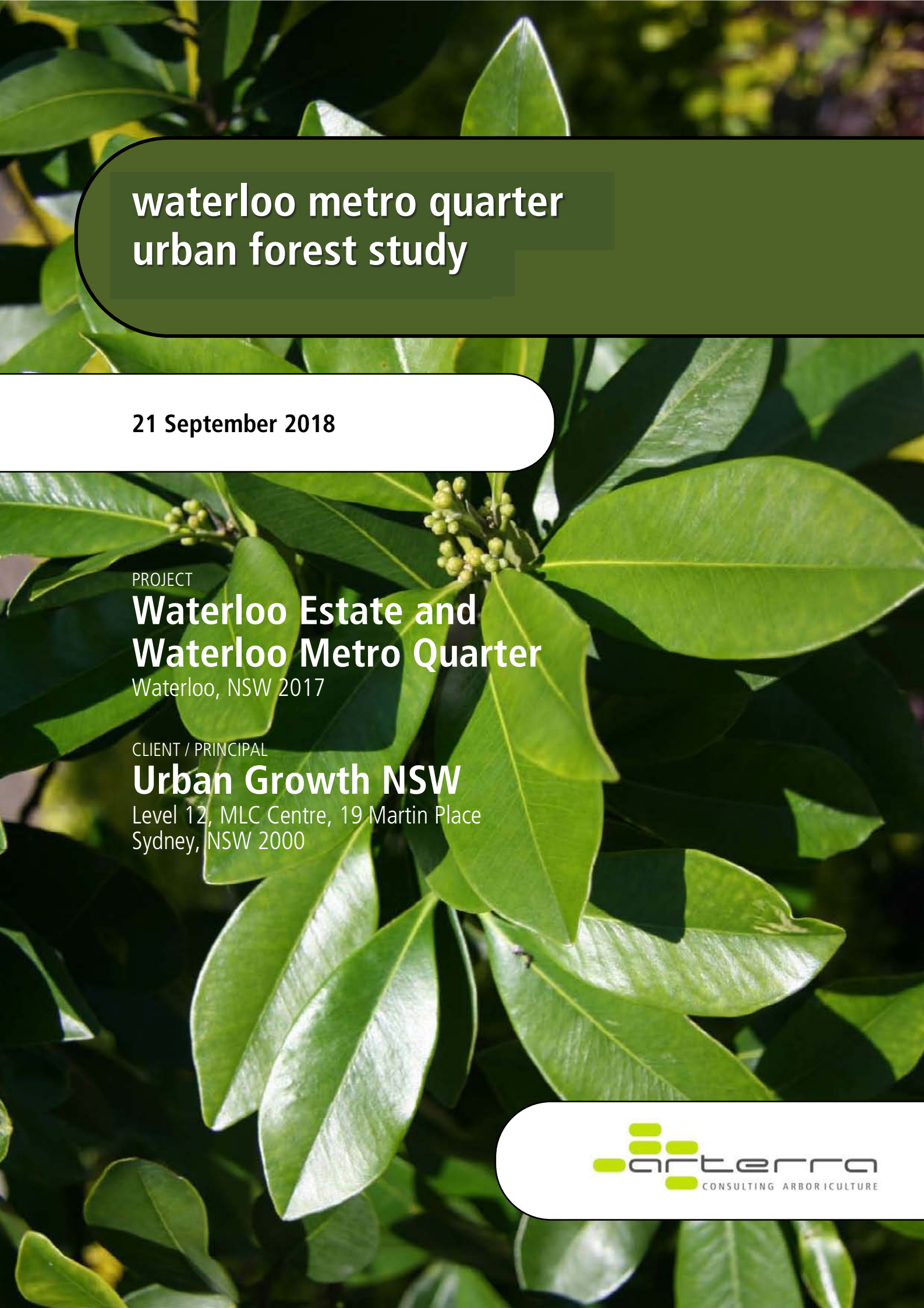

waterloo metro quarter urban forest study

21 September 2018

PROJECT

Waterloo Estate and Waterloo Metro Quarter

Waterloo, NSW 2017

CLIENT / PRINCIPAL

Urban Growth NSW

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Acknowledgements

This document has been prepared by Arterra Design Pty Ltd, using the expertise of our in-house consulting arborist (AQF Level 5), Robert Smart. Robert Smart is a member of the International Society of Arboriculture - Australian Chapter and also a Registered Consulting Arborist with Arboriculture Australia and a licenced Quantified Tree Risk Assessment practitioner. Robert Smart has 25 years experience in managing trees in complex development sites.

Disclaimer

This document is only to be used in relation to the Waterloo Estate and Waterloo Metro Quarter SSP precinct and is only to be used for the purpose for which it was commissioned and in accordance with the specific brief and contract between Arterra Design and Urban Growth NSW.

Arterra Design accepts no liability or responsibility whatsoever for or in respect of any use of, or reliance upon, this report and its supporting material by any third party.

The following limitations apply to this report: -

1. It is a strategy document: and is to provide guidance to the project urban designers and planners. The guidance is based on relatively brief site inspections, in some limited cases undertaken at some distance from the trees due to restrictions in access to parts of the site. It will be necessary to undertake further detailed site investigations once the exact nature and extent of the proposed site works are known for each construction project.
2. Plans: All plans are based on provided information and are illustrative for planning purposes only. They should only be used relating to tree issues and are not suitable for any other purpose.
3. Confidentiality: This report is confidential to the Client and should not be released to any Third Party without consultation with Arterra and consent from the Client.
4. Further consultation on tree related issues: We advise against any detailed designs based on this information being submitted for construction approval without the relevant tree related issues being reviewed by Arterra or another qualified arborist.
5. Trees outside the precinct are not specifically addressed as part of this report.
6. Timing : Written at a point in time with no consideration for changes to other projects outside the study boundary.

CONTENTS

i EXECUTIVE SUMMARY

This study has been prepared primarily to address the State Significant Precinct Study requirements, analyse the existing tree population and identify the tree related opportunities and constraints associated with the proposed redevelopment of the Waterloo Estate and Waterloo Metro Quarter. It is intended to provide UrbanGrowth NSW and its design consultants with information that clearly identifies and ranks the trees that are most appropriate to retain and protect, and outlines the broad methodology on how to potentially retain and protect them successfully. It also provides an outline and strategy to expand and enhance the urban forest with new tree planting, creating a diverse, sustainable, attractive and robust urban forest into the future.

Urban forests and urban trees are complex **natural** and **living** assets, often growing in close proximity to people, traffic and structures. Urban trees are often growing in harsh and unnatural environments and may be subject to damage or other influences that could lead to reduced vitality, shorter life expectancies and increased risk of tree failure. It is important that issues regarding the urban forest are stated and well understood early in the planning process and continue to be considered at the start of each detailed development stage.

Figure i.1 – Trees are one of the hardest working, multi-tasking assets within the cities green infrastructure. (Photo: Arterra)

The Existing Tree Population

Significant trees line many of the streets within the Waterloo Estate. Trees located in the adjoining parks, together with those within the setback of the existing residential developments, currently make significant contributions to the overall urban forest of the precinct and the Waterloo area.

- There are currently **1080** trees within the Waterloo SSP study area.
- **338** (30%) are street trees.
- A further **175** trees are in close proximity to the streets. Therefore a total of **513** trees or **47%**, of all trees are on, or very close to, the streets and may be affected by work that may happen in the streets.

- The majority of the 'High Value' trees are directly related to the streets, either street trees themselves or very close to the street edges.
- The 'overall' canopy coverage currently for the SSP area stands at **28%**. The City of Sydney (CoS) target is 27%.
- 30% of the SSP site area is road reserve. Currently street trees provide **32%** canopy coverage to 'street areas'. The CoS target is 50%, so we are falling short on this metric.
- Although the SSP now has very good canopy coverage, no historically significant trees were evident in the aerial images from 1943.
- The only significant trees evident in the 1943 aerial are located outside the SSP in the adjacent historical parks of Waterloo Park (Mt Carmel), and nearby Redfern Oval and Alexandria Park. This highlights that all the large and prominent Figs and Eucalyptus trees now scattered throughout the study area are typically less than **45** years old.
- The tree population is dominated by 4-5 main 'Families'. As expected, and as commonly found throughout many Australian cities, **Myrtaceae** dominates, at over 45% of the total population. The 'best practice' target is to have no more than 40% in any one 'Family'.
- **Tree Retention Values**. The individual number and the percentage of the total population of trees in the different retention value ratings are:-
    - High 181 (17%)
    - Moderate 329 (30%)
    - Low 547 (51%)
    - Very Low / Remove 23 (2%)
- With regard to the181 **High Value** trees, the majority are represented by the following species:-
    - *Eucalyptus microcorys* (Tallowood) (25%),
    - *Ficus macrocarpa var. hillii* (Hills Weeping Fig) (17%),
    - *Ficus rubiginosa* (Port Jackson Fig) (15%)
    - *Corymbia maculata* (Spotted Gum) (7%)
    - *Eucalyptus saligna* (Sydney Blue Gum) (4%) and
    - *Corymbia citriodora* (Lemon Scented Gum) (4%).

Figure i.2 – Artist impression of the Cope Street plaza at the Waterloo Metro Station. (Source: Turner Studio / Turf)

The Trees of the Waterloo Metro Quarter Precinct

The above statistics outline the existing urban forest over the entire Waterloo Precinct. The following summarises the basic statistics, as they relate to the immediate site and surrounds of Waterloo Metro Quarter. Please note that this includes the entire road reserve of Cope, Raglan and Wellington Street where it fronts the Metro Quarter. The study 'canopy coverage area' calculations only include to the centre line of the adjoining streets.

- There are currently **45** existing trees within the Waterloo Metro Quarter study area. All are street trees. There were no trees on private owned land within the Metro Quarter.
- **No historically significant** trees were evident in the aerial images from 1943, within or adjacent to the Metro Quarter and none were identified during site investigations.
- A large majority of the existing trees are **'low' retention value** trees due to their small size and or because they have been significantly misshapen by overhead power line clearance pruning. If retained

the misshapen trees are unlikely to sufficiently recover their form to become worthwhile contributors to the urban forest. It is recommended these trees be removed and replaced as part of a holistic approach to new tree planting, but at present are proposed to be retained.

- Several specimens, specifically the potentially very large growing figs on Raglan Street, would also be considered **unsuitable for their current location**, given their ultimate potential size and habit. It is recommended these trees be removed and replaced as part of the holistic redevelopment of the area, before they create issues and maintenance problems.
- There are **28** trees within the Waterloo Metro Quarter study area to be retained. Importantly all six (6) of the identified 'high' value trees are proposed to be retained and only one (1) moderate value tree is proposed for removal.
- As part of the master plan for the Metro Quarter it is proposed to plant approximately an **additional 90** trees. They are likely to be a mixture of approximately twelve (12) different species. These are mostly medium sized trees and generally comply with the current *City of Sydney Street Tree Master Plan's* suggested species. They are believed to be an appropriate choice for the spaces and streetscape proposed. Some seasonally deciduous species have been included to provide solar access in cooler months.
- The 'overall' potential **canopy coverage** for the Metro Quarter has been calculated at **23%**. The CoS target is 27%. This is a positive outcome given the highly urbanised locality and transport focussed nature of the Metro Quarter development. The provision of additional planting on the podium levels of the buildings, which has currently not been included, should mean the target is capable of being reached.
- 30% of the Metro Quarter precinct site area (calculated for Urban Forest purposes) is road reserve. Currently the existing and proposed street trees will provide approximately **53%** canopy coverage to these corresponding '**street areas'**. The CoS target is 50%, which currently exceeds the target and is a positive result for this highly urbanised precinct.

