled road works refer the TRC Regional Road Standards Drawings typical cross sections which outline tree planting clear zone requirements and distances from other road and services infrastructure.

6.2 Existing Streets versus New Streets

6.2.1 Existing Streets

Throughout the TRC area, the existing streetscape environment provides the greatest challenge in terms of maintenance and management. This is largely due to the variety of applications of planning requirements and standard service alignments. When considering built infrastructure impacts with regard to street tree planting, proposals need to be reviewed on a case by case basis with the overall masterplan in mind to ensure consistency of application across the TRC area.

Further information is also provided in the Urban Design Principles section of this STMP.

6.2.2 New Streets

New streets provide improved opportunities to minimise the potential conflicts between built and green infrastructure. Coordinating across engineering, landscape and services can allow for long term tree health and therefore leaving room for future growth of trunks and roots with minimum impact to built infrastructure.

The design life of built infrastructure needs to be considered when designing for new streets as many street trees may have a ‘design life’ of 80-100 years or more. This is significant because most infrastructure elements would be expected to have a much shorter design life than the life span of a street tree, and therefore upgrades and realignments are likely to take place around the tree.

6.3 Active Transport Alignment Opportunities

When shared paths are installed in existing streetscapes, consideration needs to be taken with the proposed alignment so that existing advanced trees are retained in streetscapes to provide amenity for new path users.

It is recommended consultation be undertaken with TRC Landscape Architects to discuss options and opportunities to minimise impacts to existing street tree plantings.

Work around existing trees during construction of the active transport corridors will need to consider AS 4970-2009 Protection of Trees on Development Sites and the technical drawings in Section 9.

New streetscapes should be designed to ensure a minimum of 2m width is provided for street tree planting, particularly where pathways are to be located so as to be able to be shaded by trees. If necessary, offset road pavements should be considered, along with offset shared pathway alignments to allow sufficient tree planting space between back of kerb and pathway.
6.4 Services

6.4.1 Service Networks

Road reserves are the main corridors for service networks. They accommodate electricity, telecommunications, water, sewerage and gas lines. However, historically these services have not coordinated, and conflicts between street trees and services occur.

6.4.2 Overhead Services

Overhead power lines are a significant problem in most areas, with compulsory undergrounding of electricity only a requirement imposed by TRC since 1991. Overhead power lines can restrict the development of uniform avenues, may require the planting of different species on either side of the street, and increase the need for maintenance pruning where larger trees exist under the power lines.

Aerial bundled cabling has been installed in some areas of Toowoomba City, aimed at reducing the extent of pruning required. However, pruning practices based on the clearance widths plus a significant width for regrowth has still resulted in holes in the canopies of street trees of about 4m. If the clearance area only was pruned, the hole around the cables only needs to be 600mm wide, but would require more regular pruning. These issues are still subject to ongoing discussions between the service providers and TRC.

6.4.3 Trees under Powerlines

Trees appropriate for planting under powerlines have been listed in the Master Street Trees List in Section 9.

Trees safe to grow directly under powerlines need to be smaller than 4m tall at maturity. The use of shrubs in lieu of street trees is discouraged for both aesthetic, vehicular sight line and CPTED reasons. The species shown with a "P" in the TRC height Category lists in the Master Street Tree Species lists in Section 8 have been proposed after collaboration with Energex, Ergon Greening Australia and TRC as being suitable for planting within the TRC area.

Plants have different frost; drought and soil pH tolerances that need to be taken into account in order to determine that the plant is suitable to the site's growing conditions prior to installation (refer to the Master Street Trees List in Section 8 for guidance).

6.5 Vehicle Clearance Requirements – Pruning Envelopes

Large vehicles require trees to be pruned to a height clearance of 4.8m (TCC 2003). DTMR 2011 standards require clearance to traffic lights of 5.4 metres. Where trees are not pruned to appropriate clearance heights and are struck, damage to the tree can be considerable and place the long-term health of the tree at risk. It is likely to be costly and detrimental to the aesthetic value of the streetscape to prune all trees to 4.8m. There may be some opportunity to introduce some flexibility on collector and local roads as required.

On DTMR controlled roads, where the speed limit is 60km/hour it is suggested that the pruning height is 4.8m above carriageways and 4.2m above designated parking lanes (TCC 2003). Where the speed limit is 50km/hour, a more flexible arrangement could be implemented by maintaining a minimum 5m wide pruning envelope of 4.8m depending on individual road circumstances. The pruning of street trees on 50km/hour roads could also be based on a reactive rather than proactive process; i.e. street trees are pruned to the minimum 6m wide envelope with further pruning initiated by requests or complaints.

For walkways, bikeways and nature strips it is suggested that a pruned height of 2.5m is maintained for head clearance, sightlines and safety (TCC 2003). Where trees are located close to intersections pruning to maintain visibility/clearance needs to be carried out on a case-by-case basis as required.

6.6 Works Close to Existing Trees

In developed areas there may be difficulty installing new infrastructure and services adjacent to existing established and/or semi-mature street trees. Trenching in road verges often contributes to the decline and the instability of existing street trees when roots are severed in the process. Refer technical drawings in Section 9 for required standards for working around existing trees.
6.7 Strategies to Avoid Damage to Footpaths and Services

The design life of built infrastructure needs to be considered when designing streets as many street trees have a ‘design life’ of 80-100 years or more. Factors which may minimise the conflict between built and green infrastructure in streetscape includes:

- Design of sufficient size street tree pits – if 2m x 2m is not possible, then narrow width pits should be lengthened to provide a similar volume of soil for healthy root growth eg. 1.5m x 3m or 1m x 4m bearing in mind the narrower dimension still needs to be accommodate the expected mature trunk size
- Specification of the right tree species in the right place including consideration of the different clear zones and space for growth provided in different standard street types
- Bunching of services where possible to minimise pruning and maintenance requirements
- Ensure new service alignments as per the Toowoomba Regional Planning Scheme are installed as per the design requirements so as to ensure sufficient room for tree growth without conflict
- Avoid species with invasive roots or provide measures to control root growth such as root barriers where required
- Increasing engineering requirements for pavements and kerbs near large species where required e.g. avoid concrete cold joints (refer glossary) near tree pits to minimise potential future cracking along “weak points”
- Consider realignment of desired active transport paths to take into account the value of existing trees
- In new streets, consider offsetting standard alignments of wide active transport paths, and possibly the road, to allow sufficient room to plant street trees in locations where they can provide the most benefit e.g. to provide shade on the north side of active transport paths.

Conflicts between green and built infrastructure can be avoided if tree size is allowed for at the design stage - Toowoomba (RPS 2011)
7. STREET TREE SELECTION PROCESS AND TOWN MASTERPLANS

This section outlines

- The process to be undertaken when planting trees on individual streets
- Which street trees are to be planted on key avenues in the towns within the TRC area

Each town masterplan outlines the broad context contributing to the townscape character and provides information on existing species occurring within the town (in 2011), whether they be in the street or adjacent areas. The purpose of this is to provide a snapshot of local information on what species are growing in which towns, and the local conditions.

7.1 Street Tree Selection Process

The diagram at right outlines the private development process to be undertaken when trying to determine which tree should be planted where within the Toowoomba Regional Council area.

7.2 Street Tree Selection Criteria

Tree selection is based on a number of criteria, but of primary importance is a species’ suitability to individual street conditions. Other considerations include:

- Amenity
- Character
- Shade
- Biodiversity
- Maintenance requirements
- Seasonal interest
- Planting constraints imposed by built infrastructure
- An adaptability to a range of climates to improve likelihood of resilience to climate change
- Species that can withstand periods of drought once established
- Species that can withstand periods of low humidity with hot drying winds
- Species that can withstand moderate frosts
- Species with non-invasive root systems to reduce demand on the maintenance budgets.
- If the street/road is controlled by TRC or is State controlled

The fabric of the existing established urban forest needs to be taken into account when selecting new street tree plantings. For example, the suggested street tree plantings on the Toowoomba masterplan map have generally been selected based on the existing tree species occurring on particular streets as a base. Many of the avenues and streets have a wide variety of established species occurring along their length with little consistency or regard to streetscape hierarchy or formal avenue plantings. The species shown on the maps are not intended as a short term replacement strategy, but as long term guidance for creating future consistency along these streets when trees are required to be removed or replaced.

Street trees are living and growing assets that take time to reach maturity and offer increasing value (benefits) over time until they decline and die. A street tree may take 30-50 years to reach maturity and have a lifespan of 100-150 years, depending on species, environment and other factors. In Australia, we are experiencing a decline of some of our early grand avenue plantings. It is likely that lifespans will reduce with a drier and hotter environment, as projected with climate change. (Tarran 2011)

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<table>
<thead>
<tr>
<th>Street Tree Selection Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>I want to plant a new street tree as part of my development</td>
</tr>
<tr>
<td>is the road a State (DTMR) controlled road?</td>
</tr>
<tr>
<td>yes</td>
</tr>
<tr>
<td>no</td>
</tr>
<tr>
<td>consult DTMR requirements ie Road Landscape Manual and Austroads Guide to Road Design Parts 6 and 6B</td>
</tr>
<tr>
<td>is the street in one of the towns listed in section 7 of the STMP?</td>
</tr>
<tr>
<td>yes</td>
</tr>
<tr>
<td>no</td>
</tr>
<tr>
<td>does the street have street trees allocated to it on the masterplan for the town?</td>
</tr>
<tr>
<td>yes</td>
</tr>
<tr>
<td>no</td>
</tr>
<tr>
<td>check local conditions (eg. possible powerlines overhead etc.) to ensure they support planting of nominated species;</td>
</tr>
<tr>
<td>specify plant species according to masterplan</td>
</tr>
<tr>
<td>determine local conditions eg. soil type, frost, powerlines overhead etc.</td>
</tr>
<tr>
<td>consult street tree matrix in Section 8 of the STMP to confirm best species for local conditions</td>
</tr>
<tr>
<td>propose species to TRC for approval</td>
</tr>
<tr>
<td>plant approved species</td>
</tr>
<tr>
<td>refer to street tree matrix in Section 8 of STMP and if State controlled road to DTMR requirements</td>
</tr>
<tr>
<td>propose street tree species to TRC for approval</td>
</tr>
<tr>
<td>plant approved species</td>
</tr>
</tbody>
</table>
7.2.1 Local Conditions

Recommendations have been made for tree species for the key streets and avenues within each town. Generally, where two or more species have been recommended for one street or avenue, this is to provide a lower growing species for planting under wires and a taller species where no wires are present on the opposite side of the street/avenue. In some case two or more species may be recommended to provide alternative choices. Other tree species can be selected from the Master Tree Species List (Section 8) to plant in the remainder of each town once site conditions have been taken into account. The species which occur on other land uses have been noted as a guide for what grows well in that township.

7.2.2 Existing Species Occurrence

The Existing Street Tree Species lists are based on preliminary field investigations undertaken in March 2011 and are not necessarily indicative of all species occurring in the towns. Some towns had very little or no deliberate street tree plantings. Many towns have a dominance of one or two species, particularly Callistemon spp, Jacaranda mimosifolia, Grevillea robusta and a variety of Eucalypts, many of Western Australian origin.

7.2.3 Existing Soil Conditions

Soil types are based on broad scale mapping and are intended as a guide only. Local soil conditions may vary within towns. Refer Appendices for a list of the available soil maps for the TRC region.

7.2.4 Species Recommendations

Recommendations for selection of trees in each town were based on a combination of factors including:

- Observations of tree species already growing successfully in the town
- The prevalence of that species
- Which species are growing in other places outside the streetscape and appear to be healthy
- Selecting species that will provide a variety of types of canopy cover and structure, as well as differing landscape character to assist in creating a hierarchy of streets within towns,
- Improvement of the town centre amenity and shade
- Cognisance that those species currently occurring are likely to grow well there in short to medium term future and that these species should be used elsewhere in town if appropriate
- Review of which species currently have a broad geographical distribution and are therefore most likely to adapt to climate change
- Review with TRC officers of which species have performed well over time and those that have maintenance issues

The recent outbreak of Myrtle Rust disease has the potential to affect all Myrtaceae plantings in current and future streetscapes including Eucalyptus, Callistemon, Melaleuca, Syzygium, Acmena, Backhousia, Waterhousea and Xanthostemon species. New strategies for disease control may be required in future. It is recommended to plant a diversity of tree families, genera and species to minimise impacts of disease upon a single family or genus. This approach also improves the general biodiversity of the urban forest.

Notes:

* Field investigations were undertaken in March 2011 after an extremely wet summer following approximately 10 years of drought, therefore observations of apparent tree health may not be truly indicative of how well specific species are surviving in the long term.

** It was observed that many towns have a limited number of trees in their “Main Street” and very few of these trees are of any substantial structure to provide shade and amenity for the towns. With this in mind a concerted effort has been made to provide for larger shade tree species along major thoroughfares and main street locations.

7.3 Key Plan - Toowoomba Regional Council Area : Town Masterplan Locations
7.4 Bowenville

Bowenville is a small township with a population of approximately 126 located off the Warrego Highway, 56km northwest of Toowoomba. The town was based around the rail industry and is framed by the railway system. It is surrounded by good quality agricultural land. The main street, Bowenville Moola Road serves as a heavy vehicle through route servicing intensive animal industries in the area.

Soils and Geology: Vary from shallow stony clays to moderately deep self mulching clays. Alluvium, Minor basalt, Mudstone and Siltstone soil types are also present. The pH is slightly acidic.

Local Issues: Moderate to high frequency frosts.