The Urban Forest Opportunities In The Metro Quarter

There are significant opportunities to protect and enhance the existing urban forest. Some key strategies of the Urban Forest Study for the Metro Quarter are outlined below:

- Achieve the overall 27% **canopy coverage** within the Metro Quarter. The redevelopment should aim to achieve the CoS targets of 50% canopy to streets.
- **Retain and protect** the most significant existing trees around the site. Incorporate them as mature elements within the proposed public domain landscape.
- Recognise that **mature trees require space** around them, to protect their roots, so it will be necessary to minimise buildings, level changes or service trenching though any areas retaining trees.
- Take an holistic view to new **street profile design** to work trees in as a core design element, not as an afterthought. Provide appropriate space above and below ground for trees to flourish. Consider final sizes of root plates, trunks and canopy, services alignments and setback from the road edges.
- Incorporate new and existing trees into **appropriately sized verge garden and lawn areas.** Provide adequate space for the trees trunks and structural roots to expand and allow infiltration of air and water into the root zones.
- Design pavements to direct surface water and runoff towards the existing and new trees to **passively irrigate** the trees in an ever-warming climate.
- Utilise trees for **wind amelioration**, understanding the most desirable forms, sizes and densities of tree canopy in given locations. Larger trees with dense canopies will typically be more important than smaller trees or trees with very open canopies.
- Incorporate a **range of species** into the final designs to increase resilience and population diversity. Consider species that currently prosper in slightly warmer climates to cater for climate change. Some deciduous trees may be required for better solar access during cooler months, particularly in the northern facing public spaces. Trees that transpire during hot conditions will help mitigate urban heat island effects through increased evaporative cooling. Good access to soil moisture and passive irrigation is critical for these trees.
- Specify a **diversity of sizes** with a balanced provision of small, medium, and large trees.
- Incorporate some trees into **upper levels of built forms**, on podiums and on roof tops to improve canopy coverage and increase connections to nature.
- Explore opportunities for **community orchard-style** planting in semi-public open spaces such as roof terraces and podiums to provide urban food production and community engagement with trees.
- Consider **expanded verge widths and in-road planting (blister)** opportunities to move trees away from services and building facades, allowing them to fully develop their canopies and ultimate sizes. This also shades street pavements and helps achieve canopy coverage targets. This type of planting also calms traffic and improves the perception of the street.
- Utilise structurally supportive soil systems and vaulted tree pit designs to provide appropriate soil volumes for vigorous and healthy tree growth in the long term under pavements. Utilise appropriate **setbacks** to allow the planting of trees away from street kerbs and potential vehicle impacts.

- **Don't over plant** for instant visual impact – allow time and space for trees to mature with full and symmetrical canopies where possible, considering the **ultimate size** of the species. Give trees space to access adequate resources rather than compete with each other. Trees will be easier to manage with better long-term health, and when the time comes for tree replacement, it will be easier and less likely to damage surrounding trees.
- Consider trees as a **multi-tasking asset** that provide shade, traffic calming, wind amelioration, environmental services, fauna connectivity and aesthetic benefits. They make the streets more inviting and contribute to people wanting to use them for activities like socialising, walking and cycling.
- Utilise **best practices** for plant stock procurement, planting and handling techniques and tree establishment maintenance to ensure the potentials of the urban forest are achieved and within acceptable resource limitations.

In terms of urban trees, the most important thing to consider as part of the planning is that all trees to be retained (and any new trees to be planted within the development) must be given the appropriate space to grow and thrive both below ground and above ground, in order to continue to develop and prosper for many years to come. **We must design our cities for the trees, not expect the trees to conform to the city.**

Figure i.3 – Existing trees are important assets. We must design to retain and utilise them and not expect them to conform to the cities needs. They are living and natural organisms and need to be supplied with the basics of life in order to prosper and provide the myriad of benefits we demand. (Photo: Arterra)

1.0 INTRODUCTION

1.1 Background and Overview

The Minister for Planning has determined that parts of Waterloo (the Precinct) are of State planning significance which should be investigated for rezoning through the State Significant Precinct (SSP) process. Study Requirements for such investigations were issued by the Minister on 19 May 2017.

Investigation of the Precinct is being undertaken by UrbanGrowth NSW Development Corporation (UrbanGrowth NSW), in partnership with NSW Land and Housing Corporation (LAHC) and Sydney Metro. The outcome of the State Significant Precinct process will be new planning controls that will enable development applications for renewal of the Precinct.

The Precinct includes two separate but contiguous and inter-related parts:

- The Waterloo Metro Quarter (**the Metro Quarter**)
- The Waterloo Estate (**the Estate**)

While the study requirements for the Precinct were provided as separate requirements for the Metro Quarter and for the Estate, comprehensive baseline investigations have been prepared for the entire Precinct. However, lodgement of a separate SSP study for the Metro Quarter in advance of the SSP Study for the Estate is proposed to allow construction of Over Station Development (OSD) within the Metro Quarter to be delivered concurrently with the Metro Station, as an Integrated Station Development (ISD).

While this report therefore provides comprehensive baseline investigations for the entire Precinct, it only assesses the proposed Planning Framework amendments and Indicative Concept Proposal for the **Metro Quarter**.

1.2 Purpose and Structure

The purpose of this report is to address the relevant Study Requirements detailed in Section 1.8.1. In summary it is to:

- Provide an urban forest study and guiding strategy consistent with the overall objectives sought for the Precinct and that supports the Waterloo Precinct Proposals.
- Provide a robust, defensible evidence base to inform the Precinct Proposals.
- Promote solutions to protect and enhance the urban forest that can be readily implemented and supported by key stakeholders.

1.3 Overall Precinct Objectives

The following are UrbanGrowth NSW and LAHC's objectives for renewal of the Precinct:

Housing: A fully integrated urban village of social, private and affordable housing.
A place that meets the housing needs of people with different backgrounds, ages, incomes, abilities and lifestyles – a place where everyone belongs. New homes for social, affordable and private residents that are not distinguishable and are modern, comfortable, efficient, sustainable and adaptable.
Services and Amenities: New and improved services, facilities and amenities to support a diverse community.
A place that provides suitable and essential services and facilities so that all residents have easy access to health, wellbeing, community support, retail and government services.
Culture and Design: A safe and welcoming place to live and visit.
A place where there is activity day and night, where people feel safe, at ease and part of a cohesive and proud community. A place that respects the land and Aboriginal people by showcasing and celebrating Waterloo's culture, history and heritage.
Open Space and Environment: High quality public spaces and a sustainable urban environment.
A place that promotes a walkable, comfortable and healthy lifestyle with high quality, well designed and sustainable buildings, natural features and safe open spaces for everyone to enjoy, regardless of age, culture or ability.
Transport and Connectivity: A well connected inner city location.
Integrate the new metro station and other modes of transport in such a way that anyone who lives, works or visits Waterloo can get around easily, safely and efficiently.

1.4 Waterloo State Significant Precinct

The Precinct is located approximately 3.3km south-south-west of the Sydney CBD in the suburb of Waterloo (refer Figure 1.1). It is located entirely within the City of Sydney local government area (LGA).

It is bordered by Phillip Street to the north, Pitt Street to the east, McEvoy Street to the south and Botany Road to the west. It also includes one block east of Pitt Street bordered by Wellington, Gibson and Kellick Streets. The Precinct has an approximate gross site area of 20.03 hectares (ha) (including road reserves and comprises two separate but adjoining parts:

1. The Waterloo Estate (the Estate); and
2. The Waterloo Metro Quarter (the Metro Quarter).

A map of the Precinct and relevant boundaries is at Figure 1.2.

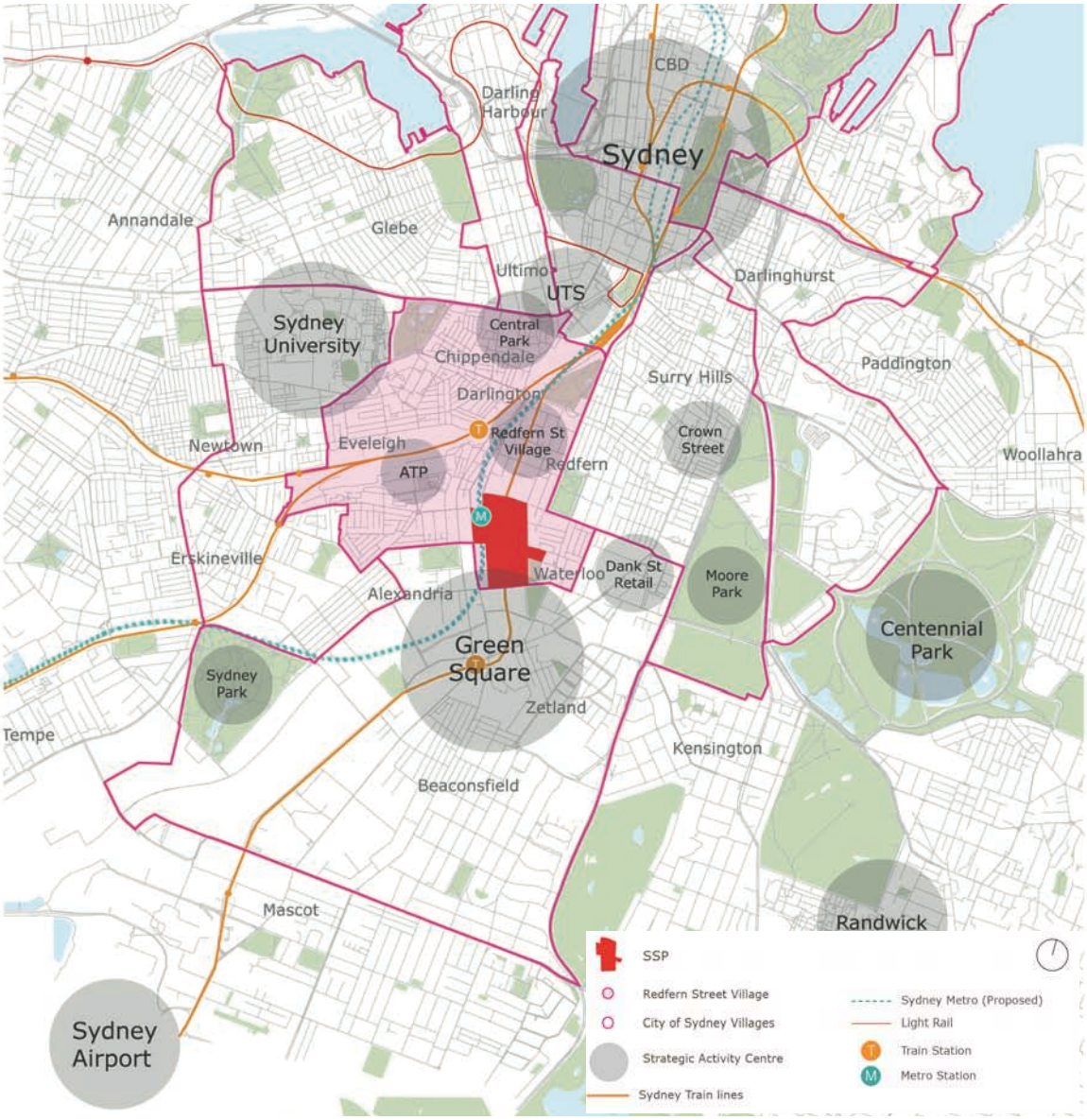

Figure 1.1 - Location and site plan of the Precinct [Source: Turner Studio]