Existing Street Tree Species:
- Allocasuarina spp. black sheoak
- Brachychiton spp. Illawarra flame tree
- Callistemon viminalis bottlebrush red flower
- Eucalyptus decorticata ironbark
- Eucalyptus exserta Queensland peppermint

Existing Trees Occurring On Other Land Uses:
- Acacia pendula weeping acacia
- Callistemon viminalis bottlebrush red flower
- Casuarina glauca swamp sheoak
- Tipuana tipu pride of Bolivia (racehorse tree) (weed)

Proposed Street Tree Species:
- Backhousia citriodora lemon myrtle
- Brachychiton populneus black kurrajong tree
- Callistemon viminalis bottlebrush red flower
- Eucalyptus racemosa scribbly gum
- Lagerstroemia indica crepe myrtle

7.5 Brookstead

Brookstead is located between Pittsworth and Millmerran on the Gore Highway with a population of approximately 288.

Soils and Geology: The soil type within Brookstead is predominately black with a neutral pH level. Very deep grey cracking clays can also be found.

Existing Street Tree Species:
- Eucalyptus spp.

Proposed Street Tree Species:
- Backhousia citriodora lemon myrtle
- Brachychiton populneus black kurrajong tree
- Callistemon viminalis bottlebrush red flower
- Eucalyptus racemosa ironbark
- Lagerstroemia indica crepe myrtle
7.6 Cabarlah
Cabarlah is a locality approximately 15 km north of the Toowoomba city centre. It is situated on the Great Divide with views to the east of the Lockyer Valley through to Brisbane and to the west across the Darling Downs. Traditionally the area has been used for farming, however in recent years the expansion of the TRC has led to acreage and other residential development. It has a population of approximately 860.

Soils and Geology: The soil types vary from deep red clay to deep red loam soils. As you move off the ridges the soils become more of a stony basalt, grey brown self mulching clays.

Local Issues: There is no sense of entry and exit to the town. Large remnant bushland on road reserves is characteristic throughout the settlement. Urban structures split by considerable distance along the highway and there is no sense of town extent. The residential areas hidden off the main highway and don’t form part of a cohesive settlement. There are no formal street tree plantings in the residential areas. However, there are some Callistemon species planted on one side of the New England Highway.

Existing Street Tree Species:
Callistemon viminalis  weeping bottlebrush
Pinus sp. (to edges of Highway)

Proposed Street Tree Species:

7.7 Cambooya
Cambooya, a rural town of approximately 850 people, is 20 km south-west of Toowoomba. Grain silos dominate the townscape.

Soils and Geology: Soil types are generally very deep, dark, cracking clays. However, in the south lighter textured alluvial soils can be found.

Existing Street Tree Species:
Araucaria cunninghamii  Moreton Bay pine (hoop pine)
Corymbia torelliana  cadagi tree
Dodonaea  hop bush
Eucalyptus citriodora  lemon scented gum
Eucalyptus decorticans  ironbark
Eucalyptus exserta  Queensland peppermint
Eucalyptus melanophloia  silver leaved iron bark
Eucalyptus tereticornis  forest red gum
Ulmus parvifolia  Chinese elm

Trees Occurring in Gardens/Parks:
Acacia pendula  weeping acacia
Callistemon viminalis  bottlebrush red flower
Casuarina glauca  swamp sheoak
Tipuana tipu  pride of Bolivia (racehorse tree)
Xanthostemon chrysanthus  golden penda

Proposed Street Tree Species:

All Other Streets: Buckinghamia celasima  ivory curl tree
Magnolia Little Gem  little gem
Tristaniopsis laurina  kanooka or water gum

For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.8 Cecil Plains

Cecil Plains is a township with a population of approximately 240 on the banks of the Condamine River. It is located in an agricultural and timber producing area of the Darling Downs and is home to one of the largest cotton gins in the southern hemisphere. Cecil Plains lies 45 km to the north of Millmerran, 45 km to the south of Dalby and 84 km to the west of Toowoomba.

Soils and Geology: Fertile black soil - predominately mixed alluvial clay soils. Mainly very deep, dark, cracking clays with some duplex soils on the low banks and rises.

Existing Street Tree Species:
- Acacia podalyriifolia
- Allocasuarina littoralis
- Eucalyptus extensa
- Eucalyptus tesselaris
- Schinus terebinthifolius
- Tagasaste
- Ulmus parvifolia

Trees Occurring in Gardens/Parks:
- Callistemon salignus
- Callistemon viminalis
- Callitris glaucophylla
- Grevillea robusta
- Lagerstroemia indica

Proposed Street Tree Species:
- Callistemon viminalis
- Callitris glaucophylla
- Grevillea robusta
- Lagerstroemia indica
- Ulmus parvifolia

7.9 Clifton

The town of Clifton has a population of approximately 1,255. It is located 49km south of Toowoomba on the New England Highway. Clifton was once a large wheat growing area. It now has a diverse range of agriculture including cattle, cereal crops, sunflowers, peanuts, and honey production.

Soils and Geology: Soil types are generally very deep, dark, cracking clays and alluvial soils.

Existing Street Tree Species:
- Acer ‘October Glory’
- Brachychiton acerifolius
- Cinnamomum camphora
- Dodonea
- Fraxinus griffithii
- Melaleuca linariifolia
- Tamarix aphylla
- Ulmus parvifolia

Trees Occurring in Gardens/Parks:
- Callistemon salignus
- Callistemon viminalis
- Callitris glaucophylla
- Grevillea robusta
- Lagerstroemia indica
- Ulmus parvifolia

Proposed Street Tree Species:
- Callistemon viminalis
- Callitris glaucophylla
- Grevillea robusta
- Lagerstroemia indica
- Ulmus parvifolia

All Other Streets:
- bottlebrush red flower
- snow in summer
- black kurrajong tree
- ironbark
- ghost gum

Trees Occurring in Gardens/Parks:
- Acer sp.
- Araucaria bidwillii
- Brachychiton rupestris
- Callistemon salignus
- Callistemon viminalis
- Casuarina glauca
- Jacaranda mimosifolia

Trees Occurring in Gardens/Parks:
- Acer sp.
- Araucaria bidwillii
- Brachychiton rupestris
- Callistemon salignus
- Callistemon viminalis
- Casuarina glauca
- Jacaranda mimosifolia

Legend - Street Trees For Key Avenues
1. Jacaranda mimosifolia, Acer ‘October Glory’
2. Brachychiton populneus, Lagerstroemia indica
3. Grevillea robusta, Acer buergerianum

Legend - Street Trees For Key Avenues
1. Acer ‘October glory’, Calodendron capense
2. Callistemon viminalis
3. Calodendron capense, Lophostemon confertus

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.10 Cooyar

Cooyar is a small town in the Cooyar River valley located north of Toowoomba on the New England Highway. The town has a population of approximately 290.

Soils and Geology: Soil types include loamy or sandy lithosols on scarps and hill tops with moderately deep, duplex soils on the lower slopes.

Existing Street Tree Species:
Mixed Eucalyptus
Eucalyptus torelliana cadaghi
Eucalyptus Casuarinas
Syagrus romanzoffiana cocos palm
Nerium oleander oleander

Trees Occurring in Gardens/Parks:
Callistemon salignus willow bottlebrush
Callistemon viminalis bottlebrush red flower
Grevillea robusta silky oak

Proposed Street Tree Species:

7.11 Crows Nest

Crows Nest is a country town located 44kms north-east of Toowoomba on the New England Highway with a population of approximately 1,571. Although located in the region defined as the Darling Downs, the Crows Nest area is hilly country, situated in the Great Dividing Range on the eastern edge of the Downs.

Soils and Geology: Soils vary from shallow, stony, brown, grey brown or grey, to moderately deep, grey or grey brown self mulching clays.

Local Issues: There is a dominance of Callistemon species and long avenues of them can be found on the New England Highway. However, there is a lack of street tree planting on the main street except around park. As a result there is a lack of entry experience to town.

Existing Street Tree Species:
Acer sp. maple
Banksia sp. banksia
Brachychiton sp. Illawarra flame tree
Cinnamomum camphora camphor laurel
Cupaniopsis anacardioides tuckeroo
Flindersia australis crows Ash
Fraxinus x oxyacarpa ‘Raywoodii’ claret Ash
Melaleuca linariifolia snow in summer
Platana occidentals plane tree
Pyrus sp. pear
Stenocarpus sinuatus fire wheel

Trees Occurring in Gardens/Parks:
Araucaria bidwilli bunya pine
Brachychiton rupestris bottle tree
Callistemon salignus willow bottlebrush
Callistemon viminalis bottlebrush red flower
Fraxinus americana American white ash
Grevillea robusta silky oak
Jacaranda mimosa/fuli jackson

Proposed Street Tree Species:

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.12 Goombungee

Goombungee, with a population of approximately 772, is located 35kms north of Toowoomba with beef cattle, dairying, pigs, grains and forestry the dominant primary industries surrounding the town. It is situated in the eastern Darling Downs, approaching the hilly dividing range and the headwaters of Oakey Creek. Much of the original vegetation was ironbark forest and brigalow scrub.

Soils and Geology: Soil types are loamy or sandy lithosols on scarps and hill tops with moderately deep, duplex soils on the lower slopes.

Existing Street Tree Species:
- Eucalyptus decoricans - ironbark
- Eucalyptus populnea - poplar box
- Melaleuca linariifolia - snow in summer
- Salix babylonica - Babylon willow

Trees Occurring in Gardens/Parks:
- Brachychiton rupestris - bottle tree
- Callistemon viminalis - bottlebrush red flower
- Corymbia maculata - spotted gum
- Grevillea robusta - silky oak
- Jacaranda mimosifolia - jacaranda
- Lagerstroemia indica - crepe myrtle
- Xanthostemon chrysanthus - golden penda

Proposed Street Tree Species:

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.

7.13 Gowrie Junction

Gowrie Junction is a town and locality located just five minutes drive west from Toowoomba’s city outskirts, just off the Warrego Highway. This country community lies amongst the rolling hills which border the open cropping plains of the Darling Downs. It contains a small shop, a school and a community hall and has a population of approximately 1218.

Soils and Geology: Soils vary from shallow, stony, brown, grey brown or grey, to moderately deep, grey or grey brown self mulching clays.

Existing Street Tree Species:
- Allocasuarina luehmannii - bull oak
- Eucalyptus decoricans - ironbark
- Melaleuca linariifolia - snow in summer
- Eucalyptus spp.

Trees Occurring in Gardens/Parks:
- Acacia pendula - weeping acacia
- Caesalpinia ferrea - leopard tree
- Grevillea robusta - silky oak
- Jacaranda mimosifolia - jacaranda
- Melaleuca quinquenervia - broad leaf tea tree
- Tipuana tipu - pride of Bolivia (racehorse tree)
- Xanthostemon chrysanthus - golden penda

Proposed Street Tree Species:

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.14 Greenmount

The township of Greenmount is located 28kms south of Toowoomba on the New England Highway with a population of approximately 379. It is surrounded by barley, horticulture or vegetables, sunflower, wheat and dairy and beef cattle farming.

Soils and Geology: Soil types are generally very deep, dark, cracking clay types.

Existing Street Tree Species:
- Brachychiton acerifolius
- Brachychiton populneus
- Cinnamomum camphora
- Dodonaea
- Eucalyptus decoricans
- Eucalyptus exserta
- Ficus
- Melia azedarach
- Platanus occidentalis
- Toona ciliata

Trees Occurring in Gardens/Parks:
- Callistemon viminalis
- Jacaranda miniata
- Xanthostemon chrysanthus
- bottlebrush red flower
- jacaranda
- golden penda

Proposed Street Tree Species:

7.15 Haden

The township of Haden has a population of approximately 306.

Soils and Geology: Soil types are moderately deep, brown and grey brown loams and clay loams overlying dark clays. Grey cracking clays occur on the slopes.

Existing Street Tree Species:
- Araucaria cunninghamii
- Pittosporum x eugenioides ‘Variegata’
- Pittosporum phillyreaoides
- Pittosporum undulatum
- Brachychiton sp

Trees Occurring in Gardens/Parks:
- Callistemon viminalis
- Grevillea robusta
- Jacaranda miniata
- Bauhinia

Proposed Street Tree Species:
7.16 Hampton

Situated at the top of an escarpment on the Great Dividing Range, Hampton is one of the small hamlets located along the New England Highway between Toowoomba, (29 kilometres to the south) and Crows Nest (12 kilometres to the north). Hampton and the surrounding area had a population of approximately 477. Eucalypt and pine forests as well as grass land are present in this area. Local produce includes citrus and avocados which are grown on many of the farms located around the district.

Soils and Geology: Soil types vary from shallow, stony, brown, grey brown or grey, to moderately deep, grey or grey brown self mulching clays.

Local Issues: Hampton does not have a clearly defined entry and exit to the town and is currently defined by an opening in the surrounding forest. On the main street, at the New England Highway junction of the Esk - Hampton Road there is an opportunity to provide additional plantings. There is a large eucalypt and bottle tree in the main street. Secondary streets off the main road soon change character into rural residential and forested areas.

Existing Street Tree Species:
Eucalyptus species remnant forest

Trees Occurring in Gardens/Parks:
- Brachychiton rupestris: bottle tree
- Callistemon salignus: willow bottlebrush
- Fraxinus americana: American white ash
- Jacaranda mimosifolia: jacaranda
- Lagerstroemia indica: crepe myrtle
- Melaleuca quinquenervia: broad leaf tea tree

Proposed Street Tree Species:

7.17 Highfields

The Highfields district, with a population of approximately 8,010, is located 12kms north of Toowoomba on the New England Highway. Highfields was originally a rural residential district but is now being developed as urban housing. The district is one of the fastest growth areas in the TRC area and this is reflected in the housing industry and growth in other sectors such as retail.