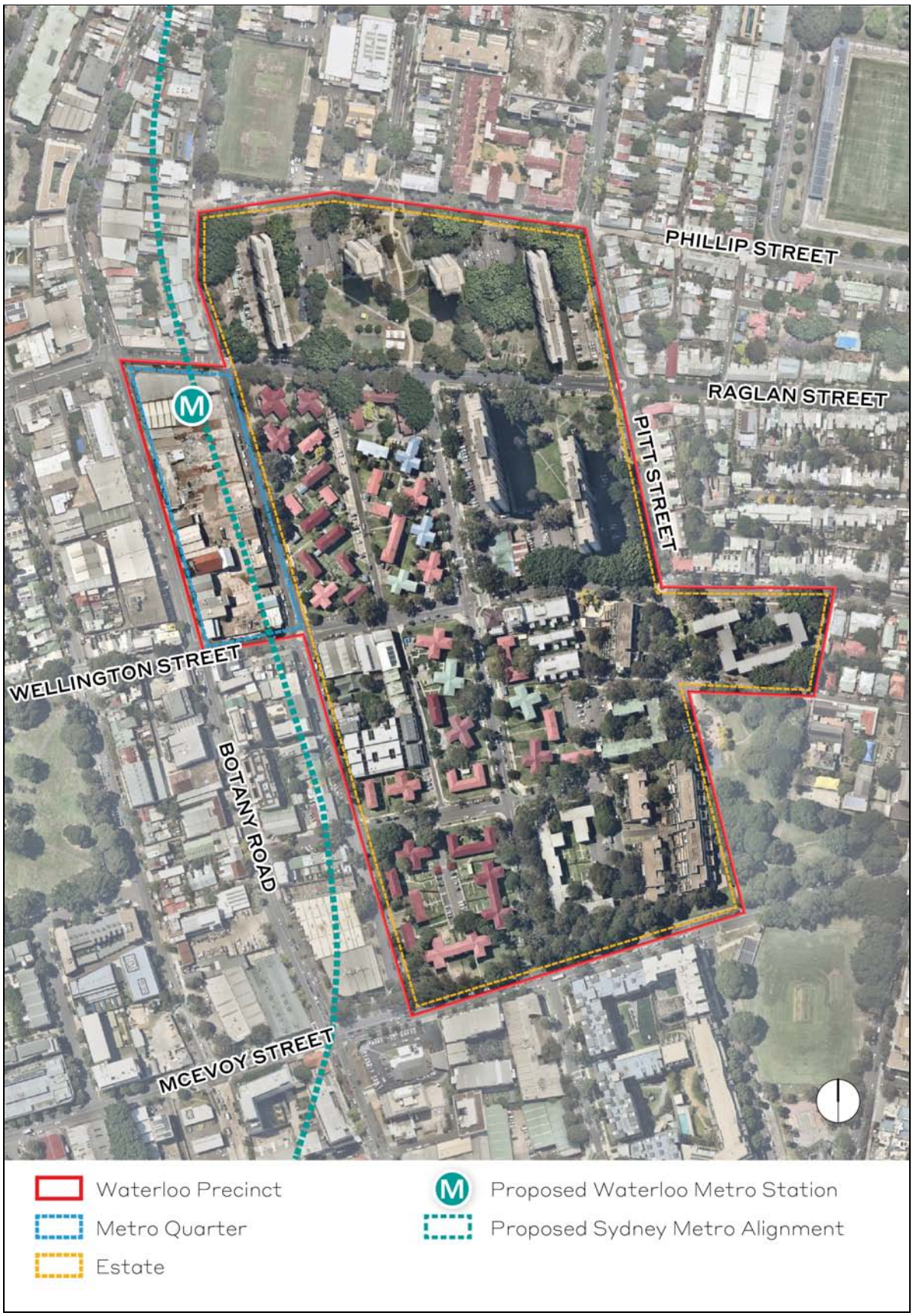

Figure 1.2 - Aerial photograph [Source: Ethos Urban and Nearmap]

1.5 The Metro Quarter

The Metro Quarter comprises land to the west of Cope Street, east of Botany Road, south of Raglan Street and north of Wellington Street. It has an approximate gross site area of 1.91ha and a developable area of 1.28ha. The heritage listed Waterloo Congregational Church located at 103–105 Botany Road is located within the Precinct. However, there are no proposals for physical works or changes to the planning framework applicable to the church.

Formerly privately owned, all land in the Metro Quarter was purchased by the NSW Government to facilitate construction of the Waterloo Metro Station and associated over station development.

Figure 1.3 – A plan of the proposed Metro Quarter development illustrating the built forms and proposed public domain improvements including a central plaza space fronting Cope Street. (Source: Turner Studio/ Turf Design)

1.5.1 Approved Metro Rail Infrastructure

The Waterloo Metro station will be constructed within the eastern side of the Metro Quarter as part of the Sydney Metro City & Southwest - Chatswood to Sydenham. This section of the Sydney Metro project received planning approval in January 2017 (SSI 15_7400), with construction led by Sydney Metro. While most of the Metro Station will be located beneath finished ground level, two substantial entry/plant structures, with heights equivalent to a 5 storey residential building (up to 20 metres), will protrude above finished ground level; one along the northern end of Cope Street, the other along the southern end of Cope Street.

Demolition of existing buildings has been completed and excavation of the Waterloo Metro Station is underway.

1.6 Why Are Trees So Important?

There is a considerable and rapidly expanding body of research that exists on the benefits that urban trees bring. The 'urban forest' consists of all trees and vegetation located within a defined urban area, irrespective of the tree species, origin (native, exotic), location (street, park, garden, school) or ownership (public, private, institutional).

The urban forest, often most easily measured as a canopy cover percentage of the total land area, is recognized as a primary component of the urban ecosystem (LGA NSW 2003). It is one component of a complex built environment that includes roads, car parks, footpaths, underground services, buildings and other urban structures (North Sydney 2011).

In practice, the 'urban forest' incorporates and encompasses all vegetation within streets, parks, wetlands, balconies, facades and roofs. This document, however, primarily addresses the existing and proposed tree stratum. The 'non-tree' vegetation, such as roof gardens, shrubs and groundcovers, and 'rain garden' planting is more specifically dealt with in numerous other technical studies being prepared for the precinct such as the urban and landscape designs, the ecological studies and the sustainability reports.

Trees in cities are a major and visible component of the natural resources upon which the City relies. They provide a substantial contribution to the "sense of place", and character of an area. They can have historical significance and provide numerous environmental and psychological benefits to visitors and residents. They can also provide important way-finding and 'landmark' statements. Trees of civic scale or with distinctive forms can be important markers in the landscape and help to demarcate the entry or gateways to an area or help to define important areas, improving way-finding and urban legibility.

Figure 1.4 – Trees are good. Trees provide the most significant and tangible contribution to an urban area's ecosystem services and the comfort and enjoyment of the public realm. A well planned street with excellent tree cover promotes walking and social interaction and contributes to many psychological and social benefits. (Photo-Arterra)

Examples of these benefits, both direct and indirect include:-

- reducing the urban heat island effect and moderation of other weather extremes and winds
- providing cooling and shading to pedestrians and buildings
- lowering energy use (due to the above)
- increasing longevity of pavements and road surfaces due to shading
- shading of parked cars and reduction in hydrocarbon emissions
- storage of carbon dioxide
- interception and storage of rainwater and stormwater via leaves and roots
- filtering of particulate matter and polluting gases
- ameliorating wind
- production of atmospheric oxygen and uptake of carbon dioxide
- provision of habitat for native fauna, birds and insects
- general human health, calming and wellbeing

Few things can compare with the visual impact and seasonal interest a tree provides. They foster community cohesion, creating a sense of place and local landmarks. Very importantly, trees can have surprising and profound effects on the psychological wellbeing of nearby residents, particularly in urban areas (Ferrini et al, 2017).

Trees remain one of the most cost effective measures of drawing excess CO^2 from the atmosphere. They also improve air quality by removing and storing a surprising amount of harmful pollutants such as sulfur dioxide, nitrogen oxides, particulates, and heavy metals such as cadmium, nickel and lead.

Figure 1.5 - Trees bring many important benefits, as well as beauty and delight. They can also play an important part of place making and community engagement, being the focus or framework for art installations and lighting displays. (Photo: Arterra)

They have also been shown to help reduce incidences of asthma and stress-related hypertension. Studies have shown that trees and other greens paces can have a therapeutic effect for children suffering ADHD, improving both attention levels and social function. Current studies in Ontario, Canada suggest that people who live in neighbourhoods with a higher density of trees on their streets report significantly higher health perception and considerably fewer cardio-metabolic conditions, even when allowing for socio-economic factors and demographic factors (Carpani, 2016).

Trees have also been shown to provide direct economic benefits to a region. The attractiveness of an environment is an important factor in attracting inward investment. Values of properties in tree-lined areas may be up to 6% greater than in similar areas without trees (Wolf, 1998).

Rental rates are up to 7% higher for commercial office properties having a quality landscape. Furthermore, consumers report being willing to spend up to 12% more in central business districts having large trees (Wolf 2009).

Figure 1.6 – The existing trees that were planted some 30-40 years ago have served the precinct well and often create a perception of a extensively planted, green area. They represent a large mix of species, sizes and ages and provide a good framework for a sustainable urban forest going forward.

Trees also have costs associated with planting and maintaining them and many challenges involved in growing healthy trees in otherwise complex and often unnatural, urban environments. Although the urban forest can most definitely be considered an asset, if not properly planned, cared for and managed, it can also become a liability.

The Waterloo Urban Forest Strategy (UFS) provides a strategic and long-term vision for the development and management of the Waterloo urban forest. Through careful planning and implementation of the UFS it is hoped the urban forest will mature gracefully and provide a long lasting legacy for future generations and make Waterloo a memorable and beautiful place in which to live, work and play.

1.7 Urban Forest Objectives

Urban forest management focuses on the "forest" or the broader population of trees and can be described as "the science and art of managing trees, forests and natural ecosystems in and around urban communities to maximise the physiological, sociological, economic and aesthetic benefits that trees provide society" (Schwab 2008).

This plan begins with the detailed assessment of the existing urban forest of the entire Waterloo SSP. The assessment provides insights as to the current composition, conditions, opportunities and constraints posed by the existing urban forest and the current urban landscape, both of which have evolved primarily since the construction of the Estate during the 1960s, 70s and 80s.

Having quantified the current status of the urban forest, the UFS will seek to answer two key questions:

- What do we want from the future Urban Forest – What is the future vision?
- What needs to be done in the planning stages to make this vision a reality?

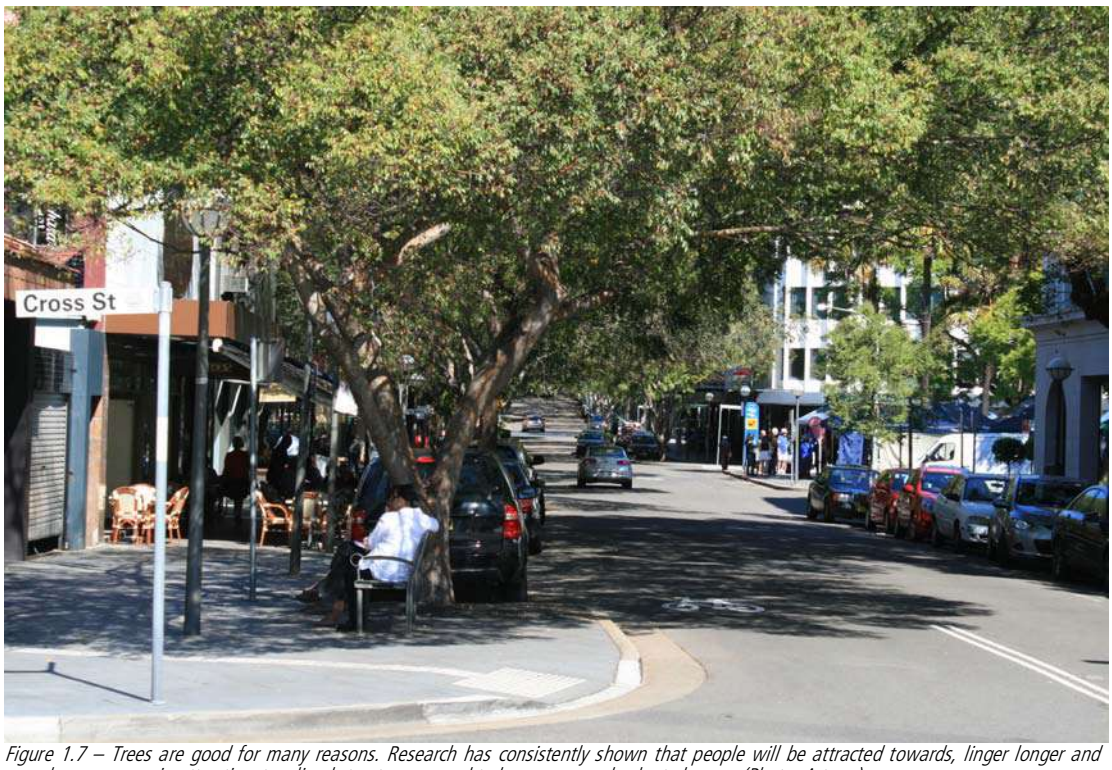

Figure 1.7 – Trees are good for many reasons. Research has consistently shown that people will be attracted towards, linger longer and spend more money in attractive, tree lined streets compared to barren or poorly planted areas. (Photo: Arterra)

1.8 Study Requirements and Methodology

The Urban forest is a complex natural asset and a major component of the green infrastructure and the natural resources upon which the City relies. As such, detailed planning and collaboration are required by professionals in key fields (such as arboriculture, landscape architecture, planning, engineering and heritage) to deliver an urban forest that will provide the community with the required environmental, social and economic benefits.

1.8.1 Study Requirements

On 19 May 2017 the Minister issued Study Requirements for the nominated Precinct. This report addresses the Urban Forest Study requirements identified as part of the State Significant Precinct (SSP) planning requirements for the Precinct, that is to identify the existing tree species, their location, size, condition, retention value and life expectancy. It provides guidance on the composition and history of the trees and the potential constraints and opportunities afforded by the existing trees within the study area.

This report discusses the trees that should, or could, be considered for retention as part of the new development and provides guidelines for the required Tree Protection Zones and other measures to enable the trees to continue to grow and thrive, where they are retained. The schedule of existing trees at Appendix 6.1 of this report provides the numerical Tree Protection Radius for each tree. This should be consulted as detailed development footprints and building envelopes and landscaping details crystallise beyond the current phase of the process.

Table 1 – SSP Study Requirements

SSP Reference No.	State Significant Precinct – Study Requirement	Where Addressed in This Report
14.1	This study requires a Project Arborist qualified in arboriculture to Australian Qualifications Framework (AQF) level 5 or above and have at least 5 years demonstrated experience in managing trees within complex development sites.	Acknowledgement and Author Qualification (pii)
14.2	Provide a preliminary arboricultural report that identifies tree location, condition, quality, life expectancy and indicative Tree Protection Zones to enable the urban design to minimise impacts to trees.	Section 2.0 and 6.0 Appendices of this report
14.3	Undertake an arboricultural impact assessment for the proposal outlining the trees to be removed or retained and the possible impacts on the trees to be retained including allowing for future construction methodology.	Section 5.2 and 6.0 Appendices- Drawing MQ04
14.4	The plan for the retention of existing and provision of new trees is to consider: a) the capacity of the public domain and urban design approach to protect existing trees and allow for the growth of new trees; b) species selection that maximises solar access during winter; c) the provision of sufficient soil volumes and quality (including within the private domain) provide for long term tree health; d) canopy design concepts that consider expanded verges and central verges (through setbacks, reduced carriageway or widened reservation) to increase planting, incorporation of landmark large scale trees in key locations and street gardens and low plantings to improve streetscape amenity; and e) coordinate outcomes of the Public Domain Design, Urban Design, Utilities (ensure overground utilities are undergrounded), Wind (ensuring that trees are not expected to be the wind mitigation device) and transport parts of this study.	Section 4.0 and 5.0 and the Public Domain Plan prepared by Turner/Turf
14.5	Demonstrate how the project addresses the CoS Urban Forest Strategy, in particular the following site specific targets: a) minimum canopy cover of 50% to streets, 25% to parks and 25% to private property; b) minimum species diversity targets of 40% family, 30% genius, and 10% species; and c) minimum distribution of tree heights of 10% small trees (3-5m), 45% medium trees (5-10m), 35% large trees (10-20m) and 10% extra-large trees (20m+). d) Consult closely with CoS	Section 5.0 and 6.0 Appendices. Note: Consultation has occurred with CoS Urban Forest Manager throughout the report preparation.
14.6	Provide an indicative tree and landscape planting strategy across the site, accounting for biodiversity and habitat considerations that includes: a) a tree sensitive public domain and that protects existing trees, and allows for the growth of new trees; b) species selection that maximises solar access during winter; and c) sufficient soil volumes and quality are provided for long term tree health.	Overarching guidelines provided in Section 5.0 with specifics addressed in Public Domain Plan prepared by Turner/Turf
14.7	Demonstrate that Council policies, strategies, master plans are complied with, including, Tree Management Controls: SLEP; SDCP; Urban Forest Strategy; Tree Management Policy; Street Tree Master Plan; Urban Ecology Strategic Action Plan and Landscape Code.	Whole of report

1.8.2 Existing Tree Assessment Methodology

An assessment of all the existing trees was carried out via a brief visual inspection from the ground only. The trees were photographed and all were given a unique identification number. This was aligned with the CoS tree asset ID number, where one had already been allocated. (This included most of the street and public park trees). Other private property trees were allocated a unique sequential number by Arterra. The tree locations were based on the issued survey plans. Most of these surveys dated from circa 2011, so Arterra verified the existence of the trees (some trees had been removed or added since the survey) and plotted them onto the accompanying drawings for referencing, co-ordination and identification.

Tree trunk diameters, tree heights and canopy spreads were estimated in the field and cross-referenced to survey information and current aerial photography. Canopy position and extents have been adjusted, where necessary, on the plans to more accurately portray the canopy extent and positions.

Due to difficulty in gaining access to certain private areas, some trees were only assessed from a distance, or from one side only. Arterra can, therefore, not guarantee that all significant defects or major issues were assessed and identified with all trees.

1.8.3 Relevant Guiding Policies and Strategies

The Waterloo UFS has been considered in relation to many other existing and draft Council and other authority policies that will influence the future pattern and development of our streets and tree planting. This has included documents such as:

- NSW Government Architects Office -The Green Grid-creating Sydney's open space network
- Transport NSW - Cycling Future 2013, Walking Future 2013
- CoS -Streets Code
- CoS -DCP 2012
- CoS -Public Domain Manual
- CoS -Landscape Code 2016
- CoS -Greening Sydney Plan 2012
- CoS -Urban Forest Strategy 2013
- CoS -Tree Management Policy 2013
- CoS -Street Tree Master Plan 2015
- CoS -Environmental Action 2016-2021 Strategy and Action Plan (Draft endorsed March 2017)

Some other documents considered include:

- Low Carbon Living CRC – Guide to Urban Cooling Strategies (July 2017)
- NSW Government Architects Office –(Draft) Greener Places (Oct 2017)
- National Green Infrastructure Network-Urban Ecology : Theory Policy and Practice in NSW (May 2017)
- City of Melbourne/Victorian Dept. Environment, Land, Water and Planning – How to grow an urban forest
- The Nature Conservancy Washington – Outside our Doors (2016)
- Trees and Design Action Group – No trees, no future : trees in the urban realm (Nov 2008)

1.8.4 Tree Retention Values of Existing Trees

The retention value of existing trees throughout the study area was assessed using a combination of techniques commonly used and recognised in the arboricultural industry. All the trees have been given one of the following retention values:

- High
- Moderate
- Low
- Very Low / Remove

The location of the trees and their relative retention values was plotted on to survey drawings. Refer to Appendix 6.4 for a graphical representation of the trees and their retention value for both the wider Waterloo Estate and the Waterloo Metro Quarter. Explanation of the criteria used to determine the 'Tree Retention Values' are summarised in the following pages.

"High" Retention Value – these are trees that are typically large and visually prominent, historically or environmentally important, in good or very good condition. They may also be part of an important group of trees. They should represent a serious physical constraint to the development and their removal avoided where possible and feasible. The following figures illustrate examples of 'high' value trees.

Figure 1.8 – Example of a significant 'High' value tree (Ficus microcarpa var. hillii a Hills Weeping Fig (T297) planted adjacent to Wellington St) (Photo: Arterra)

Figure 1.9 – Example of a significant 'High' value tree (Eucalyptus microcorys a Tallowood (T15097) planted on Wellington St) (Photo: Arterra)

"Moderate" Retention Value – these are trees that are in good to reasonable condition and should be retained where possible and feasible to do so. They may also be lesser trees, but part of a relatively good grouping of trees and therefore warrant retention based on the overall group's value.

The trees ranked as moderate as part of this assessment covered a broad range of trees and tree forms. Most were mature trees with average forms and vigour or some minor defects. Many were also smaller trees or semi-mature trees with very good forms, vigour and future potential to actively contribute to the urban forest, as shown in the examples below.

Figure 1.10 – Example of a 'Moderate' value tree (Cupaniopsis anacardioides – Tuckeroo (T8524) on George St) (Photo: Arterra)

Figure 1.11 – Example of a 'Moderate' value tree (a semi-mature Corymbia eximia – Yellow Bloodwood growing well and recently planted on Cope St (T6846)). This tree is in keeping with the desired species as set out in the CoS Street Tree Master Plan. (Photo: Arterra)

"Low" Retention Value – these are trees that are of poor condition or have structural defects, are particularly small growing or commonplace trees, are not historically, environmentally or socially significant and should not be considered as a constraint to the future development. They could be retained, but only if they are not likely to be impacted by, or constrain potentially desirable, development outcomes.

The trees ranked as low as part of this assessment were either considered young and replaceable, or were suppressed due to their close proximity of other trees or were in poor or declining condition, as shown in the examples below.

Figure 1.12 – Example of a 'Low' value tree (Eucalyptus bicostata – Southern Blue Gum (T963)) (Photo: Arterra)

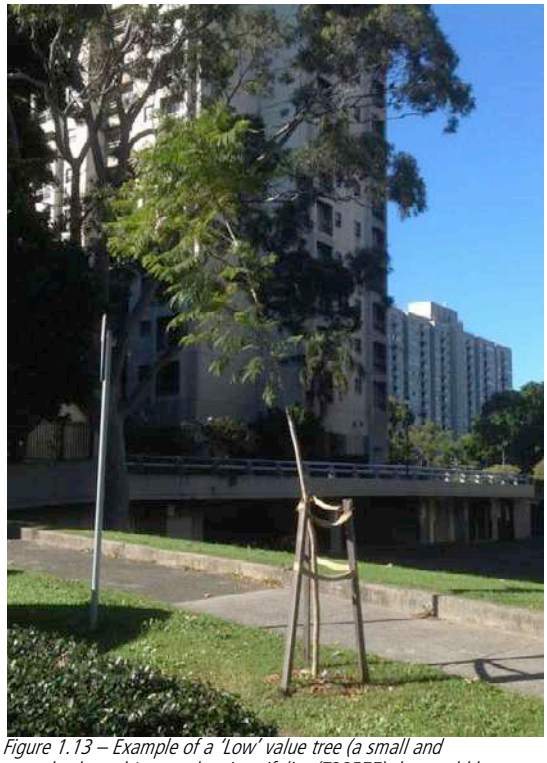

Figure 1.13 – Example of a 'Low' value tree (a small and recently planted Jacaranda mimosifolia- (T32577) that could be easily replaced if needed) (Photo: Arterra)

Figure 1.14 – Example of a 'Low' value tree (a very supressed Tristaniopsis laurina – Water Gum (T15088) on Wellington St growing under the much larger and more significant fig trees) (Photo: Arterra)

"Should Remove" / No Retention Value – these are trees that are in very poor health, or poor form, or have serious structural defects, are considered weeds or a combination of these, and therefore should be considered for removal regardless of any future development.

Figure 1.15 – Example of a 'Very Low' value tree (a very poorly formed Robinia pseudoacacia 'Frisia' – Black Locust (T12446) on Pitt St growing beneath power lines. (Photo: Arterra)

Figure 1.16 – Example of a 'Very Low' value tree - one of the many self-sown Celtis sinensis – Chinese Hackberry T461 growing within the private yards and car parking areas of the existing units, many are in very inappropriate locations and should be removed. (Photo: Arterra)

2.0 BASELINE INVESTIGATIONS – THE EXISTING URBAN FOREST

2.1 Site Context

The Waterloo SSP is currently a highly urbanised, primarily social housing estate, developed between the 1950s and 1980s. It is characterised by a variety of medium to high density residential developments interspersed with tree-lined streets, parks and public open spaces.

Significant trees line many of the streets within the Estate. Trees located in the adjoining parks together with those within the setbacks of the residential developments, currently make significant contributions to the overall urban forest of the precinct and the wider area.

Waterloo Estate is surrounded by several important open spaces within a 200m radius. Redfern Oval is located to the northeast, Mt Carmel/Waterloo Park is located directly to the east/ south-east, and Alexandria Park is located two blocks to the west. Tobruk Memorial Reserve is a small park located near the Waterloo Estate SSP at the eastern side, fronting Elizabeth Street.

Figure 2.1 - Today Waterloo is a variety of medium to high density residential developments interspersed with tree-lined streets, parks and public open spaces. (Photo: UrbanGrowth NSW).