Soils and Geology: Soil types vary from deep red clay to deep red loam soils. Moving off the ridges soils become more of a stony basalt, grey brown self mulching clays.

Local Issues: Previous studies show that the residents value Highfields for its forested setting and wildlife. Most of this character however is derived from private property plantings on large blocks and there is very little formal street tree planting except in newer areas. These values are at risk as narrow columnar species continue to be planted in new subdivisions, where underground power provides an ideal opportunity to create leafy shady streets. This combined with future subdivision pressures and potential private tree loss means that street tree planting is a priority for Highfields. Long avenues provide the potential for consistent avenue tree plantings and to change improved shade and amenity to footpaths and streetscapes.

Existing Street Tree Species:
- Buckinghamia celsissima: ivory curl flower
- Celtis australis: European nettle tree
- Flandersia americana: crow's ash
- Fraxinus americana 'Raywood': claret ash
- Grevillea spp: little gem
- Magnolia 'Little Gem': little gem
- Magnolia 'St. Marys': star magnolia
- Magnolia grandiflora: southern or Bull Bay magnolia
- Magnolia stellata: royal star
- Melaleuca armillaris: bracelet honey myrtle
- Melaleuca leucadendron: paper bark or cajuput
- Melaleuca linariifolia: snow in summer
- Melaleuca styphelioides: prickly leaf paper bark
- Pittosporum eugenioides 'Variegatum': lemonwood
- Pittosporum phillyraeoides: Queensland pittosporum
- Pittosporum undulatum: sweet pittosporum
- Prunus x blireana: flowering peach
- Prunus mume 'Pendula': pendula
- Pyrus Redspire: redspire
- Pyrus calleryana 'Bradford': Bradford
- Pyrus nivalis: snow pear
- Pyrus spp: pear
- Pyrus ussuriensis: Manchurian pear
- Tristaniopsis laurina: water gum
- Mixed Eucalyptus: white gums
- Waterhousea floribunda: water gum
- Podocarpus spp: yellowwood species

Trees Occurring in Gardens/Parks:
- Brachychiton rupestris: bottle tree
- Callistemon salignus: willow bottlebrush
- Fraxinus americana: American white ash
- Jacaranda mimosifolia: jacaranda
- Lagerstroemia indica: crepe myrtle
- Melaleuca quinquenervia: broad leaf tea tree

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
Proposed Street Tree Species:

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.18 Jondaryan

Jondaryan is 140 km west of Brisbane and midway between Toowoomba and Dalby. The name originated from the Jondaryan pastoral station (1842), derived from an Aboriginal expression thought to describe something a long way off. This may have been associated with a view from the Bunya mountains of a tree line or topographical feature on the black soil plains. The population is approximately 300.

Soils and Geology: Deep self mulching soils predominate with a slightly acidic pH.

Existing Street Tree Species:
- Allocasuarina luehmannii
- Eucalyptus deccorticans
- Eucalyptus populnea
- Melaleuca linariifolia

Trees Occurring in Gardens/Parks:
- Brachychiton rupestris
- Callistemon salignus
- Callistemon viminalis
- Pittosporum angustifolium

Proposed Street Tree Species:
- Eucalyptus moluccana
- Eucalyptus scaparia
- Melaleuca linariifolia

7.19 Kingsthorpe

Kingsthorpe, a town of approximately 1500 people, is midway between Toowoomba and Oakey. Its concealed location recommends it for rural/residential living, within 18 km commuting distance of Toowoomba. There are local shops, the Gowrie Hotel and rural businesses.

Soils and Geology: Black Vertosol. Soil types vary from shallow, stony, brown, grey brown or grey, to moderately deep, grey or grey brown self mulching clays.

Existing Street Tree Species:
- Allocasuarina luehmannii
- Eucalyptus deccorticans
- Eucalyptus populnea
- Melaleuca linariifolia

Proposed Street Tree Species:
- All Other Streets: For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.20 Kulpi

Kulpi is a small rural community in which cattle and grain properties figure most prominently. The town has a population of approximately 231.

**Soils and Geology:** Soil types are moderately deep, brown and grey brown loams and clay loams overlying dark clays. Grey cracking clays occur on the slopes.

**Existing Street Tree Species:**
- Eucalyptus decorticans ironbark
- Melaleuca linariifolia snow in summer
- Mixed Eucalyptus

**Trees Occurring in Gardens/Parks:**
- Callistemon salignus willow bottlebrush
- Callistemon viminalis bottlebrush red flower

**Proposed Street Tree Species:**
- Calodendron capense
- Eucalyptus decorticans, Flindersia australis, Callistemon viminalis

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.

7.21 Maclagan

Maclagan is a town situated at the foothills of the Bunya Mountains near the Bunya Mountains National Park. It has a population of approximately 136.

**Soils and Geology:** Soil types are moderately deep, brown and grey brown loams and clay loams overlying dark clays. Grey cracking clays occur on the slopes.

**Local Issues:** Currently a mix of street trees have been planted. However there is the potential to create a cohesive main street with street tree planting on both sides of the road.

**Existing Street Tree Species:**
- Melaleuca armillaris bracelet honey myrtle
- Melaleuca leucadendron paper bark or cajuput
- Melaleuca linariifolia snow in summer
- Pinus sp. pine
- Mixed Eucalyptus

**Trees Occurring in Gardens/Parks:**
- Callistemon salignus willow bottlebrush
- Callistemon viminalis bottlebrush red flower
- Lagerstroemia indica crepe myrtle
- Melaleuca quinquenervia broad leaf tea tree

**Proposed Street Tree Species:**
- Quercus palustris, Ginkgo biloba, Brachychiton populneus

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.22 Meringandan And Meringandan West

Meringandan and Meringandan West are two very close towns located near Highfields, 19 kilometres north west of Toowoomba with a population of approximately 1,474.

Soils and Geology: The soil is predominately a very, deep, dark, self mulching, cracking clay soil.

Local Issues: Meringandan is the smaller of the two and lies on the Oakey Meringandan Road. The road is quite narrow through town and there are minor commercial services on it. There is little street tree planting and there is no defined sense of entry or exit to the town. Meringandan West is a few kilometres west of Meringandan at the junction of Goombungee Meringandan Road. It consists of a cluster of rural residential properties with limited commercial services. There are no distinct entry plantings or street tree plantings around the town except for some in the newer subdivisions.

Existing Street Tree Species: Mixed Eucalyptus

Trees Occurring in Gardens/Parks:
- Jacaranda mimosifolia: jacaranda
- Grevillea robusta: silky oak

Proposed Street Tree Species:

Trees Occurring in Gardens/Parks:
- Caesalpinia ferrea: leopard tree
- Callistemon salignus: willow bottlebrush
- Callistemon viminalis: bottlebrush red flower
- Fraxinus americana: American white ash
- Jacaranda mimosifolia: jacaranda

Proposed Street Tree Species:

7.23 Millmerran

Millmerran is located 84km south-west of Toowoomba on the Gore Highway and has a population of approximately 1,324. The town is surrounded by a rural primary production area with industries including stud/beef cattle, pork, poultry, sheep, timber, olives, grain and cotton.

Soils and Geology: Chief soils are moderately deep to very deep, dark, grey brown to brown calcareous clays and clay loams overlying dark brown clays.

Local Issues: The main highway through to Goondiwindi runs through the town and is heavily utilised by road-train through traffic (including three carriage trucks) with the resulting noise and dust impacting on the amenity of a large section of the main street. The remainder of the main street off the highway has considerable street tree plantings with a mix of Caesalpinia ferrea (Leopard Tree) and Tristaniopsis laurina – (Water Gum), however there is little shade on the main street provided by these trees. The remainder of town has a reasonable number of tree plantings of mixed species including eucalypts, many of which are established Callistemon species. Mixed eucalyptus species have been used in avenue planting leading into the town from the outlying areas.

Existing Street Tree Species:
- Fraxinus x oxycarpa ‘Raywoodii’ claret ash
- Lophostemon confertus: brush box
- Melaleuca linariifolia: snow in summer
- Ulmus parvifolia: Chinese elm
- Mixed Eucalyptus
- Tristaniopsis laurina: water gum

Trees Occurring in Gardens/Parks:
- Caesalpinia ferrea: leopard tree
- Callistemon salignus: willow bottlebrush
- Callistemon viminalis: bottlebrush red flower
- Fraxinus americana: American white ash
- Jacaranda mimosifolia: jacaranda

Proposed Street Tree Species:

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.

Legend - Street Trees For Key Avenues
1. ACER ‘October Glory’, GEIHERA parviflora
2. FLINDERSIA australis, BRACHYCHITON populneus, LOPHOSTEMON confertus

Legend - Street Trees For Key Avenues
1. BRACHYCHITON populneus, FLINDERSIA australis
2. CALODENDRON capense, LAGERSTROEMIA indica, JACARANDA mimosifolia
3. TRISTANIOPSIS laurina, FLINDERSIA collina

All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.24 Mount Tyson

Mount Tyson is a rural town amongst the grain and cattle farms of the Darling Downs 40 km west of Toowoomba, and is approximately halfway between Oakey and Pittsworth. It has a population of approximately 519.

Soils and Geology: Soils vary from shallow, stony, brown, grey brown or grey, to moderately deep, grey or grey brown self mulching clays.

Existing Street Tree Species:
- Corymbia tarelliana cadagi tree
- Eucalyptus decorticans ironbark
- Eucalyptus tessellaris ghost gum
- Ulmus parvifolia Chinese elm

Trees Occurring in Gardens/Parks:
- Acacia pendula weeping acacia
- Callistemon viminalis bottlebrush red flower
- Grevillea robusta silky oak
- Jacaranda mimosifolia jacaranda
- Melaleuca bracteata black / river tea tree
- Xanthostemon chrysanthus golden penda

Proposed Street Tree Species:
All Other Streets: For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.

7.25 Nobby

Nobby is a small town located halfway between Toowoomba and Warwick with a population of approximately 391.

Soils and Geology: The soil type is predominately black soil.

Existing Street Tree Species:
- Melaleuca linariifolia snow in summer

Trees Occurring in Gardens/Parks:
- Brachychiton rupestris bottle tree
- Eucalyptus fibrosa red iron bark
- Grevillea robusta silky oak
- Jacaranda mimosifolia jacaranda
- Xanthostemon chrysanthus golden penda

Proposed Street Tree Species:
All Other Streets: For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
### Toowoomba Regional Council Street Tree Masterplan

**7.26 Oakey**

The town of Oakey, with approximately 3,901 residents, is located on the Warrego Highway 29km north-west of Toowoomba. Local industries are rural based, many of which are associated with the beef industry and, a meatworks is located near the town. There are also coal mining operations in the surrounding districts. Just outside town, the Australian Army Aviation Centre provides a training facility and also hosts a Singapore Armed Forces Helicopter Squadron.

**Soils and Geology:** Red sodosol; red Chromosol. The soil types are moderately deep to very deep, red brown loams to clay loams overlying brown or yellow brown clays.

### Existing Street Tree Species:

- *Corymbia citriodora*  lemon scented gum
- *Corymbia torelliana*  cadagi tree
- *Eucalyptus bakeri*  Baker’s mallee
- *Eucalyptus calycogona*  square-fruited mallee
- *Eucalyptus camaldulensis*  river red gum
- *Eucalyptus crenata*  narrow-leaved ironbark
- *Eucalyptus decorticans*  ironbark
- *Eucalyptus eucalyptoides*  sand mallee
- *Eucalyptus exserta*  Queensland peppermint
- *Eucalyptus exserta*  ironbark
- *Eucalyptus malaccana*  grey box
- *Eucalyptus leucoxylon*  red flowering yellow gum
- *Eucalyptus melaleuca*  silver leaved iron bark
- *Eucalyptus malaccana*  grey box
- *Eucalyptus oleosa*  red mallee
- *Eucalyptus platypus*  Moort (WA)
- *Eucalyptus viridis*  green mallee
- *Grevillea robusta*  silky oak
- *Hakea lorea*  bootlace oak or cork tree
- *Jacaranda mimosifolia*  jacaranda
- *Lagunaria patersonia*  Norfolk Island hibiscus
- *Lagerstroemia indica*  crepe myrtle
- *Melaleuca linariifolia*  snow in summer
- *Tamarix aphylla*  athel pine

### Proposed Street Tree Species:

- BRACHYCHITON rupestris, CORYMBIA tessellaris
- EUCALYPTUS decorticans
- MELALEUCA linariifolia

### Trees Occurring in Gardens/Parks:

- Araucaria cunninghamii  bottle tree
- Brachychiton rupestris  willow bottlebrush
- Callistemon salignus  bottlebrush
- Callistemon viminalis  bottlebrush red flower
- Callitris glaucophylla  white cypress
- Casuarina glauca  swamp sheoak
- Castanopsis australis  black bean
- Flindersia australis  Crow’s ash
- Lophostemon confertus  brush box
- Melaleuca bracteata  black / river tea tree
- Xanthostemon chrysanthus  golden penda

### All Other Streets:

For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.27 Peranga

Peranga is 70 kilometres north-west of Toowoomba and 55 km north-east of Dalby with a population of approximately 50. There is a post office and general store, a one-man police station and a town hall.