2.2 History and Age of Existing Tree Population

By the 1820s this suburb located about 4km south of Sydney CBD supported a number of industrial operations, including a paper mill and the Waterloo Flour Mills, from which the suburb took its name. The area remained Crown Land until 1823 when 1400 acres were granted to William Hutchinson, as Waterloo Farm. In the 1850s Waterloo became an industrialised suburb. (Pollon, F. 1996)

Waterloo Estate, as it stands today, was developed over approximately three decades from the late 1950s to the 1980s. Some small trees can be seen in the 1975 aerial on the corner of Pitt and Philip Street and along George Street (Figure 2.5).

This highlights that all the large and very prominent Figs and Eucalyptus trees now scattered throughout the study area are typically all **less than 45 years old**.

Figure 2.2 – Aerial oblique of the development circa 1970. (Photo: Dept. of Housing/ LAHC).

It should be noted that although the site now has a very good canopy coverage (Figure 2.6 and 2.7), no significant trees were present in the aerial images from 1943 (Figure 2.4). The housing was mostly small, in tight rows of terraces. The only trees evident are outside the site in the adjacent historical parks of Waterloo Park (Mt Carmel), and nearby Redfern Oval and Alexandria Park.

The aerial images from 1943 through to 1975 provide a clear visual representation of the stark difference between that earlier period with virtually no trees and that of today with many tree-lined streets and numerous trees within the public and semi-public spaces.

Figure 2.3 – Extensive and significant trees of Mt Carmel. Although not specifically within the Waterloo SSP, they represent an important part of the urban forest due to the visual and historical significance they provide. (Photo: Arterra)

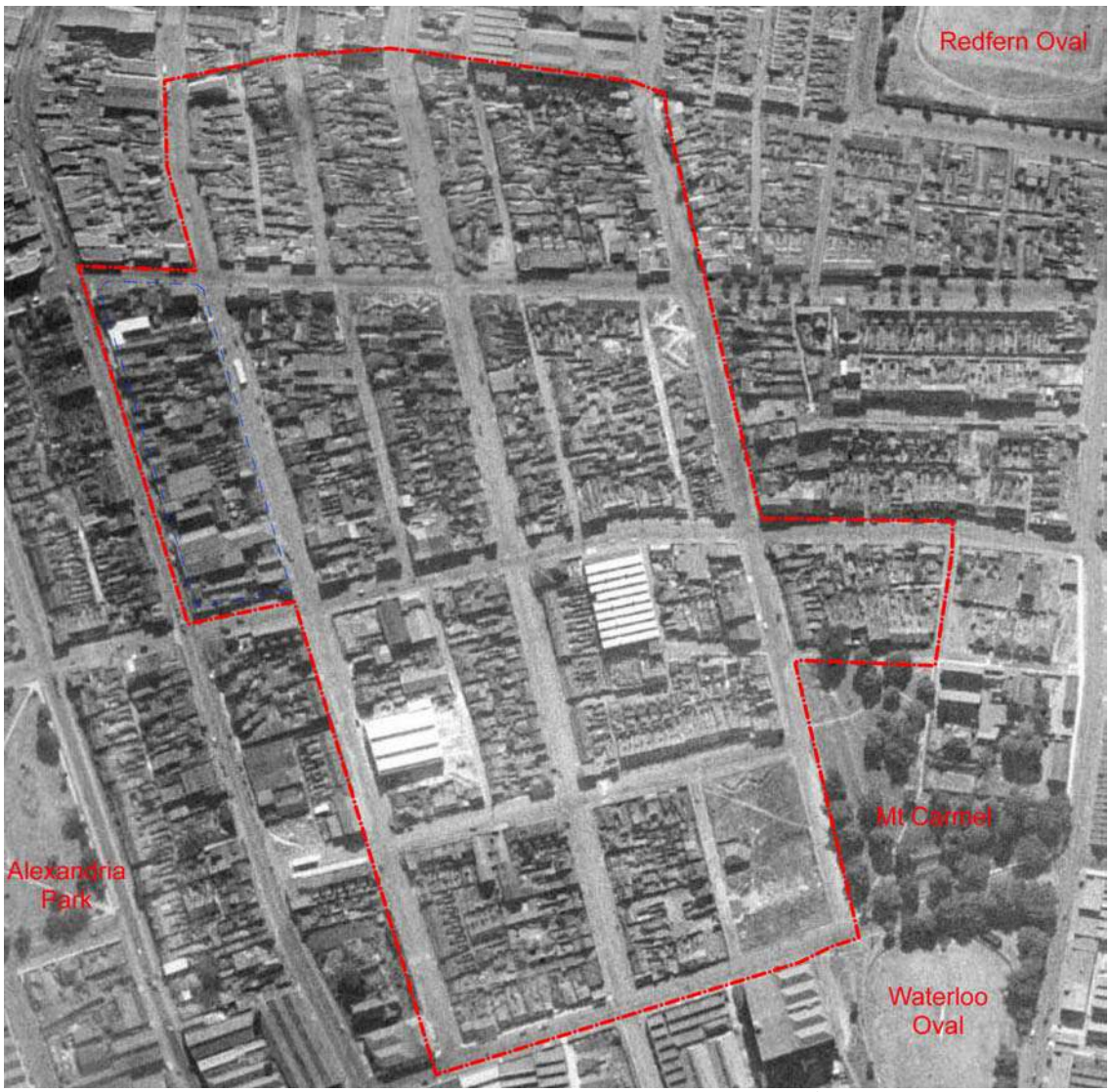

Figure 2.4 – 1943 aerial clearly showing the trees in the nearby parks, there appears to be no significant trees within the study area. (Source: NSW Lands Dept. - Six Maps)

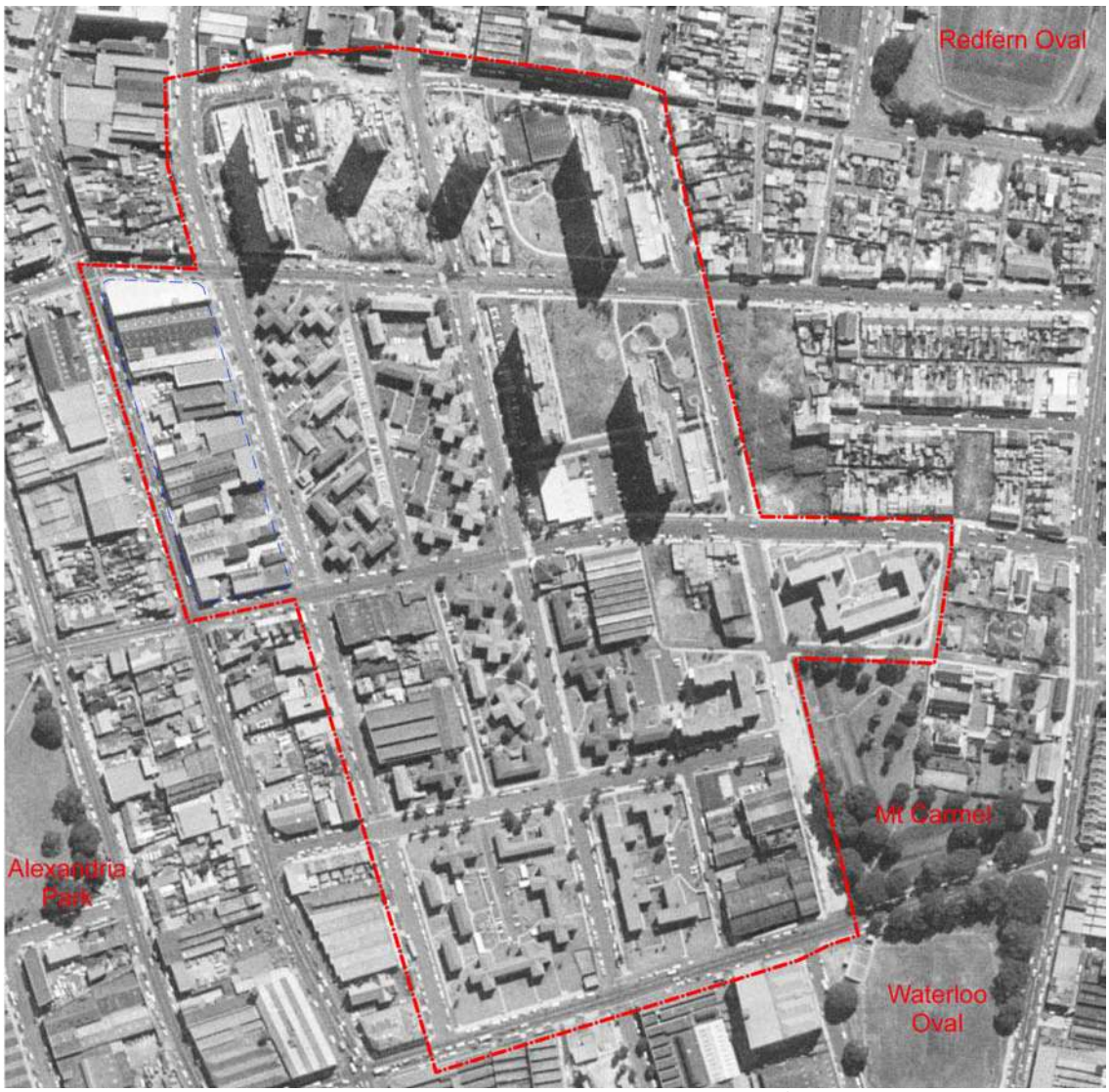

Figure 2.5 – 1975 aerial showing the trees in the nearby parks. Note there still appears to be very few trees within the study area. Some young trees are noted along George Street, John Street and in the corner of Pitt and Philip Street. (Source: CoS)

Figure 2.6 – 2017 aerial of the site illustrating its relatively dense tree canopy, dominated primarily by Hill's Weeping Figs, Tallowoods and some other large, but scattered, Eucalypts. (Nearmap 11.02.2017)

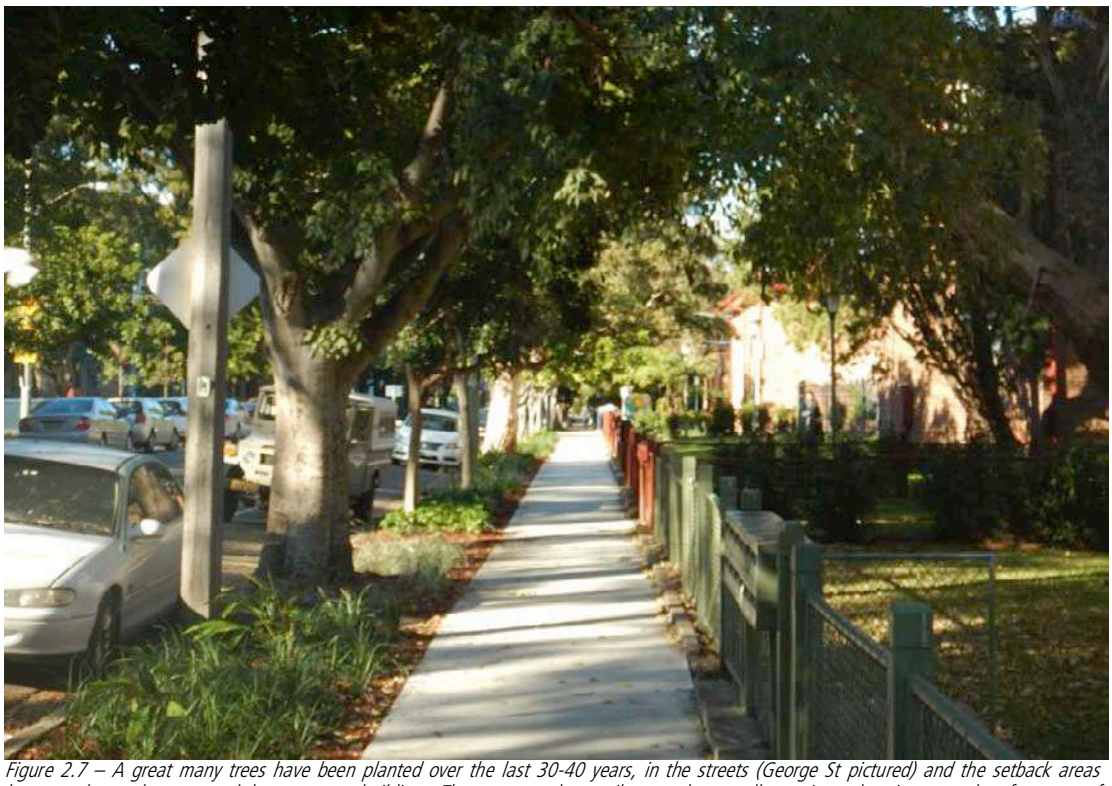

Figure 2.7 – A great many trees have been planted over the last 30-40 years, in the streets (George St pictured) and the setback areas between the road reserve and the apartment buildings. The trees greatly contribute to the overall amenity and environmental performance of the area. Where possible and feasible the existing trees should be retained and protected. (Photo: Arterra)

2.3 Soils and Landform

Soil mapping describes the area as being part of the Tuggerah Soil Landscape association, a geologically recent deposit of wind blown, fine to medium grained, well-sorted marine quartz sand. The topsoil is expected to be naturally a loose speckled grey-brown loamy sand, with little organic matter. The topsoil usually overlies a much deeper, bleached sand layer. Stones are usually absent. The soils are therefore expected to be apedal, non-cohesive with low fertility and low water holding capacity with extremely high permeability. (Chapman 1989).