**Soils and Geology:** The soil types are moderately deep, brown and grey brown loams and clay loams overlying dark clays. Grey cracking clays occur on the slopes.

**Local Issues:** There is no sense of arrival except for the close proximity of buildings indicating a town. There are minimal formal street tree plantings. Except a short row of Schinus molle (pepper tree) planted adjacent to the police station. Also there is a row of Eucalyptus torelliana (Cadaghi) on the Quinalow Peranga Road.

**Existing Street Tree Species:**
- Corymbia ptychocarpa spring bloodwood
- Schinus molle pepper tree
- Eucalyptus torelliana cadaghi

**Trees Occurring in Gardens/Parks:**
- Grevillea robusta silky oak
- Callistemon salignus willow bottlebrush
- Lagerstroemia indica crepe myrtle

**Proposed Street Tree Species:**

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7.28 Pittsworth

Pittsworth is located 40km south-west of Toowoomba on the Gore Highway and has a population of approximately 2,791. Cotton has become a widespread and valuable crop, and other primary industries include: poultry and egg production; grain growing farms; and dairy production. To town provides a service centre for the surrounding agricultural area. It is situated on the basalt uplands which is undulating in nature and the surrounding area hosts mixed farming and intensive animal industries.

**Soils and Geology:** The soil within the Pittsworth area is alkaline with a pH of 9.0.

**Local Issues:** Pittsworth has well planted streets which are dominated by the use of Grevillea robusta and Callistemon species. There have been issues with large tree plantings such as Grevillea robusta under powerlines requiring removal. Most recent plantings appear to be dominated by Crepe Myrtes and other small species for planting under powerlines. Besides the main roundabout there is little planting on the main street through the town, which affects the town amenity and there is an opportunity to undertake a comprehensive street tree planting program for the town centre in combination with a main street masterplan. Also, Jacaranda trees have been recently planted on the main entry into town from the west.

**Existing Street Tree Species:**
- Araucaria cunninghamii Moreton Bay pine (hoop pine)
- Fraxinus x oxycarpa ‘Raywoodii’ claret ash
- Melia azedarach white cedar
- Mixed Eucalyptus

**Trees Occurring in Gardens/Parks:**
- Caesalpinia ferrea leopard tree
- Callistemon salignus willow bottlebrush
- Callistemon viminalis bottlebrush red flower
- Fraxinus americana American white ash
- Grevillea robusta silky oak
- Lagunaria patersonia Norfolk Island hibiscus

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All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
Proposed Street Tree Species:

All Other Streets:
Species selection refer map overleaf for key avenue plantings. For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.29 **Quinalow**

Quinalow has a population of approximately 300.

**Soils and Geology:** The soil types are generally deep dark brown clays to brown loams and cracking clays on higher ground.

**Existing Street Tree Species:**
- *Eucalyptus decorticans* ironbark
- *Melaleuca amillaris* bracelet honey myrtle
- *Melaleuca leucadendron* paper bark or cajuput
- *Melaleuca linariifolia* snow in summer
- *Melaleuca styphelioides* prickly leaf paper bark
- Mixed *Eucalyptus*

**Trees Occurring in Gardens/Parks:**
- *Brachychiton rupestris* bottle tree
- *Callistemon salignus* willow bottlebrush
- *Callistemon viminalis* bottlebrush red flower
- *Grevillea robusta* silky oak
- *Melaleuca quinquenervia* broad leaf tea tree

**Proposed Street Tree Species:**
- *TOONA ciliate, PLATANUS x acerfolia*
- *TRISTANIOPSIS laurina, PLATANUS occidentalis ‘Autumn Glory’, HARPULLIA pendula*

7.30 **Southbrook**

Southbrook is a small town off the Gore Highway 10 km north-east of Pittsworth and 25 km south-west of Toowoomba. It has a population of approximately 780 people.

**Soils and Geology:** The soil types of Southbrook are similar to Pittsworth.

**Existing Street Tree Species:**
- *Carymbia citriodora* lemon scented gum
- *Melia azedarach* white cedar

**Trees Occurring in Gardens/Parks:**

**Proposed Street Tree Species:**

All Other Streets:
- *Pittosporum undulatum*
- *Backhousia citriodora*
- *Brachychiton discolor*
- *Elaoecarpus reticulatus*
Toowoomba, with a population of approximately 104,927 is situated about 700 metres above sea level on the edge of the Great Dividing Range. The city is located at the junction of the New England, Gore, and Warrego Highways, 127 kms or a 90 minute drive west of Brisbane.

The city is the largest centre in the TRC area and has long been a hub for commerce, industry and education, and as such is considered the capital of the ‘Darling Downs’ region.

Toowoomba can be divided into five separate ‘landscape character units’: City Core Existing Character, Cultural City Centre, City Bowl, Western City Rim and Eastern Escarpment (TRC 2003).

The City Core is the heart of the city centre. The area is dominated by commercial business and the land form is generally flat. There is little consistency in planting regimes throughout the city core and some streets have very little planting at all (TRC 2003).

The Cultural City Centre is distinct from the rest of the city due to its cultural/historical significance (TRC 2003). As the oldest section of the city, this area boasts historic architecture and streetscapes. Large and significant stands of trees exist within private properties and the major open space areas. Also mature avenue plantings of camphor laurels and some plane trees are evident within many streets, creating a shady atmosphere.

The City Bowl comprises land within the ridge line that encircles the city centre, its distinguishing characteristics includes the inward focus and its built up appearance (TRC 2003). Views within this character unit are directed towards the centre of town due to its topography and aspect. Vegetation cover is moderate, and land uses are diverse.

The Western City Rim is distinct in its undulating to steep topography and aspect towards the west (TRC 2003). This area outside the ridgeline encircles the city centre and has a more rural character. It has some sections of dense remnant vegetation, and there is also a lower density of development in this area. An opportunity exists to capture the essence of the rural/bushland character with some street tree plantings. Some areas of this character unit may be at risk from bushfires during hot dry times of the year. Street tree selection needs to address this risk by using fire-retardant or low-risk tree species where appropriate.

The Eastern Escarpment contains the majority of the Great Divide escarpment that forms a topographical barrier to Toowoomba in the east (TRC 2003). This land is steeply undulating and densely vegetated. Land use is mainly escarpment parkland with some residential uses at the top of the range. This area also has an outward focus, with significant views east to the Lockyer Valley. An opportunity exists to maintain the natural character of this area by planting rainforest and scrub species for street tree avenue development.

Soils and Geology:
Most of Toowoomba is covered by well drained, red brown loams, which allow rainfall to percolate to the underlying ground water, recharging the system. There are areas of low water infiltration, along the creeks. The two main soil groups are the ‘black’ and ‘red’ soils. The black soils are highly reactive, dark clay soils that are highly fertile and possess a high water storage capability. They cover a large area of the western part of the city and occupy most of the open plains, lower hill slopes, and in some places, extend to the ridge crests. The red soils are moderately reactive, have a lower storage capability and are moderately fertile. They are easier to cultivate, and cover most of the eastern part of the city.

Local Issues:
- Lack of hierarchy and continuity of avenue plantings in the city with many species occurring on single avenues
- Replacement plantings required for Camphor laurel avenues in the future
- Potential loss of green leafy image due to lack of undergrounding of powerlines on key avenues resulting in small species being used on at least half of the road verges
- Lack of planting in new subdivision areas

Proposed Street Tree Species:
Refer to the Toowoomba Street Tree Masterplans on the following pages for key avenue plantings. Suggested ‘landscape character unit’ areas are as follows.
7.32 Westbrook

Westbrook, once a rural town, is now an outlying suburb of Toowoomba where housing subdivisions have spread over Toowoomba’s western boundary into the former Jondaryan Shire. Westbrook is located on the Gore Highway between Toowoomba and Pittsworth and is 6 km south-west of central Toowoomba. It has a population of approximately 2289.

**Soils and Geology:** Black Vertosol. The pH levels are neutral. Soil types generally range from dark clay loams to shallower gravelly areas.

**Existing Street Tree Species:**
- Fraxinus griffithii: Griffith’s ash
- Salix babylonica: Babylon willow
- Ulmus parvifolia: Chinese elm

**Trees Occurring in Gardens/Parks:**
- Buckinghamia celssima: ivory curl tree
- Callistemon viminalis: bottlebrush red flower
- Jacaranda mimosifolia: jacaranda
- Xanthostemon chrysanthus: golden penda

**Proposed Street Tree Species:**

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7.33 Wyreema

Wyreema has a population of approximately 1000 and is an easy commute to Toowoomba but provides a rural town lifestyle and new housing development in the town.

**Soils and Geology:** Soils vary from shallow to deep grey brown clays.

**Local Issues:** There is little street tree planting in Wyreema which contributes to a homogeneity of streetscapes and little public amenity.

**Existing Street Tree Species:**
- Mixed Eucalyptus spp.

**Trees Occurring in Gardens/Parks:**
- Bauhinia spp.

**Proposed Street Tree Species:**

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All Other Streets:
For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
7.34 **Yarraman**

Yarraman has a population of 945 and is located to the east of the Great Dividing range in an area of hilly country. The town is located 118km north of Toowoomba on the junction of the New England and D’Aguilar Highways. It is set in a fertile valley and produces timber, grain, beef and dairy goods.

**Soils and Geology:** Laterite, Red Soil, Sandstone. Moderately deep, brown and grey brown loams and also clay loams overlying dark clays. Grey cracking clays occur on the slopes.

**Local Issues:** Being located at the junction of the New England and D’Aguilar Highways means very busy through traffic dominates the town. The D’Aguilar Highway has few street tree plantings, and the high traffic volumes result in a poor level of amenity for pedestrians. Street tree planting should be a priority. The New England Highway through the town has a greater number of plantings with a mix of species however there is not a formal defined avenue. The road narrows down in the urban area and there are Callistemon plantings in the main retail area.

**Existing Street Tree Species:**
- *Acmena smithii* lillypilly
- *Brachychiton acerifolius* Illawarra flame tree
- *Brachychiton discolor* lace bark tree
- *Brachychiton populneus* black kurrajong tree
- Mixed Eucalyptus

**Trees Occurring in Gardens/Parks:**
- *Brachychiton rupestris* bottle tree
- *Buckinghamia celsissima* ivory curl tree
- *Caesalpinia ferrea* leopard tree
- *Callistemon salignus* willow bottlebrush
- *Callistemon vinifolius* bottlebrush red flower
- *Callistemon glaucophylla* white bottlebrush
- *Grevillea robusta* silky oak
- *Jacaranda mimosaefolia* jacaranda
- *Lagerstroemia indica* crepe myrtle
- *Lagunaria patersonia* Norfolk Island hibiscus
- *Syzygium sp.* lillypilly

For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.

**Proposed Street Tree Species:**

![Legend - Street Trees For Key Avenues]

- **1.** BUCKHINGAMIA celsissima, CALLITRIS Sp, LAGERSTREMIA indica
- **2.** CALODENDRON capense, FLINDERSIA collina, MAGNOLIA grandiflora, MELALEUCA linariifolia
- **3.** LOPHOSTEMON confertus, TRISTANIOPSIS laurina, MELALEUCA linariifolia

- **All Other Streets:**
  - For street tree species selection refer to Section 8 Master Street Tree Species List with consideration to site conditions including mature height versus street hierarchy, as well as soil type and local climate.
### STREET TREE MATRIX