The soil profile is therefore typically very deep (greater than 2m) sandy soils. This soil is generally non-cohesive, with a very low nutrient status and low available water holding capacity. The soil tends to be moderately to strongly acidic. Most importantly the top layers of soil can become water repellent. The area can be subject to extreme wind erosion and some localised flooding with permanently high water tables (typically within 2m of the surface), particularly in lower lying areas.

The soil conditions of Waterloo present one of the greatest challenges to successful street tree planting due to:

- Low water holding capacity
- Potential water repellency
- Very low fertility and inability to hold nutrients
- Acidic pH
- Shallow water tables

This can produce frequent drought-like conditions for trees, unless they are in an area where they can seek out and access more reliable groundwater reserves. Plants that are subject to prolonged or frequent water stress can be more susceptible to pests and diseases unless they are well adapted to these conditions.

On a positive note, the soil is deep and sandy which generally means less dramatic impacts between roots and infrastructure, as roots can travel deeper and more easily beneath roadways, pathways and footings. This is mainly due to the soil still containing enough pore spaces and oxygen to sustain root development, even at depth. In contrast, in more typical soils, particularly clay based soil conditions, roots will often be confined to the top 300-400mm the profile and cause greater impacts with pavements, kerbs and footings resulting in more pronounced damage.

This does not mean that surface roots will not still cause some issues. Experience has shown that many trees will still develop shallow roots systems in an attempt to access any rains that fall and provide structural stability in the non-cohesive soils. Similarly, all trees will develop a 'root flare' that will displace the soil immediately around

the trunk regardless of the soil conditions. The larger the tree the larger this 'root flare' area will be. Figs produce significant root flares due their buttressing roots.

The site has a slightly undulating landform, highly disturbed over the past 100 years to now create levelled areas for development. Slopes across the site are typically moderate with grades around 1 in 50 to 1 in 70 (1-3% slopes). There is, however, a sharp and notable increase in slope and elevation towards the eastern portion of the study area, primarily associated with the local rise in the topography around the Our Lady of Mt Carmel School and Waterloo Park (Figure 2.8 and 2.3).

Figure 2.8 – The notable rise in landform around Mt Carmel. The photo also illustrates the assemblage of historic figs that date from circa 1900 within Mt Carmel/Waterloo Park adjacent to the site. There is a mixture of Port Jackson and Morton Bay Figs, all of significant proportions and greatly contributing to the visual character of this portion of the study area and McEvoy Street. (Photo: Arterra)

2.4 Climate and Microclimate

The Waterloo area experiences moderate temperatures, good rainfall and minimal climatic and weather extremes. It is typically described as a 'temperate' climate with hot to warm summers and cool winters, with relatively uniform rainfalls across the seasons. There is no distinctly dry season. It is located very close to the moderating affects of the coast. The average annual rainfall is 1085mm, and is fairly evenly spread across the year but with a slightly drier period from July - October. The highest rainfall usually occurs in June with an average of 123mm and the driest month is September with an average of just 60mm (figures according to the Sydney Airport AMO weather recording station).

Maximum average daily temperatures, recorded range from 26.5ºC in January to 17ºC in July. The minimum average daily temperatures range from a low of 19ºC in February down to lows of 7.2ºC in July. Frosts are extremely rare.

The primary wind direction is from the north-east to south-east in the afternoons while it is predominantly from the west and north-west in the mornings. This is common of coastal areas dominated by 'sea breeze' affects. The strongest winds (>30km/h) are normally experienced from the south-east and southerly directions and later in the day. (Source: Australian Bureau of Meteorology).

In comparison with other areas of the greater western Sydney region, that experience much higher maximum and lower minimum temperatures and substantially lower annual rainfall, the Waterloo area enjoys a very comfortable climate which in turn lends itself to a very diverse range of tree species that will happily grow in the area. There are no noticeable microclimatic influences in the area apart from the overshadowing of existing and potential tower blocks and the associated wind funnelling and down drafts that may be experienced from adjoining tall towers.

The potential impacts of climate change should be considered which is likely to result in higher average temperatures, longer drought periods and increased extreme storm events. Planting selection, therefore, should consider these factors. This has been further highlighted for the Metro Quarter within the Climate Change Adaptation Report prepared by Aecom, with the various climatic scenarios, risks and mitigation strategies considered and discussed.

2.5 Existing Tree Population and Statistics

The following statistics and commentary relates to the entire **Waterloo Estate and the Metro Quarter combined**. It is intended to provide a background to the existing urban forest and provide an analysis and understanding of existing tree population. The information is provided to support the overall recommendations made for the Metro Quarter. For the existing trees as they relate specifically to the **Metro Quarter** please refer to Section 2.8 and Appendix 6.1.

Within the urban forest study area, **1080** trees were inspected and assessed (these numbers includes Mt Carmel/ Waterloo Park [on the northern side of McEvoy St] which was immediately adjacent to the study area).

The trees within Waterloo Estate are predominantly located in the public domain, the streets and the semi-public areas surrounding the residential towers. Although there are numerous trees in the private property areas, most of these are close to the existing street frontages or within the building setbacks from the streets. The trees that are within the more 'private' yards and spaces around the low rise apartment blocks tend to be relatively smaller trees and often self-sown 'invasive' or other less desirable species.

The following analysis has broken up the existing tree population into the different **families, genus, species** and **retention values**. These have been used to assess the existing tree population against the CoS targets. Corresponding plans in Appendix 6 visually display how the existing trees are distributed across the site, which was used for information and to help identify key trees and groups to be included and protected within the Waterloo Estate master plan. [Note: that the following analysis also includes the mature Fig Trees located in the immediately adjoining portions of Waterloo Park (Mt Carmel) [on the northern side of McEvoy St only]].

2.5.1 Existing Tree Family Distribution.

The tree population is dominated by 4-5 main 'Families'. The percentage of the population they represent is illustrated in the following table. The preferred CoS target is to have no more than 40% of one family. As expected, and is very common through most Australian cities, Myrtaceae dominates at over 45% of the total population.

Table 2 – Existing Trees By Botanic Family

Botanical Families	No.	% total pop.
MYRTACEAE (eg. Eucalypts, Corymbia, Tristaniopsis, Melaleuca, Lophostemon, Waterhousea)	490	45%
MORACEAE (eg. Figs)	118	11%
CASUARINACEAE (eg. Casuarina)	90	8%
FABACEAE (eg. Robinia)	69	6%
PLATANACEAE (eg. Planes)	45	4%
ARECACEAE (eg. Palm Trees)	43	4%
SAPINDACEAE (eg. Cupaniopsis)	42	4%
BIGNONIACEAE (eg. Jacaranda)	33	3%
ULMACAEAE	20	2%
MALVACEAE	17	2%
OLEACEAE	16	1%
PROTEACEAE	15	1%
PODOCARPACEAE	13	1%
HAMAMELIDACEAE	10	<1%
LAURACEAE	9	<1%
RUTACEAE	8	<1%
ROSACEAE	7	<1%
ARAUCARIACEAE	7	<1%
ANACARDIACEAE	5	<1%
MELIACEAE	4	<1%
PITTOSPORACEAE	3	<1%
SALICACEAE	3	<1%
ELAEOCARPACEAE	2	<1%
CUPRESSACEAE	2	<1%
EUPHORBIACEAE	2	<1%
LYTHRACEAE	2	<1%
MAGNOLIACEAE	2	<1%
ARALIACEAE	1	<1%
APOCYNACEAE	1	<1%
ASPARAGACEAE	1	<1%
Total	**1080**	**100%**

2.5.2 Existing Genus Distribution.

There are currently **71 different genera** within or immediately adjacent to the study area. The CoS target is to have no more than 30% of the population in any one genus. The top 15 genera are represented in the following table. As expected, and is common in many Australian cities, the Eucalyptus and Ficus genera currently dominate at approximately 29% of the total tree population (18 and 11% respectively).

Table 3 – Existing Trees By Botanic Genus

Most Prevalent Genus (in order of prevalence)	No.	% total pop.
Eucalyptus	196	18%
Ficus	117	11%
Casuarina	90	8%
Melaleuca	82	8%
Robinia	59	5%
Lophostemon	52	5%
Corymbia	52	5%
Platanus	45	4%
Cupaniopsis	34	3%
Jacaranda	32	3%
Agonis	20	3%
Callistemon	29	3%
Tristaniopsis	28	3%
Archontophoenix	25	2%
Celtis	17	2%

2.5.3 Existing Species Composition.

There are currently **111 different species** within or immediately adjacent to the study area. The CoS target is to have no more than 10% in any one species. The top 15 species are illustrated in the following table.

Table 4 – Existing Trees By Species

Most Prevalent Species (in order of prevalence)	No.	% total pop.
Melaleuca quinquenervia (Broad-leaved Paperbark)	76	7%
Eucalyptus microcorys (Tallowood)	75	7%
Casuarina cunninghamiana (River She-Oak)	68	6%
Ficus microcarpa var. hillii (Hill's Weeping Fig)	64	6%
Robinia pseudoacacia 'Frisia' (Black Locust)	58	5%
Lophostemon confertus (Brush Box)	52	5%
Platanus x acerifolia (London Plane Tree)	42	4%
Eucalyptus botryoides (Bangalay)	40	4%
Ficus rubiginosa (Port Jackson Fig)	38	4%
Corymbia maculata (Spotted Gum)	36	3%
Cupaniopsis anacardioides (Tuckeroo)	34	3%
Jacaranda mimosifolia (Jacaranda)	32	3%
Tristaniopsis laurina (Water Gum)	31	3%
Agonis flexuosa (Willow Myrtle)	29	3%
Callistemon viminalis cv. (Bottlebrush)	27	2%

2.5.4 Existing Tree Retention Values.

The number and the percentage of the total population of trees in the different retention values are shown in the following table.

Table 5 – Existing Trees By Retention Value

Retention Value	No.	% total pop.
High	181	17%
Moderate	329	30%
Low	547	51%
Very Low / Remove	23	2%

With regard to the High Value trees, the majority are represented by the following species:

- *Eucalyptus microcorys* (Tallowood) (25%),
- *Ficus macrocarpa var. hillii* (Hills Weeping Fig) (17%),
- *Ficus rubiginosa* (Port Jackson Fig) (15%),
- *Corymbia maculata* (Spotted Gum) (7%)
- *Eucalyptus saligna* (Sydney Blue Gum) (4%) and
- *Corymbia citriodora* (Lemon Scented Gum) (4%).

The remaining High Value trees are typically represented by only few individual specimens within any given species. Refer to accompanying Tree Retention Values Plan for a graphical representation of the tree retention values and their distribution around the site.

2.5.5 Existing Tree Age Class, Type, Size and Origin.

The tree population represents what would be considered a relatively normal breakup of age class, size and origin. None of these statistically represent a great cause for concern and the existing population provides a good basis upon which to create a sustainable urban forest strategy moving forward.