**LEGEND**

<table>
<thead>
<tr>
<th>Frost Hardiness</th>
<th>TRC Height Category</th>
<th>Provenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>light (-2°C)</td>
<td>tall (≥12m)</td>
<td>LN locally native</td>
</tr>
<tr>
<td>medium (-2 TO -5°C)</td>
<td>medium = 8-12m</td>
<td>N native</td>
</tr>
<tr>
<td>heavy (&gt;−5°C)</td>
<td>small = 4-8m</td>
<td>E exotic</td>
</tr>
<tr>
<td>P</td>
<td>powerlines = &lt;4m</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Approx height (m)</th>
<th>Approx spread (m)</th>
<th>Frost Hardiness</th>
<th>Drought Hardiness</th>
<th>Acid Soil Tolerance</th>
<th>Alkaline Soil Tolerance</th>
<th>Trees for Focal Points and Entry Features</th>
<th>Trees for Wide Medians and Verges only</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acer</em> 'October Glory'</td>
<td>October glory red maple</td>
<td>M/T 12</td>
<td>9</td>
<td>E</td>
<td>X</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Acer buergerianum</em></td>
<td>Trident maple</td>
<td>S</td>
<td>6</td>
<td>6</td>
<td>E</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Acmena smithii</em></td>
<td>Eucalyptus drummondii</td>
<td>M</td>
<td>10-15</td>
<td>10-20</td>
<td>LN</td>
<td>**</td>
<td>X</td>
<td></td>
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<tr>
<td><em>Agathis robusta</em></td>
<td>Kauri pine</td>
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<td>20-30</td>
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<td></td>
<td><em>Eucalyptus</em> drummondii</td>
</tr>
<tr>
<td><em>Allocasuarina luehmannii</em></td>
<td>Shingle oak</td>
<td>8-15</td>
<td>10-20</td>
<td>LN</td>
<td>**</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td><em>Eucalyptus</em> drummondii</td>
</tr>
<tr>
<td>* Allocasuarina littoralis</td>
<td>Black sheoak</td>
<td>M</td>
<td>8-12</td>
<td>8-20</td>
<td>LN</td>
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<td></td>
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</tr>
<tr>
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<td>10-20</td>
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<tr>
<td><em>Banksia integrifolia</em></td>
<td>Banksia</td>
<td>S/M</td>
<td>3-8</td>
<td>3-10</td>
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</tr>
<tr>
<td><em>Brahea armata</em></td>
<td>Mexican blue palm</td>
<td>M/T</td>
<td>12</td>
<td>6</td>
<td>LN</td>
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<td>X</td>
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<td><em>Callistemon viminalis</em></td>
<td>Weeping bottlebrush</td>
<td>S</td>
<td>3-8</td>
<td>3</td>
<td>LN</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td><em>Callitris glaucophylla</em></td>
<td>White cypress</td>
<td>T</td>
<td>18</td>
<td>15</td>
<td>LN</td>
<td>**</td>
<td></td>
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</tr>
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<td><em>Calodendron capense</em></td>
<td>Cape chestnut</td>
<td>T</td>
<td>8-15</td>
<td>8-20</td>
<td>LN</td>
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<td></td>
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<td><em>Eucalyptus</em> drummondii</td>
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<tr>
<td><em>Cassia brewsteri</em></td>
<td>Brewer’s cassia</td>
<td>M</td>
<td>12</td>
<td>8-12</td>
<td>LN</td>
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<tr>
<td><em>Cassinia glauca</em></td>
<td>Swamp sheoak</td>
<td>M/T</td>
<td>8-20</td>
<td>8-30</td>
<td>LN</td>
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<td></td>
<td><em>Eucalyptus</em> drummondii</td>
</tr>
<tr>
<td><em>Ceratonia siliqua</em></td>
<td>Carob or chocolate tree</td>
<td>M/T</td>
<td>8-10</td>
<td>8</td>
<td>E</td>
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<td><em>Corymbia eximia ‘Nana’</em></td>
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<td>8</td>
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<td><em>Cupaniopsis anacardioides</em></td>
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<td><em>Eucalyptus arborescens</em></td>
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<tr>
<td><em>Eucalyptus cadiegenea</em></td>
<td>Red mallee</td>
<td>S/M</td>
<td>5-10</td>
<td>5-10</td>
<td>LN</td>
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<td>Sugar gum</td>
<td>T</td>
<td>35</td>
<td>X</td>
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<td>Dunkirk mallee</td>
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<td>4-6</td>
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<tr>
<td><em>Eucalyptus melanophloia</em></td>
<td>Silver-leaved ironbark</td>
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<td>15</td>
<td>LN</td>
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<tr>
<td><em>Eucalyptus scoparia</em></td>
<td>Willow gum</td>
<td>T</td>
<td>15</td>
<td>10</td>
<td>LN</td>
<td>**</td>
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<tr>
<td><em>Eucalyptus sideroxylon</em></td>
<td>Red ironbark</td>
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<td>20-40</td>
<td>LN</td>
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<td><em>Eucalyptus</em> drummondii</td>
</tr>
<tr>
<td><em>Eucalyptus ‘Summer Red’/ ‘Summer Sun’</em></td>
<td>S</td>
<td>4-6</td>
<td>3-5</td>
<td>*</td>
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<tr>
<td><em>Flandersia australis</em></td>
<td>Crowe ash</td>
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<td>10-40</td>
<td>10-50</td>
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### Suggested Street Tree Trial Species

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### Declared Weeds

The following species are not approved for planting in the TRC area:

- Acacia baileyana: Coontamundra wattle
- Cinnamomum camphor: camphor laurel *except for replacement in key iconic avenues
- Corymbia torelliana: cadgah
- Melia azedarach: white cedar
- Salix babylonica: willow
- Schinus molle var. arena: Californian pepper tree, peppercorn tree
- Schinus terebinthifolius: Brazilian pepper tree
- Tamarix ophyla: Athel pine
- Tecoma stans: yellow tecoma
- Tipuana tipu: tipuana

Weblinks to photos of tree species can be found below:

9. SPECIFICATION, TECHNICAL DRAWINGS AND STANDARDS

The following drawings are to be used as standard details for street tree plantings in the TRC area. In addition refer to the Landscape Specification (contact TRC Parks and Recreation Services for the latest version, details on inside front cover).

Refer also:

TRC Planning Scheme Policy No. 2 - Engineering Standards - Roads and Drainage Infrastructure

Queensland Department of Main Roads requirements
NOTE: For State controlled roads also refer to the requirements for DTMR's Road Landscape Manual and Ausroads Guide to Road Design (Parts 6 & 6b)

TWO LANE MAJOR ROAD - 12m WIDE

FOUR LANE UNDIVIDED ROAD WITHOUT PARKING LANES

FOUR LANE UNDIVIDED ROAD WITH PARKING LANES

NOTE:
Extent of clearance envelope should be defined by required contingency widths, not necessarily existing kerb line.

TWO LANE MAJOR ROAD - 10m WIDE
NOTE: For State controlled roads also refer to the requirements for DTMR's Road Landscape Manual and Austroads Guide to Road Design (Parts 6 & 6B).
NOTE: For State controlled roads also refer to the requirements for DTMR’s Road Landscape Manual and Austroads Guide to Road Design (Parts 6 & 6B)
NOTE: For State controlled roads also refer to the requirements for DMR's Road Landscape Manual and Austroads Guide to Road Design (Parts 6 & 6b).

- Verify location of services prior to excavation of tree hole.
- Refer planting & maintenance specifications.
- 2 x tree stakes placed parallel to road (1000 x 50 x 50) located 50 mm outside root ball & driven to 600 mm depth, tie with 2 NO. INTERLOCKING OR HESSIAN TIES in figure eight.
- Tree trunk
- Extent of rootball
- Mulch as specified, maintain 100 mm radius
- Separation between mulch and stem of tree. Tree stake as noted above

A = Tree pit size 1.0m x 1.0m x 1.0m
2.0m x 2.0m x 2.0m

B = 150 mm deep organic topsoil layer to required standard

C = 2 x rootball depth min 1000 mm

Pavement

NOTE:

- Verify location of services prior to excavation of tree hole.
- Refer planting & maintenance specifications.
- 2 x tree stakes placed parallel to road (1000 x 50 x 50) located 50 mm outside root ball & driven to 600 mm depth, tie with 2 NO. INTERLOCKING OR HESSIAN TIES in figure eight.

Tree as per plant schedule

Tree hole slightly crowned

75 mm depth mulch

Root barrier if specified for aggressive tree roots

Sub soil (drainage) pipe for road pavement

500 mm min depth (B) organic topsoil mix in tree pit, backfill soil around rootball. Ensure no air pocket is present. Lightly compact soil to 150 mm layers and place rootball on top. Soil transition zone where soil layers mix. Inorganic soil backfilled & lightly compacted in 150 mm layers. 100 mm layer of 30 mm dia gravel. Drainage medium, refer landscape specification, cultivate base of pit as specified.

Pavement
2 NO. TREE STAKES PLACED PARALLEL TO ROAD (100 x 50 x 50mm) LOCATED 50mm OUTSIDE ROOT BALL & DIPPED TO 500mm DEPTH. THE WITH 2 NO. INTERLOCKING DR HESSIAN TIES IN FIGURE EIGHT.
- TREE TRUNK
- EXTENT OF ROOTBALL
- MULCH AS SPECIFIED. MAINTAIN 100mm RADIUS SEPARATION BETWEEN MULCH AND STEM OF TREE.
- TREE STAKE AS NOTED ABOVE
- PLANTING BAG

PLAN VIEW

TREE

MID-An MIN 1m ROUNDABOUTS 6m MIN. Bk

TREES & PLANTING AS PER PLANT SCHEDULE

TREE HOLE SLIGHTLY CROWNED

75mm DEPTH MULCH

500mm DEPTH TOPSOIL TO GARDEN

500mm DEPTH ADJACENT TO TREE PLANTING

ROAD SURFACE

500mm MIN DEPTH (B) ORGANIC TOPSOIL MIX IN TREES PIT. BACKFILL SOIL AROUND ROOTBALL. ENSURE NO AIR POCKETS REMAIN. LIGHTLY COMPACT SOIL IN 100mm LAYERS AND PLACE ROOTBALL ON TOP.

SOIL TRANSITION ZONE WHERE SOIL LAYERS MIX.

INORGANIC SOIL BACKFILLED SLIGHTLY COMPACTED IN 100mm LAYERS

FILTER FABRIC A11 OR EQUIVALENT M IN 300mm BELOW PAVEMENT LAYER 100MM DEEP NO FINISH GRAVEL LAYER WITH 100mm CORRUGATED PERFORATED PIPES PIP CLASS 16 CONNECTED TO SWG

SECTIONAL VIEW

NOTE: For State controlled roads also refer to the requirements for DMR's Road Landscape Manual and Austroads Guide to Road Design (Parts 6 & 6b)
NOTE: For State controlled roads also refer to the requirements for DTM's Road Landscape Manual and Austroads Guide to Road Design (Parts 6 & 6B)
REFERENCES


RPS (2010) TRC Bushfire Hazard Mapping Project, unpublished report commissioned by TRC.

RPS (2011) A First Pass Assessment of Climate Change Risks and Opportunities in the TRC Area, unpublished report commissioned by TRC.

RPS (2011) Key Climate Change Risks and Opportunities for Street Tree Masterplanning for TRC.


Tarran, J (2011). Report - Street Tree Selection and Climate Change - Considerations and Strategies for TRC.


University of Southern Queensland (2010) Future Climate Profile of the TRC area, unpublished report commissioned by TRC.


Appendix A - Methodology

The TRC Street Tree Masterplan (STMP) Project was undertaken during 2011.

Review of Current and Draft Policy Documents

A new Toowoomba Regional Planning Scheme for the amalgamated TRC is being developed during 2011 and draft documents from various sections were made available to the project team as a guide. Research was also undertaken into the eight former planning schemes and street tree plans (where they existed) and a review was undertaken of other data available pertaining to street trees.

Review of Reference Materials

Other sources were investigated which are included in the reference list.

Internal Stakeholder Workshops

Two internal stakeholder workshops with TRC officers were undertaken during the masterplan process; one in March 2011 prior to starting the masterplanning work and one in May 2011 after the release of the Preliminary Draft STMP. The second workshop was used to discuss the masterplan and to ensure local knowledge contributed to the overall masterplan content and outcomes.

Field Investigations

Field investigations were undertaken in March 2011 which involved visiting all thirty-one towns outlined in the masterplan to confirm what species were growing in the towns. Street tree species were noted as well as those growing well in private gardens and other areas within the towns. Samples of various unknown Eucalypt and Corymbia species were gathered and sent to the Queensland Herbarium for identification.

Some genii noted with large numbers of species and hybrids such as Callistemon, were not always able to be identified by differentiation between species/hybrids and this detail requires further investigation over time and/or during flowering periods if specific species/hybrids need to be recorded.

The field investigations did not include detailed notes on exact locations, number, sizes and health of species on specific streets but were a broad investigation into what species occurred where in the towns.

Climate Change Adaptability

Various methods were used to attempt to determine if tree species in the TRC preferred species list and those currently occurring in the towns of the region are likely to be able to adapt to climate change. The projected likely Toowoomba climate for the 2060 horizon was investigated, as outlined in the USQ 2010 report and the Climate Change Australia website.

Further investigations were made with various bodies to try to determine if the TRC area’s future climate could be illustrated in an existing place in Australia to determine existing species used in that climate, and therefore likely suitability and adaptability to the projected Toowoomba climate in 2060. Clear direction on this was unable to be determined due to the variability of the available data for the future climate predictions and current lack of research data available on species adaptability to climate change.

The Australian Virtual Herbarium website was used to ascertain the current known distribution of noted species in the towns and on the existing preferred TRC species list. By investigating which species had wide distribution and/or those which occurred in existing hotter and drier climates, combined with anecdotal evidence from the Council officers about which had performed better during the recent drought, a determination was made about which species would be likely to be able to adapt to climate change.

The information and evidence available is not conclusive, particularly for the exotic species due to unknown stock origin and drought hardiness. Therefore it is recommended that all tree species should be monitored periodically over the coming decades to determine how they are coping and adapting to the changing climatic conditions as they occur.

Street Tree Species Selection

Street Tree species selection shown in this masterplan were made for a variety of reasons including and combining the elements of existing species occurring in the towns performing well, species that have a large climatic range and therefore greater likelihood of coping with a changed climate, species diversity, colour and interest and character for main street plantings, hardiness to local conditions, and suitability of species to location. The species selection has also been reviewed during the Internal Stakeholder workshop process by TRC officers, and also by the project team’s arborist, urban forester and horticultural advisor.
4. Determining the preferred environmental ranges of tree species can be difficult

Street tree species used in cities in Australia can be exotic species from overseas (e.g. northern hemisphere), “Australian native” species from elsewhere in the northern hemisphere, or “Australian native” species from elsewhere in Australia (e.g. see Hughes 2003). There are several ways to attempt to determine their preferred environmental ranges, based on existing information, but it should be remembered that tree species can be adaptable to conditions beyond their preferred ranges. Tree species growing in urban areas may have different physiology and morphology from the same tree species in natural forests (McCarthy & Pataki 2010), so a preferred natural environmental range may underestimate an acceptable urban environmental range.

4.1 “Australian native” species and locally indigenous species

Whilst there has been some research into projected species distributions in relation to climate change in Australia (e.g. see Hughes 2003), much of this work has focussed on natural areas, especially of iconic vegetation assemblages and biodiversity hotspots (e.g. SW Western Australia) and for rare and endangered species, in particular. The general aim is to model likely species distribution in future climates (using SDM or Species Distribution Modelling), to assess whether the species are likely to survive through, for example, migration along gradients within a reserve system. This approach is based on establishing “bioclimatic envelopes” for species. For Australian native species and locally indigenous species, Australia’s Virtual Herbarium (AVH) (Council of Heads of Australasian Herbaria (CHAH) Inc. 2010) provides an easy way to visualise species distributions to date, based on actual specimen collections held in herbaria throughout Australia, with overlays available for temperature and rainfall. These distributions are only as good as the efforts put in to collecting specimens i.e. each species could have a wider distribution, representing areas not yet sampled. Reference books, including Floras of each state, can also be used.

Since spatial gradients in climate can serve as proxies for temporal climate change, the presence (up to now) of a particular species in a wide range of climates, including hotter and drier climates, suggests that such a species would be useful for planting in an area that is currently cooler and wetter, but may become hotter and drier in the future.

For example, using AVH, street tree species tabulated in the Toowoomba Street Trees Plan of 2003 (Parks & Recreation Branch, Toowoomba City Council 2003) were queried online to obtain maps of their distributions, with rainfall and temperature overlays. The main purpose was to determine whether these species were narrowly restricted to moist coastal locations, or whether they had distributions which extended into hotter and drier inland areas, including to the north and west of Toowoomba. The results of this investigation are presented in Table 1 (see following page).

Following Table 1 are figures illustrating species distribution maps from AVH for four species from Table 1, which are on the Preferred Species List of the current Toowoomba Street Tree Inventory -

(1) Callistemon viminalis, a common street tree with a distribution in hotter drier areas, as well as coastal areas from Queensland through to NSW (Figure 1)
(2) Geijera salicifolia, suggested as a replacement for Cinnamomum camphora, with a distribution in hotter drier areas, as well as coastal areas (Figure 2)
(3) Brachychiton populneus, which has a very widespread inland distribution, in Queensland, NSW and Victoria (Figure 3)
(4) Syzygium luehmannii, which has a very narrow coastal distribution in Queensland and Victoria (Figure 4)

For species that do extend into hotter and drier inland areas, it is important to determine whether their presence in these areas is restricted to locally moist conditions, such as along creeks and rivers or with access to subsurface moisture, such as groundwater supplies. The species that are not restricted in this way are more useful for street planting for hotter and drier future climates.
Table 1. Tree species (Australian, including locally indigenous) suggested in Toowoomba Street Trees Plan (2003), for different areas (City Core, Cultural City Centre, City Bowl, Western City Rim and Eastern Escarpment), and their general distribution. Species data obtained from Australia’s Virtual Herbarium with permission of the Council of Heads of Australasian Herbaria Inc.

<table>
<thead>
<tr>
<th>Tree Species</th>
<th>Common Name</th>
<th>Family</th>
<th>Areas of planting suggested in Toowoomba Street Trees Plan (TSTP) (2003)*</th>
<th>Tree Inventory Data** (Most Common, Current, Preferred)</th>
<th>Distribution restricted to coast (mosaic)</th>
<th>Distribution in hotter and drier inland areas as well e.g. N &amp; W of Toowoomba</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acmena smithii</td>
<td>Lilly Pilly</td>
<td>Myrtaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td>Yes (a few inland)</td>
<td></td>
</tr>
<tr>
<td>Agathis robusta</td>
<td>Kauri Pine</td>
<td>Araucariaceae</td>
<td>West CR East Esc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allocasuarina lorikeet</td>
<td>Forest Oak</td>
<td>Casuarinaceae</td>
<td>West CR</td>
<td>Cu, Pref (mostly coastal)</td>
<td>Yes (a few inland)</td>
<td></td>
</tr>
<tr>
<td>Araucaria cunninghami</td>
<td>Hoop Pine</td>
<td>Araucariaceae</td>
<td>CCC (pk) City Bowl (pk) West CR</td>
<td>Cu, Pref</td>
<td>(a few inland)</td>
<td></td>
</tr>
<tr>
<td>Brachychiton australis</td>
<td>茏叶橡</td>
<td>Sterculiaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td>(a few inland)</td>
<td></td>
</tr>
<tr>
<td>Brachychiton discolor</td>
<td>Lace Bark Tree</td>
<td>Sterculiaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td>(a few inland)</td>
<td></td>
</tr>
<tr>
<td>Brachychiton populnea</td>
<td>Kurrajong Tree</td>
<td>Sterculiaceae</td>
<td>West CR</td>
<td>Pref</td>
<td>Yes - widespread (Fig. 3)</td>
<td></td>
</tr>
<tr>
<td>Brachychiton rupestris</td>
<td>Queensland Bottle Tree</td>
<td>Sterculiaceae</td>
<td>West CR</td>
<td>Cu, Pref Yes - many in dry areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buddingheuma cellestrum</td>
<td>Irony Cloth</td>
<td>Proteaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td>Yes (a few inland)</td>
<td></td>
</tr>
<tr>
<td>Camphor laurel</td>
<td>Camphor Laurel</td>
<td>Lauraceae</td>
<td>City Core</td>
<td>Common</td>
<td>(a few inland)</td>
<td></td>
</tr>
<tr>
<td>Callistemon viminalis</td>
<td>Weeping Bottlebrush</td>
<td>Myrtaceae</td>
<td>West CR</td>
<td>Common Cu, Pref</td>
<td>Yes (Fig. 1)</td>
<td></td>
</tr>
<tr>
<td>Elaeocarpus reticulatus</td>
<td>Blueberry Ash</td>
<td>Elaeocarpaceae</td>
<td>East Esc</td>
<td>Cu, Pref (mostly coastal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eucalyptus bakeri</td>
<td>Myrtaceae</td>
<td></td>
<td>West CR</td>
<td>Yes - mostly inland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eucalyptus australis</td>
<td>Tea, Slender Ash</td>
<td>Rutaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grevillea robusta</td>
<td>Silky Oak</td>
<td>Proteaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leucaena saligna</td>
<td>Brush Wilga</td>
<td>Rutaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lophostemon confusus</td>
<td>Brush Box</td>
<td>Myrtaceae</td>
<td>City Bowl West CR East Esc</td>
<td>Common Cu, Pref</td>
<td>(a few inland)</td>
<td></td>
</tr>
<tr>
<td>Podacarpus elatus</td>
<td>Nawaiara Plum</td>
<td>Podocarpaceae</td>
<td>CCC</td>
<td>Cu, Pref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pittosporum oblongipes</td>
<td>Weeping Pittosporum</td>
<td>Pittosporaceae</td>
<td>West CR</td>
<td>Cu, Pref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pittosporum undulatum</td>
<td>Tree Pittosporum</td>
<td>Pittosporaceae</td>
<td>City Bowl West CR East Esc</td>
<td>(mostly coastal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Podocarpus rutherfordii</td>
<td>Tulp Satinwood</td>
<td>Anacardiaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td>(a few inland)</td>
<td></td>
</tr>
<tr>
<td>Stenocarpus multives</td>
<td>Firewheel Tree</td>
<td>Proteaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syzygium saligna</td>
<td>Stickle-leaf Willawong</td>
<td>Myrtaceae</td>
<td>East Esc</td>
<td>Cu, Pref (Fig. 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syzygium oleosum</td>
<td>Blue Lilly Pilly</td>
<td>Myrtaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waterhousea floribunda</td>
<td>Weeping Lilly Pilly</td>
<td>Myrtaceae</td>
<td>East Esc</td>
<td>Cu, Pref</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Areas - City Core; Cultural City Centre (CCC); City Bowl, Western City Rim (West CR); Eastern Escarpment (East Esc)
** Tree Inventory - Most common species used (Common); Current Street Trees (Cu); Preferred Street Trees (Pref)

Figure 1. Distribution of Callistemon viminalis in relation to annual average rainfall (mm). Occurs in hotter and drier areas, as well as coastal areas. Specimen data reproduced from Australia’s Virtual Herbarium with permission of the Council of Heads of Australasian Herbaria Inc.

Figure 2. Distribution of Geijera saligna in relation to annual average rainfall (mm). Occurs in hotter and drier areas, as well as coastal areas. Specimen data reproduced from Australia’s Virtual Herbarium with permission of the Council of Heads of Australasian Herbaria Inc.
For locally indigenous species, species lists (including lists of trees), from remnant vegetation (e.g. bushland), both nearby and in hotter and drier areas, are good sources to determine preferred environmental ranges of these species.

The tree species from nearby natural areas are adapted to current local conditions of soil and climate. If the same species occur in more distant natural remnants in hotter and drier areas, plants sourced from these areas (by cuttings or seed) may provide different genetic material (of the same species) that is more suited to a projected hotter and drier climate in the future.

Practices in relation to bush regeneration and revegetation with local species are worth examining, as a model for future street tree planting. Current bush regeneration practices often focus on the use of plant material of "local provenance", such that local seed occurring naturally in bushland soil (the soil seedbank) is encouraged to germinate after the removal of weeds or other impacts (e.g. excess moisture directed into the bushland). As well, tubestock raised from locally produced seeds or cuttings is used for buffer plantings in parks adjacent to bushland.

Some ecologists, however, have suggested that, in view of a climate changed future (Broadhurst et al. 2008; Hoffmann 2010), the use of genetically diverse seed is more appropriate, to maximise adaptive potential. Recommendations now include the use of source material of "composite provenance", including material of local provenance plus material sourced further from the site but matched eco-geographically. A further extension of this idea, in relation to climate change, would be to source material further from the site, and areas that currently match the hotter and drier conditions projected for the future.

In the context of street tree planting, using local tree species, it would be worthwhile to trial planting stock of these species sourced, via seed or cuttings, from hotter and drier areas.

Different Australian tree species found in hotter and drier areas, such as to the west and north of Toowoomba, may indicate potential street tree species for future climates. Other requirements of these species (e.g. soil, topography, aspect etc.) should also be considered.

4.2 Exotic tree species from overseas - information and a model study for climate change

For exotic tree species from overseas, reference books and online resources can be used to determine preferred environmental ranges of specific tree species and decide whether these overlap with current and projected climatic conditions in Toowoomba (e.g. see the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (2011) Plants Database at http://plants.usda.gov/java/).

Unfortunately, the climate focus for street and park trees in the northern hemisphere (e.g. USA and Europe) has tended to be on low temperatures, since the lowest temperatures in winter tend to limit the species that can be grown in any area. For example, the USDA has developed, and continues to refine, the USDA Plant Hardiness Zone Map (e.g. see inside cover of Harris et al. 2004) which divides USA into 20 hardiness zones, based on the average annual minimum temperature for each zone. The zones are numbered 1 to 11 (with sub-zones a and b in some cases), whereby the annual average minimum temperature of zone 1 is <-45.6°C and the annual average minimum temperature of zone 11 is >4.5°C. Similar hardiness zone maps exist for Europe. Plant species and cultivars are given hardiness zone ratings which indicate the temperature down to which they can be grown and will survive the winter. Plants can usually be grown safely at higher numbered (warmer) zones, but will not necessarily thrive in extremely high temperatures.

The successful use of exotic tree species from overseas as street trees in Australia depends more on an understanding of their tolerance of potentially limited water, chiefly through rainfall, and their tolerance of higher temperatures in summer, than on an understanding of their tolerance of extremely low temperatures.
Data on Jacaranda mimosifolia and Liquidambar styraciflua (Table 2), two of the most common species used as street trees in Toowoomba (>1000 records), suggest that these species may not perform well by 2040-2069 when Toowoomba’s annual rainfall is projected to be about 800mm (TRC 2010) nor by 2070-2099 when rainfall is projected to be even lower at about 673mm (TRC 2010). Even when the adaptability of trees is considered, it may be that these trees are stressed and hence more subject to pest and disease attack.

Table 2. Biophysical limits and native distribution for two of the most common street trees in Toowoomba, Jacaranda mimosifolia and Liquidambar styraciflua (from USDA NRCS (2011) Plants Database).

<table>
<thead>
<tr>
<th>Tree Species</th>
<th>Family</th>
<th>Native Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacaranda mimosifolia</td>
<td>Bignoniaceae</td>
<td>Brazil, Argentina, South Africa, South and Central America, South East Asia, India</td>
</tr>
<tr>
<td>Liquidambar styraciflua</td>
<td>Hamamelidaceae</td>
<td>North and Middle America, Central America, Central Florida, Mexico, Guatemala, Honduras, Nicaragua</td>
</tr>
</tbody>
</table>

It is, however, difficult to know exactly how the nursery stock of these exotic species obtained in Australia will perform in future climates, since the specific place(s) of origin of these species, when brought to Australia for nursery production, are not always known. They could have come from either extreme of the native distributional range, or from somewhere in between e.g. if the nursery stock of Liquidambar styraciflua in Australia came originally from northern USA (near Connecticut) it would perform differently from stock which came from southern USA (near Florida). Ideally, optimum tree performance would be obtained by matching the source site in the USA with the destination site in Australia, but this would also increase the risk of an introduced plant becoming an environmental weed in nearby bushland areas.

There is one significant study relating to Central Europe (Roloff et al. 2009) that attempts to select appropriate tree species for use in urban habitats, such as parks and gardens, in relation to climate change. Whilst this study provides a model for approaching tree species selection, the focus on winter hardness (tolerance of low temperatures) and low rainfall (drought resistance) limits its direct applicability to Australia. For Australia, a focus on low rainfall and high temperatures would be more useful. As well, requirements for street trees are often more demanding than for park and garden trees, given the more difficult growing conditions commonly encountered in streets e.g. restricted space for roots to grow, reduced water supply (with excessive runoff and impermeable surfaces), highly compacted soil, lack of organic matter on the soil surface, reflected heat from buildings etc.