With regard to age of the population, the vast majority of trees fall into the mature age class. A good representation of semi-mature trees, however, is also present. Most importantly, there is very little evidence of an over-mature or senescent tree population that needs to be specifically addressed as part of the ultimate strategy. The new development is likely to introduce another wave of young tree planting that will help further balance the age class of the urban forest population.

Table 6 – Existing Trees By Age Class

Existing Tree Age Class	No.	% total pop.
Young	59	5%
Semi-mature	230	21%
Mature	790	73%
Over-mature	1	<1%

Table 7 – Existing Trees By Type of Tree

Existing Tree – Tree Type	No.	% total pop.
Evergreen	816	76%
Deciduous	199	18%
Palm-Single Stem	43	4%
Conifer	22	2%

Table 8 – Existing Trees By Vigour and Condition

Existing Tree – Vigour and Condition	No.	% total pop.
Excellent	29	3%
Good	593	55%
Fair	410	38%
Poor	41	4%
Moribund	4	<1%
Dead	1	<1%

Table 9 – Existing Trees By Its Ultimate Potential Size

Existing Tree – Ultimate Sizes	No.	% total pop.	CoS target.
Small	205	19%	10%
Medium	482	45%	45%
Large	369	34%	35%
Civic	24	2%	10%

Table 10 – Existing Trees By Origin

Existing Tree – Tree Origin	No.	% total pop.
Endemic to local area	175	16%
Native to wider Sydney region or Australia generally	602	56%
Exotic	274	25%
Invasive / Weeds	29	3%

2.5.6 Existing Canopy Cover

Current analysis of tree canopy coverage** in the different areas of the site is broken down in the following table. Refer to accompanying Existing Tree Canopy Cover Plan.

Table 11 – Existing Canopy Cover

Study Area	Total Area	Canopy m2	% total canopy	CoS target.
Parks / Reserves	0m2	0m2	0%	25%
Private	154,683m2	39,921m2	26%	25%
Streets	69,234m2	22,342m2	32%	50%
Total	**223,917m2**	**62,262m2**	**28%**	**27%**

**Note the site area and canopy coverage measurements includes the Waterloo Metro Quarter but does not include the adjoining Waterloo Reserve/Mt Carmel site which falls outside of the SSP study area and has therefore been excluded from the site area and canopy calculations.

We also note that the area calculations include the street reserves that are adjoining the precinct when they are Council controlled roads. We have only included the side of the road that directly abuts the precinct where the road is an RMS controlled road such as Botany Road and McEvoy Street.

2.6 Arrangement and Relationship to Existing Structures

The trees are situated widely throughout the Warterloo SSP study area, within the roadside verges, in the gardens surrounding the buildings and the public and semi-public open spaces. Most of the significant and important trees are often located either in the road verge or within the setback between the road reserve and the existing buildings.

2.6.1 The Fig Trees

- **Scale.** The numerous *Ficus microcarpa var. hillii* (Hill's Weeping Fig) and occasional *Ficus macrophylla* (Morton Bay Fig) are very large, civic-scaled trees that dominate much of the surrounding open spaces and streets. They require ample space both above and below ground.
- **Density.** The Figs have often been planted in close proximity to each other with very little consideration for their ultimate size and shape (Figure 2.9). Their canopies are often inter-grown and asymmetric and their roots intertwined throughout the adjacent built infrastructure and with other trees.
- **Infrastructure.** They are often planted very close to buildings and other infrastructure (Figure 2.10 and 2.11). This has often created issues with the form of individual trees and presents conflicts with the surrounding infrastructure such as footpaths, walls and car parking and below ground drainage lines.
- **Shade.** The Figs now present a real challenge for creating inviting and usable spaces beneath, and around them, due to the heavy shade, near constant fruit and leaf fall and extensive surface roots and buttressing. They do provide very useful shading in summer and substantially help to alleviate 'urban heat island' effects.
- **Root Systems.** The extensive buttress root system of the Figs will create challenges for developing new pathways and other new infrastructure (Figure 2.11). Adequate space must be allowed for the trunks and roots to allow for future expansion. The roots of figs often spread many 10s of metres away from the tree. Significant figs roots could easily be found 30-50m away from an individual tree.

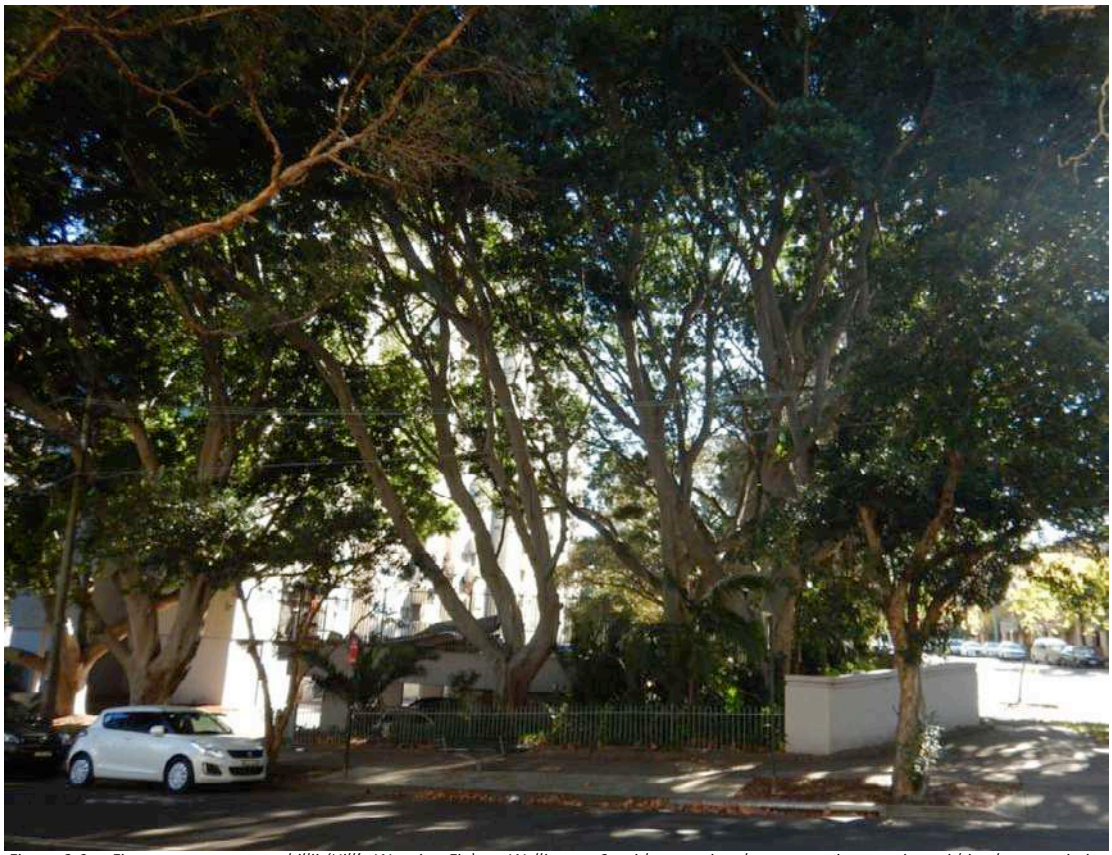

Figure 2.9 – Ficus macrocarpa var. hillii (Hill's Weeping Fig) on Wellington St with extensive dense canopies growing within close proximity of each other. (Photo: Arterra)

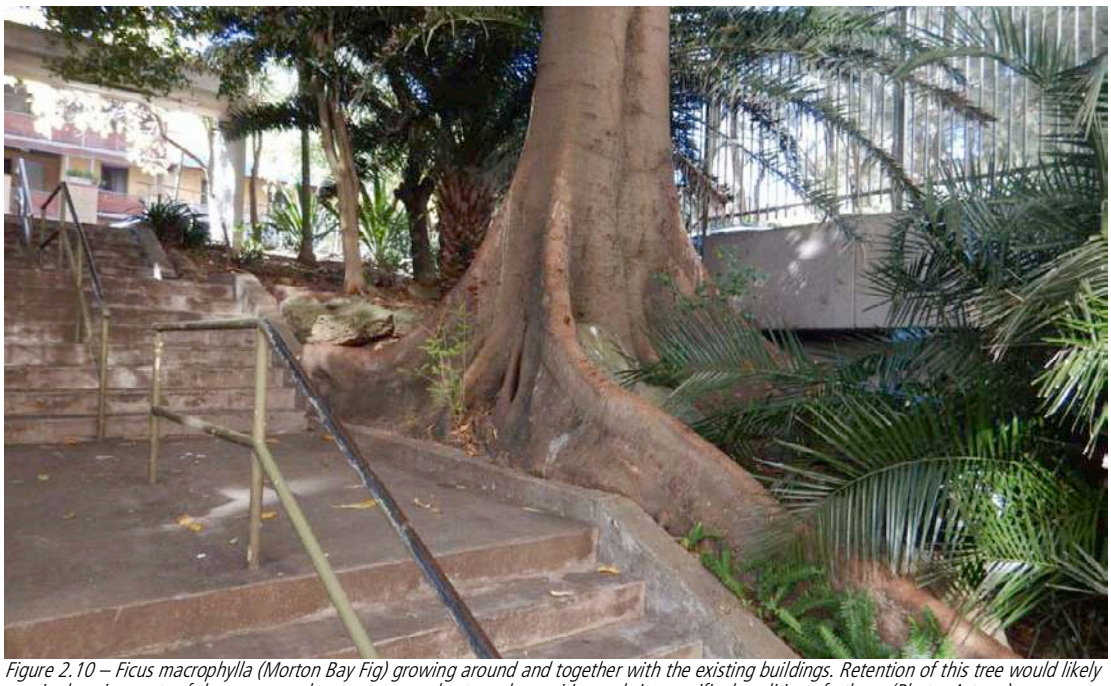

Figure 2.10 – Ficus macrophylla (Morton Bay Fig) growing around and together with the existing buildings. Retention of this tree would likely require keeping parts of the many nearby structures and extremely sensitive and site specific demolition of others. (Photo: Arterra)

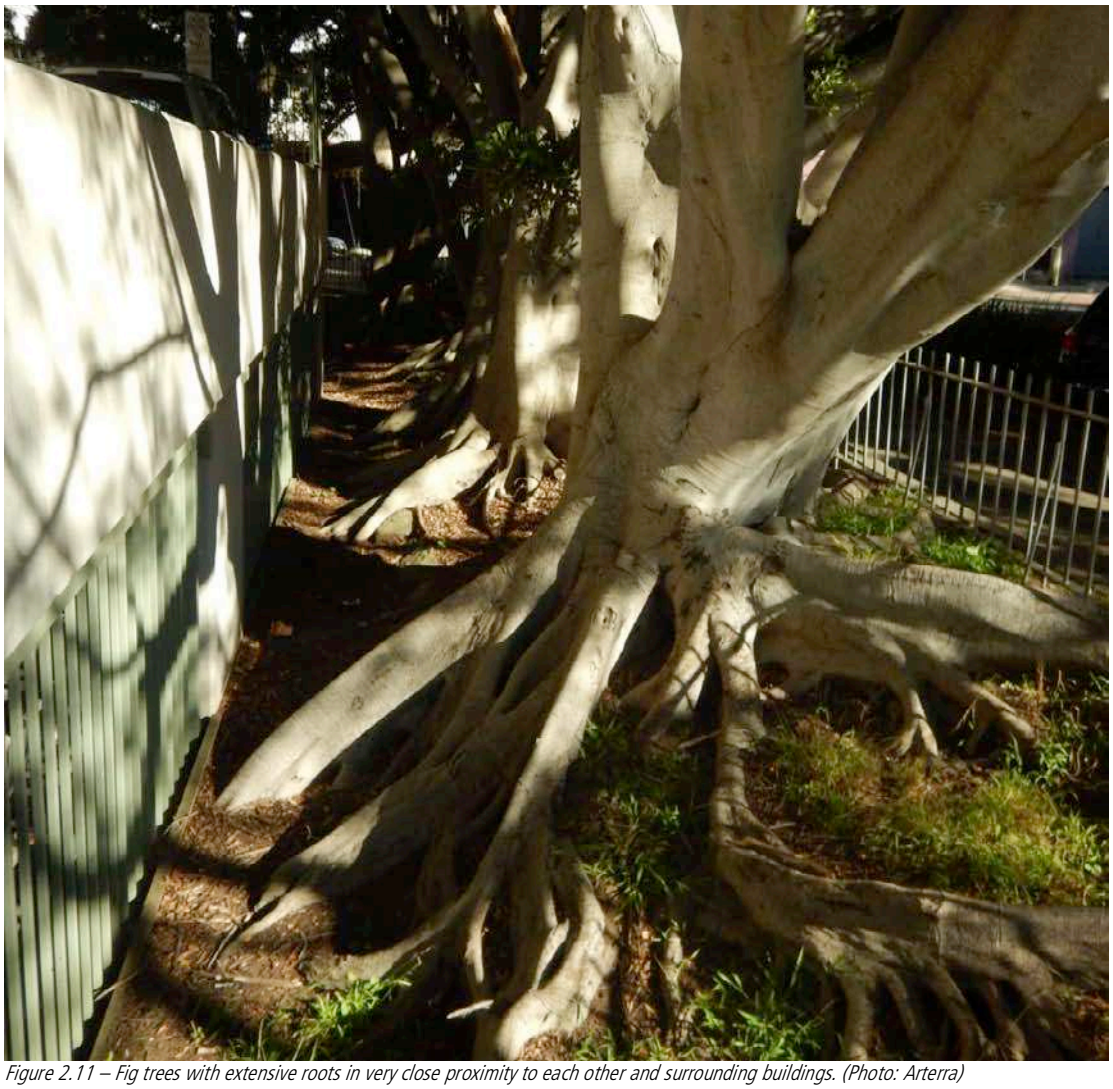

Figure 2.11 – Fig trees with extensive roots in very close proximity to each other and surrounding buildings. (Photo: Arterra)