This study looked at 250 urban woody species currently used in parks and gardens in Central Europe and, using reliable reference information, attempted to classify them with regards to their usability after projected climate change, based on their drought tolerance and winter hardness. The mean annual precipitation threshold was set at 500 mm or less. The species were classified using four categories of drought tolerance (1=very suitable, 2= suitable, 3=problematic and 4=not suitable) and four categories of winter hardness (same descriptors), giving a matrix of 16 sub-categories or “grade pairs”, e.g. 1-1=very suitable for both drought tolerance and winter hardness and 4-4=not very suitable for both drought tolerance and winter hardness. Blocks (i.e. species sub-sets) within the 16 cell matrix were then graded in relation to projected climate change as very suitable (1-1, 1-2), suitable (1-2, 2-1, 2-2), suitable but occasionally problematic (2-3, 3-1, 3-2, 3-3) and not very suitable (seven pairs containing a 4).

Whilst the winter hardness information is of little use for urban Australia, the drought tolerance information using a threshold of 500 mm mean annual precipitation in the study by Roloff et al. (2009) provides information on a few of the exotics used in Toowoomba and elsewhere in Australia. This information is given in Table 3 below. However, a combination of low rainfall and high summer temperatures was not investigated in this study, so the classification categories may not be directly applicable to future climates in Toowoomba.

Table 3. Drought tolerance classification, using a threshold of 500 mm annual average rainfall, for woody plant species, including street trees, as provided in the study by Roloff et al. (2009) of species in urban areas of Central Europe.

<table>
<thead>
<tr>
<th>Tree Species</th>
<th>Common Name</th>
<th>Drought Tolerance (using 500 mm annual average rainfall as threshold)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia dealbata</td>
<td>Tallow Maple</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Acer negundo subsp.</td>
<td>Ashdown Maple</td>
<td>Suitable</td>
</tr>
<tr>
<td>Acer rubrum</td>
<td>Red Maple</td>
<td>Problematic</td>
</tr>
<tr>
<td>Allamanda altissima*</td>
<td>Chinese Tree-of-Heaven</td>
<td>Not very suitable</td>
</tr>
<tr>
<td>Betula pendula</td>
<td>Silver Birch</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Catalpa bignonioides</td>
<td>Indian Bean Tree</td>
<td>Problematic</td>
</tr>
<tr>
<td>Catalpa species</td>
<td>Mexican Candel</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Cupressus sempervirens</td>
<td>Italian Cypress</td>
<td>Problematic</td>
</tr>
<tr>
<td>Gmelina biloba</td>
<td>Grigo</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Koelreuteria panulata</td>
<td>Sugar-Maple Tree</td>
<td>Problematic</td>
</tr>
<tr>
<td>Liquidambar styraciflua</td>
<td>Liquidambar, Sweet Gum</td>
<td>Not very suitable</td>
</tr>
<tr>
<td>Morinda lucida</td>
<td>Kigelia</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Platania x frainiana</td>
<td>London Plane</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Platania orientalis</td>
<td>Oriental Plane</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Pyrus cactorum</td>
<td>Bradford Pear</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Quercus palustris</td>
<td>Pins Oak</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Quercus rubra var.</td>
<td>Common Oak</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Rhus rectifolia</td>
<td>Black Locust</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Ulmus parvifolia</td>
<td>Chinese Elm</td>
<td>Very suitable</td>
</tr>
<tr>
<td>Zelkova serrata</td>
<td>Japanese Zelkova</td>
<td>Very suitable</td>
</tr>
</tbody>
</table>

** Note that A. styraciflua naturally occurs in areas of rainfall of 1000-1800mm (see Table 2)**

*** Note that L. styraciflua naturally occurs in areas of rainfall of 1000-1500mm, but can survive on 400mm (World Agriculture Centre, undated)**

There has been some interest in water requirements of and water use by urban trees, as well as drought tolerance, since it was suspected that urban trees faced water stress as a result of limited water supply, associated with restricted rooting area, increased evaporative demand, and reduction of water infiltration resulting from increased impervious surfaces and soil compaction (e.g. Whittow & Buskak 1987). Furthermore, radiation loads on the tree canopy, lower relative humidity and wind tunnels were thought to increase tree demand for water.

There is a renewed interest in water use by trees associated with projected climate change resulting in hotter and drier climates and likely increased competition for water between various uses (e.g. see the study by McCarthy & Pataki 2010, in California). At this stage, however, there is relatively little experimental data from field research to understand the water relations of urban trees. Whether or not particular urban trees are under water stress at certain times depends on local site factors, tree species, extent of both root system and canopy, and many other aspects. Furthermore, urban trees may be artificially irrigated and this obscures their actual water requirements.
McCarthy & Pataki (2010) found that, in the Los Angeles Basin, the non-native Pinus canariensis (Canary Island Pine) could grow in locations without significant irrigation or groundwater access, with very low transpiration. It is native to a Mediterranean climate and, being in areas ranging in precipitation over 200-1200mm, has considerable plasticity (i.e. ability to respond to variable and extreme environmental conditions) and tolerance of dry conditions. By contrast, the locally native Platanus racemosa (California Sycamore) could not grow in locations without significant irrigation or groundwater access, which is not surprising given its natural distribution along riparian and canyon habitats in Southern California.

There is a strong urban forestry research community in California and, with their street tree species lists having considerable overlap with temperate urban Australian street tree species lists, including widespread use of “Australian native species” in California, research into drought tolerance undertaken there may be useful for Australia.

Occasionally, research is undertaken into drought tolerance within a genus, such as the study by Percival et al. (2006) into drought tolerance of Fraxinus (Ash) genotypes for urban landscape plantings. However, this study in the UK, using containerised plants and a temperature range of 5.5-18.4°C, is of limited use for the higher summer temperatures encountered in Toowoomba, both now and in a climate changed future.

5. Sources of tree species

For tree species that occur naturally both in coastal areas and in inland Australia, it is generally found that the inland populations can withstand extreme conditions of heat and dryness better than their coastal counterparts (Hoffmann 2010). Firstly, the individuals of the inland populations respond to exposure to extreme conditions by triggering a set of protective mechanisms, often by turning on genes that produce specific proteins that prevent molecules in cells degrading under hot conditions i.e. they possess phenotypic plasticity. Secondly, the inland populations possess different types of genes which have been selected for, over time, so that these populations, become adapted to local conditions. Genetically, these inland populations are different from their coastal counterparts.

As noted in the previous section, the nursery stock of these species, produced for planting in specific environments, is usually sourced from local parent plants in order to match the current environmental, including climatic, conditions of the site i.e. material of “local provenance” is used. To build resilience in future street tree populations, in the face of projected climate change, it would be worthwhile to obtain nursery stock sourced from parent plants living in hotter and drier regions. At present, nurseries commonly grow stock of known provenance for revegetation using indigenous species and could be contracted to grow specific stock for street tree purposes. At the very least, it is important to know the environmental parentage of nursery stock intended for street tree planting.

In the case of tree species that are exotics from other countries and intended for street tree plantings, it would be useful to know -
* the source of the original propagation material, as regards its climatic parameters, or
* the performance of trees derived from the original propagation material in both the current climate and hotter and drier climates

This would enable selection of species that are more likely to perform well in hotter and drier projected climates.

6. Weed potential in future climates

In selecting street tree species for a particular area, it is usual to eliminate from planting lists those species that are recognised as weeds and that are likely to invade natural areas nearby, by reference to national and state weed lists. Given the time lag between new plant introductions to an area, and the appearance of plants as weeds in natural areas, there is always the possibility that plants currently being used in landscapes have future weed potential. Some databases of “emerging weeds of significance” exist, for current conditions.

It is possible that current street tree species could become weeds in a climate-changed future environment, or that new street tree species suggested could also become weeds in the future. The tree species should be assessed for weed potential e.g. the production of abundant fruit and/or seeds, the rapid in budding of fruit and/or seeds, high levels of seed viability etc. Those tree species that are potentially weedy should be avoided. It is often suggested that low fruiting or sterile selections of desired urban tree species can minimise future weed problems and is cost-effective in the long term.

7. Monitoring health and condition of current street tree populations is critical

Given that climate change has already been occurring over the last 50 years or so (CSIRO & BoM 2010), monitoring of the performance of existing mature street trees, as well as the survival during the establishment phase of newly planted street trees, is critical to determine whether and how to modify existing street tree planting lists.

Given that Toowoomba Regional Council (TRC) already has a Street Tree Inventory (presumably a complete listing of all trees throughout Toowoomba City, and maybe of some other towns in the region), the ongoing collection and addition of monitoring data by TRC regarding tree condition / health would be worthwhile. The focus should be on tree health in relation to extreme climatic events e.g. prolonged dry periods, storms etc. Any increase in insect damage associated with higher temperatures should also be noted.

8. Tree canopies and access to sunlight for solar hot water panels and photovoltaic panels

An emerging issue for urban street tree selection and placement, in relation to climate change, is canopy shading which impacts upon solar hot water panels and photovoltaic panels, which are increasingly used as carbon reduction strategies. There is also the issue of access to northerly sunlight in winter, for passive solar heating, and shading of east- and west-facing windows in summer, for maintaining cooler house temperatures.

These issues require street tree species lists to contain both deciduous and non-deciduous tree species, as well as species of different mature heights, so that the most appropriate species can be placed at particular sites.

9. Sustainability principles relevant to urban forests (Clark et al. 1997) - healthy trees that are well adapted to local growing conditions, species diversity, age diversity, climate-appropriate tree cover and native forest stands as one component of tree cover

Creation and management of urban forests, including the street tree component, in order to achieve sustainability has received greater attention over the last decade or so (e.g. Clark et al. 1997; Lacan & McBride 2008; Kirnbauer et al. 2009). Sustainable urban forests have features relating to the vegetation (tree) resource itself, to the community framework underpinning the urban forest and to aspects of resource management.

In relation to the tree resource, attention is usually paid to -
* species mix
* age distribution
* canopy cover
* locally native vegetation (biodiversity)

9.1 Species mix and age distribution

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9.1 Species mix and age distribution

Species diversity underpins the long term health of urban street tree populations. Past experiences with species-specific pests or diseases, such as with Dutch elm disease in the northern hemisphere, have indicated the problems arising from depending upon one tree species (or a few species in a vulnerable genus), even if this species is an otherwise outstanding street tree.

It is often recommended that no more than 10% of a city's tree population, or 5-10%, consists of one species (e.g. see Clark et al. 1997; Santamour 1990), such that there should be at least 10 different tree species (or 10-20 species) making up the majority of the street tree population. This provides some protection against the introduction of a new pest or disease to an area.

Another frequently cited recommendation is the 10-20-30 formula (Santamour 1990) for urban tree planting, such that there is no more than 10% of any one species, no more than 20% of any one genus, and no more than 30% of any one family. This formula addresses more broadly pest and disease problems, since some pests and diseases have a wide host plant range and may attack trees in several families (e.g. Armillaria root rot), trees in several genera within a family (e.g. Myrtle Rust, caused by Uredo rangelii, which has been newly recorded in Australia) or trees of several species within a genus.

Lacan & McBride (2008) have recently proposed a Pest Vulnerability Matrix (PVM) methodology for assessing tree species diversity and urban forest susceptibility to insects and diseases. PVM depends on assembling pest (insect pests and diseases)-host information for the common urban trees in an area, assigning pests to one of three severity classes, and expanding the matrix to include pest-host information for proposed tree plantings as well as emerging pests relevant to both existing and proposed urban trees. The PVM matrix can be run with just the 20 or so most-common trees species since this will largely determine overall vulnerability.

Of relevance to pest and disease vulnerability is the three-way interaction between trees, pests and diseases, and environmental factors. It is known that plants that are stressed by environmental factors are more susceptible to pest and disease attack, and that infested and infected plants are similarly more susceptible to environmental extremes. In a climate changed future, different pest and disease problems may emerge on existing trees and, if existing trees are stressed in hotter and drier climates, the extent of pest and disease problems could increase.

As well, there is always the possibility of new pests and diseases being introduced into an area, as occurred recently with Myrtle Rust. Since Myrtle Rust affects a range of genera within the family Myrtaceae, urban tree managers in Australia should pay more attention to the 10-20-30 formula (above), such that this family comprises no more than 30% of the tree population, with no more than 20% in any one genus within the Myrtaceae. At this stage, the extent of potential problems with Myrtle Rust are not known but the Precautionary Principle should be applied.

There has been a brief debate on urban tree diversity in relation to stability of urban tree populations over time (e.g. see Sanders 1980/1981, Richards 1982/1983, and a reply by Guntenpergen & Stearns 1982/1983). Stability for a street tree population refers to "a low probability that the number of functional trees will decline over the foreseeable future to the point of disrupting both the values of the population and the management allocations needed for removal and replacement of trees" (Richards 1982/1983).

Both species diversity and age distribution are components of urban tree diversity. Species diversity is considered above. Age distribution is not often considered in as much detail, but the predominance of the major species in the street tree population in mature age classes will have a destabilising effect on the population when many of them die over a short time frame in the near future. Given that different tree species have different life-spans, it is possible that periods of decline of different major species could inadvertently coincide. This problem has been identified in Canberra's urban trees, where longer-lived trees planted in the 1920s and shorter-lived trees planted in the 1950s are aging simultaneously, and declining in a drying climate (Flanery 2010).
The main conclusions from this debate are given in Table 4 below, with climate change comments added by the author of this document (JT).

Table 4. Species and age diversity in urban tree populations, and performance of particular tree species, and their relationships to stability in urban tree populations - conclusions to date and relevance to projected climate change

<table>
<thead>
<tr>
<th>Diversity/stability in urban tree populations</th>
<th>Relevance to projected climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tree species diversity</strong> is important, to protect against species-specific effects, such as pests and diseases, but also environmental incidents (e.g. storms).</td>
<td>Tree species diversity is also likely to provide some protection against projected climate change.</td>
</tr>
<tr>
<td>Species diversity should not be pursued for its own sake, such that known successful and long-lived tree species are not cloned.</td>
<td>Known successful and long-lived street trees* may or may not be suitable in a climate changed future, but active monitoring of existing trees as the climate changes will help answer this question.</td>
</tr>
<tr>
<td>The oldest, surviving street trees are likely to indicate the trees best adapted to the current site conditions, since less-adapted species will have been lost over time.</td>
<td>The oldest surviving street trees are best adapted to current and past climates, and not necessarily best adapted to future climates.</td>
</tr>
<tr>
<td>Take care with accepting species/cultivar recommendations from other tree managers at other sites (towns), even if the sites appear superficially similar.</td>
<td>New species/cultivars are unproven until adequately tested under the local site and cultural conditions. Even so, species/cultivars that are successful in the current climate may not be so in projected future climates.</td>
</tr>
<tr>
<td>Reduction of diversity can occur over time if undesirable or non-viable species are removed and replaced with a smaller number of the “best performing” (= currently best adapted) tree species.</td>
<td>Continually updated tree inventories are needed for continuous monitoring of tree species diversity, so that unintended biological simplification does not occur. The currently best adapted tree species may not be the best adapted in future climates.</td>
</tr>
<tr>
<td>Age diversity is arguably as important as species diversity. Good age diversity, to provide adequate successful replacements over time, is essential for tree population stability. However, planning to ensure an even age distribution exists in perpetuity is exceptionally complex.</td>
<td>Older and drier climates in the future may shorten expected tree life-spans, based on past experience. Less predictable life-spans will increase the difficulty of planning for age diversity even more.</td>
</tr>
</tbody>
</table>

9.2 Canopy cover

Street trees are a significant component of canopy cover in many cities and towns. To obtain multiple urban forest benefits, attention has recently turned to canopy cover and the establishment of canopy cover targets for different land use areas. These targets vary by climate and region.

As well, recent initiatives to promote pedestrian and cycle activity in streets, for health and transport reasons, combined with a focus on climate change resulting in hotter and drier climates, have seen some cities and towns planning to increase their canopy cover targets, especially in areas recognised as being currently “shade deprived in summer”. Canopy cover targets need to consider the balance between deciduous and evergreen species, as well as requirements for species with larger and smaller canopy sizes.

9.3 Native vegetation

Preserving locally native (indigenous) trees in bushland and forest remnants adds to the sustainability of the urban forest overall. Tree planting using locally native species, sourced from locally native stock (local provenance) and/or from stock in other areas (e.g. hotter and drier areas, as discussed previously), may be undertaken along streets and other corridors to connect remnants and provide wildlife corridors.

In view of projected climate change, it has been suggested that, in some cases, native tree species in urban forests, including as street trees, may serve as a seed source and refuge to facilitate latitudinal tree migration (towards the poles) (Woodall et al. 2010).

Equally significant, however, is the possibility that current non-invasive ornamental urban tree species could become invasive if the climate changes in their favour and that urban areas could facilitate non-native tree invasion beyond what is currently experienced.

10. Street tree species selection and climate change - flow-chart (Figure 5)

The process for refining street tree species lists in relation to projected climate change is outlined below in Figure 5.

The process involves data sets for -

- **climate** - both current and projected future climate
- **street tree lists** i.e. street trees currently used in Toowoomba City and other towns in the Toowoomba Regional Council (TRC) area - existing tree inventories and management documents e.g. Toowoomba Street Trees Plan (2003)
- **existing young and mature street trees** that have the potential to be monitored, or are actively being monitored at present
- **potential new street tree species** for Toowoomba City and other towns in the TRC area

An evaluation stage is then applied to the data sets to refine the current street tree lists by -

- deletions of unsuitable tree species i.e. those that are unlikely to perform well in projected future climates and/or have not be establishing or surviving recent hotter and drier conditions, as determined by monitoring of existing street trees
- additions of suitable tree species i.e. those that are likely to perform well in projected future climates

The final street tree planting plans and programs (see large box at base of Figure 5) need to consider a range of other aspects commonly associated with a sustainable street tree population.

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Department of Environmental Sciences, UTS
Ph: (02) 9665 6663  
Email: Jane.Tarran@uts.edu.au
Figure 5. Outline for Street Tree Selection and Climate Change - Considerations and Strategies for Toowoomba Regional Council

<table>
<thead>
<tr>
<th>Climate Change Data</th>
<th>Current Street Tree Lists - Toowoomba Street Trees Plan (2003) &amp; Current Inventory</th>
<th>Currently Planted Street Trees</th>
<th>Proposed New Street Trees Lists</th>
<th>Replacements (old trees) or new plantings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate current climate, esp. rainfall &amp; temperature; annual averages &amp; extremes; focus on tree-relevant data</td>
<td>Evaluate current species against current climate via monitoring and incorporate into inventory</td>
<td>Monitor newly planted street trees for establishment success, performance in current climate, including dry periods and wet periods etc.</td>
<td>Evaluate proposed new street trees against current climate - new species should perform as well as or better than current species</td>
<td></td>
</tr>
<tr>
<td>Evaluate projected climate (2040-69 &amp; 2070-99), as above</td>
<td>Identify future climatic features that are most important for street tree selection - e.g. reduction in rainfall; average temp. increase, no. of days above 35°C</td>
<td>Prepare street tree planting plans and programs in relation to -</td>
<td>Prepare street tree planting plans and programs in relation to -</td>
<td></td>
</tr>
<tr>
<td>Delete, from tree species lists, current species that are not likely to tolerate projected future climate</td>
<td>Delete, from tree species lists, current species that are not establishing well in current climate and do not replant</td>
<td>Add, to tree species lists, proposed new street tree species that are likely to tolerate and survive well in projected future climates but will not become weeds</td>
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<td></td>
</tr>
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<td></td>
</tr>
</tbody>
</table>

References


Toowoomba Regional Council (TRC) (2010) *Future Climate Profile of the Toowoomba Region*, a report commissioned by Toowoomba Regional Council, November 2010 and USQ.


Appendix C - Community Engagement Process

The TRC Community Engagement Plan (2011) was followed for the TRC STMP project.

This document outlines the community engagement process which included:

- Internal TRC Workshop undertaken 8 February 2011 with Steering Committee and Council officers to gather information from people working across the region.
- Individual stakeholder contact throughout the project.
- PRELIMINARY DRAFT STMP issued for review on the 19 April 2011 followed by another Internal Stakeholder Workshop 12 May 2011 to enable stakeholder to comment on the Preliminary Draft STMP
- Councillor briefing session on the DRAFT STMP 22 June 2011
- Two community information sessions held 25 August 2011 to present the community with information on the DRAFT FINAL STMP
- Councillor Briefing presentation on FINAL STMP on 22nd October 2011

Appendix D - Soils of the TRC Area

The two main soil groups in the TRC area are the ‘black’ and ‘red’ soils. The black soils are highly reactive, dark clay soils that are highly fertile and possess a high water storage capability. They cover a large area of the western part of the city and occupy most of the open plains, lower hill slopes, and in some places, extend to the ridge crests. The red soils are moderately reactive, have a lower storage capability and are moderately fertile. They are easier to cultivate, and cover most of the eastern part of Toowoomba city.

Most of Toowoomba is covered by well-drained, red brown loams, which allow rainfall to percolate to the underlying ground water, recharging the system. There are areas of low water infiltration, along the creeks. The surrounding towns in the TRC area have a variety of soil types which are noted in the masterplan pages in Part D of this masterplan.

The following information is derived from the former Jondaryan Shire Waterwise garden CD (E Prentice 2006)

The soils found within the TRC area fall into the following groups:

- Ferrosol - mostly neutral to slightly acidic - red
- Dermosol - red brown to black, mostly neutral to slightly alkaline
- Upland Vertosol - neutral to alkaline, heavy black cracking clays
- Alluvial Vertosol - neutral to alkaline, heavy black cracking clays
- Sodosol – acidic topsoil, alkaline subsoil; sandy loam over clay e.g. Oakey

Important Features of the Soil Profiles

Ferrosol

Ferrosols are the red and red/brown soils of Toowoomba and isolated rises further to the west. These soils will support the largest variety of garden plants. These soils are low in fertility especially at depth. Most nutrition is found only in the A horizon where there is higher organic matter.

- pH: most are neutral to slightly acid (less acidic with depth)
- Drainage: moderately well drained
- Water holding Capacity: moderate
- Structure: red clays (non cracking)
- Topsoil Depth: medium to deep

Dermosol

These soils can range from red/brown to black but they share the feature that they are all very shallow. They are the soils of the hilltops and higher slopes. These soils are easily improved with soil conditioners and because they dry out quickly and are shallow, they benefit greatly from mulching.

- Locally the Dermosols group is made up of the shallow versions of soils similar to other classifications.
- pH: most are neutral to slightly alkaline, (Red types acidic to neutral)
- Drainage: range, most are well drained (Black types are imperfectly drained)
- Water holding Capacity: low
- Structure: range from loam to clay
- Topsoil Depth: shallow and rocky

Vertosol

Vertosols are the heavy, black, cracking clays. Those classified as “upland” exist where their parent rock is beneath them and they are usually not very deep. Surrounding land is usually hilly or undulating. These soils have some of the problems associated with the heavy black soil of the plains but drainage is slightly better because of the slope of the land.

- pH: neutral to alkaline
- Drainage: imperfectly drained, only slowly permeable
- Water holding Capacity: moderate
- Structure: medium clay
- Topsoil Depth: medium to deep

Alluvial Vertosol

These are again the heavy, black, cracking clays but the “alluvial” vertosols exist in gullies or on the flatter landscapes where the soil has been carried to its present location through the action of water (essentially they have washed into this place). These soils are deep to very deep. They are difficult soils for many plants and they also occur where frost is heavy.

- Mounding garden beds is recommended to improve soil drainage.
- pH: neutral to alkaline
- Drainage: imperfectly drained and only slowly permeable
- Water holding Capacity: very high
- Structure: medium to heavy clay
- Topsoil Depth: deep

Sodosol

These soils, for example found on the flatter parts of Oakey, are alluvial also, but they are mixed in their origin. They have a topsoil layer of lighter sandy loam over a distinctly different subsoil that is clay. The levels of Sodium in the subsoil varies with the different profiles. Sodium has a negative effect on the soil’s ability to hold nutrients and on soil structure. Some of the sodosols (e.g. Hm which has a black/grey subsoil that is high in Sodium) are difficult soils in which to grow many garden plants. Other profiles (e.g. Ok have subsoil clays that are red and not as high in Sodium) and will grow a wider range of plants.

- pH: acidic topsoil, alkaline subsoil
- Drainage: can be poor especially in the subsoil
- Water holding Capacity: low
- Structure: thin loams over deep, heavy, clay. Hard setting.
- Topsoil Depth: thin (varies from 10 to 40cm on average).

Sodic soils require good soil preparation and horticultural practices to achieve results:

- Applications of gypsum are normally recommended as it does have an effect on sodic soils. In the case of these mixed soils however it has little effect on the topsoil and so the difficulty is applying it so that it contacts the clay (Gypsum is not mobile through the soil).
- Avoid any cultivation that will bring the clay to the surface.
- The best results will be achieved with incorporation of good organic matter into the topsoil to improve its quality
- Surface mulching
- Careful use of fertilisers and irrigation (as an excess of both of these can increase the problem).
- Growing more salt tolerant plants
<table>
<thead>
<tr>
<th>Map Title</th>
<th>Map Scale</th>
<th>Map Unit</th>
<th>Year</th>
<th>Authors</th>
<th>Publisher</th>
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<td>Land Evaluation of an Area of Basaltic Soils near Pittsworth on the Eastern Darling Downs</td>
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<td>Soil Associations</td>
<td>1979</td>
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### Glossary

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**Bole height**

The height between ground level/base of the tree and the base of the first living branch that forms the tree canopy.

**Cold joints**

A joint formed when a concrete surface hardens before the next batch of concrete is placed against it; characterized by a poor bond unless special procedures are observed (Dictionary of Architecture and Construction, edited by Cyril M. Harris, published by The McGraw-Hill Companies, Inc.).

**DTMR**

Department of Transport and Main Roads, Queensland

**Green Infrastructure**

"... the network of natural landscape assets which underpin the economic, socio-cultural and environmental functionality of our towns ..." Australian Institute of Landscape Architects

**Linear Infrastructure**

Refers to infrastructure arranged in a linear manner such as roads or services.

**Street Tree**

For the purpose of this Street Tree Masterplan, street trees have been defined as deliberate plantings in a road reserve within an urban environment. Street trees do not include plantings within a park, garden or vegetation along rural roads outside town boundaries.

**STMP**

Street Tree Masterplan

**TRC**

Toowoomba Regional Council

**Urban Heat Island**

The effect of higher temperatures in urban areas compared to surrounding natural or rural areas. It is caused by a lack of shade and the presence of dark surfaces such as buildings and roads that absorb and reflect heat.

**WSUD**

Water Sensitive Urban Design