2.6.2 Large Eucalypt (Gum) Trees

- **The larger Eucalypts** (eg. *E. bicostata* (Southern Blue Gum), *E. saligna* (Sydney Blue Gum) and *E. microcorys* (Tallowood)) across the study area provide excellent scale and landscape amenity. Their retention would add value and assist with the delivery of mature landscapes to the future buildings, streets and open spaces. This may prove challenging as Eucalypts generally have a relatively low tolerance of construction related disturbances.
- **Protection Zones.** Many of the Eucalypts have large trunk diameters and will therefore require extensive setbacks and tree protection zones in order to adequately protect them.
- **Demolition.** Like the Figs, many of the larger Eucalypts are very close to existing buildings and therefore demolition and excavation would have to be dealt with very sensitively if the trees are to be successfully retained.

Figure 2.12 – A large Eucalyptus saligna (Sydney Blue Gum) T435 near Reeve St. (Photo: Arterra)

2.7 Assessment of the Overall Existing Tree Population and its Composition

- **Composition by family, genus and species.** The composition of the tree population by species is already approaching or exceeding some set targets. Care will be needed when selecting species from the Myrtaceae family to prevent further skewing of the representation of this family. Current targets advocated by the CoS, and others, state that a single family should make up no more than 40% of the population and no individual species should represent more than 10%.
- **Size Distribution.** The current population is relatively balanced, however there is a slight over reliance on small trees. The planting of more 'civic' scaled trees in prominent and appropriate positions will help to balance the sizes of trees towards the larger spectrum. Notably, many of the smaller trees are very close to the existing apartments (eg. palms) and are likely to be removed as part of any redevelopment programs. This too will assist in re-balancing this statistic, provided medium and larger trees are planted around the new development and parks.
- **Age Distribution.** The current population is relatively balanced. The likelihood of new tree planting as a result of the redevelopment will maintain the age distribution of the urban forest at acceptable levels. Maintaining an appropriate distribution within age classes of the population allows a balanced approach to maintaining and improving canopy cover over time. Mature trees typically provide the greatest benefits in terms of canopy, however it is also important to remember that trees take many years to grow and provide the benefits of the mature tree. Trees will also grow old and eventually require removal, meaning that ongoing and relatively continuous planting is always required to maintain and improve the canopy and age class distribution into the future.
- **Canopy Cover.** The current canopy cover is very good and actually just exceeds the advocated target for the overall suburb. Retaining large, high value trees retains the canopy and immediately provides all the benefits (environmental, canopy, amenity, scale and aesthetics) of big trees to a new development. Removal of large canopy trees will have a corresponding negative effect and take many years to ameliorate and offset the losses. To achieve the stated aims of the precinct redevelopment meeting and exceeding the canopy coverage targets will be crucial.

2.8 Assessment of the Existing Tree Population and Composition for the Metro Quarter Precinct

Existing Trees. There are currently only 45 trees located with direct relationship to the Metro Quarter site. They are all located on the streets surrounding the Metro Quarter site. There are:-

- **8** trees on Raglan Street (between Botany Rd and Cope Street)
- **13** Trees on Botany Road (between Raglan St and Wellington St – east side only)
- **15** Trees on Cope Street (between Raglan St and Wellington St – east side only – no trees are located on the west side)
- **9** trees on Wellington Street (between Botany Rd and Cope Street)

Composition by family, genus and species. The composition of tree species at the Metro Quarter are:

- 8 x Lophostemon confertus (Brush Box) (Family:MYRTACEAE)
- 6 x Robinia pseudoacacia 'Frisia' (Black Locust) (Family:FABACEAE)
- 5 x Eucalyptus microcorys (Tallowood) (Family:MYRTACEAE)
- 5 x Eucalyptus sideroxylon (Mugga Ironbark) (Family:MYRTACEAE)
- 4 x Ficus benjamina (Weeping Fig) (Family:MORACEAE)
- 4 x Corymbia eximia (Yellow Bloodwood) (Family:MYRTACEAE)
- 3 x Melaleuca quinquenervia (Broad-leaf Paperbark) (Family:MYRTACEAE)
- 2 x Fraxinus griffithi (Griffith's Ash) (Family:OLEACAE)
- 3 x Platanus orientalis (Oriental Plane Tree) (Family:PLATANACEAE)
- 3 x Tristaniopsis laurina (Water Gum) (Family:MYRTACEAE)
- 1 x Eucalyptus camaldulensis (River Red Gum) (Family:MYRTACEAE)
- 1 x Ficus microcarpa var. hillii (Hills Weeping Fig) (Family:MORACEAE)

The majority (71%) of the existing trees related to the Metro Quarter are considered to be of Low retention value. There are 6 trees of High value and 8 trees of Moderate value. Most of the trees are young and small and have been severely impacted by previous overhead power line clearance pruning. Refer to Appendix 6.1 for a detailed listing and ranking of the trees related to the Metro Quarter.

Figure 2.13 – Example of the typical street trees along Botany Road fronting the Waterloo Metro Quarter. Most are small and heavily affected by previous overhead power line clearance pruning. (Photo: Arterra)

Figure 2.14 – Example of the trees along Raglan street fronting the Waterloo Metro Quarter. Most are small and heavily affected by previous overhead power line clearance pruning. Several of the Fig trees located on the northern side of Ragland Street are very inappropriate selections for the space available. (Photo: Arterra)

Figure 2.15 – Example of the trees along Wellington Street fronting the Waterloo Metro Quarter. The Melaleuca quinquenervia (Broad-leaved Paperbark) seen in the right of the photo is one of the High Value trees recommended for retention. (Photo: Arterra)

3.0 PLANNING FRAMEWORK AND PROJECT PROPOSAL

3.1 Proposed Planning Framework

This report relates to:

- An SSP Study to create a new suite of planning controls; and
- an Indicative Concept Proposal

for the Waterloo Metro Quarter ISD.

The existing and proposed planning controls for the Metro Quarter are illustrated below in Table 12.

Table 12 – Metro Quarter Development Statistics

	Existing	**Proposed**
Zoning	B4 Mixed Use	B4 Mixed Use
Height of Buildings	Part 12, Part 15 metres	- Part RL 116.9 (AHD) - North - Part RL 104.2 (AHD) - Central - Part RL 96.9 (AHD) - South
Floor Space Ratio	1.75:1	6.1:1 (including Metro Station)

Figure 3.1 – An artists rendering of the potential Metro Quarter streetscape fronting Raglan Street and the contribution tree and palm planting will make to the character of the spaces. (Source: Turner Studio/Turf)

3.2 Indicative Concept Proposal

The Indicative Concept Proposal for the Metro Quarter ISD comprises:

- Approximately 69,000 sqm of gross floor area (GFA), comprising:
    - Approximately 56,500 sqm GFA of residential accommodation, providing for approximately 700 dwellings, including up to10% affordable housing and 10% social housing;
    - Approximately 4,000 sqm of GFA for retail premises and entertainment facilities
    - Approximately 8,500 sqm GFA for business and commercial premises and community and recreation facilities (indoor).
- A three storey mixed-use non-residential podium, including a free standing building located within a public plaza of approximately 1,400 sqm.
- Three residential buildings of 23, 25 and 29 storeys, and four mid-rise buildings of up to 10 storeys above the approved metro station infrastructure.
- Parking for approximately 65 cars, 700 residential bicycles and 520 public bicycles.
- Two east-west, mid-block pedestrian connections.

Approval has already been separately granted for a Sydney Metro station on the site, which will comprise approximately 8,415 sqm of GFA. The total GFA for the ISD, including the metro station GFA is approximately 77,500 sqm. Transport interchange facilities including bus stops on Botany Road and kiss and ride facilities on Cope Street will be provided under the existing CSSI Approval.

The above figures are deliberately approximate to accommodate detailed design resolution.

The existing heritage listed Waterloo Congregational Church does not form part of the SSP Study Area.

Three dimensional concept drawings of the Concept Proposal are shown at Figures 3.2 and 3.3 below.

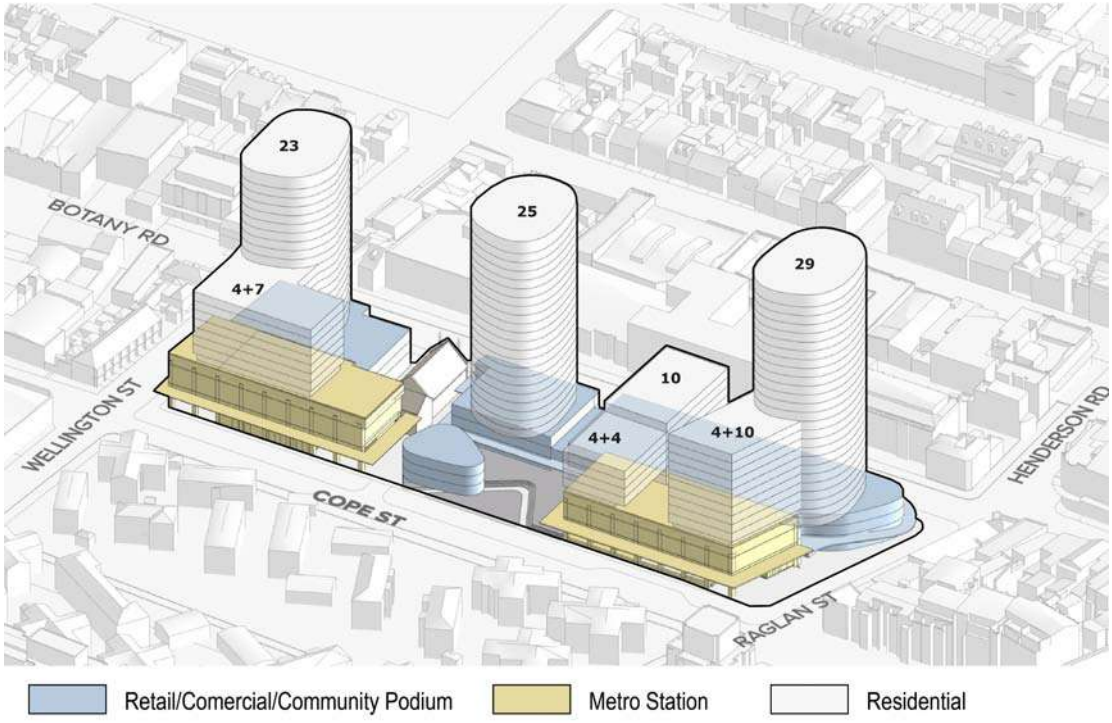

Figure 3.2 – Three-dimensional drawing of the Indicative Concept Proposal, viewed from the East (Source: Turner Studio)

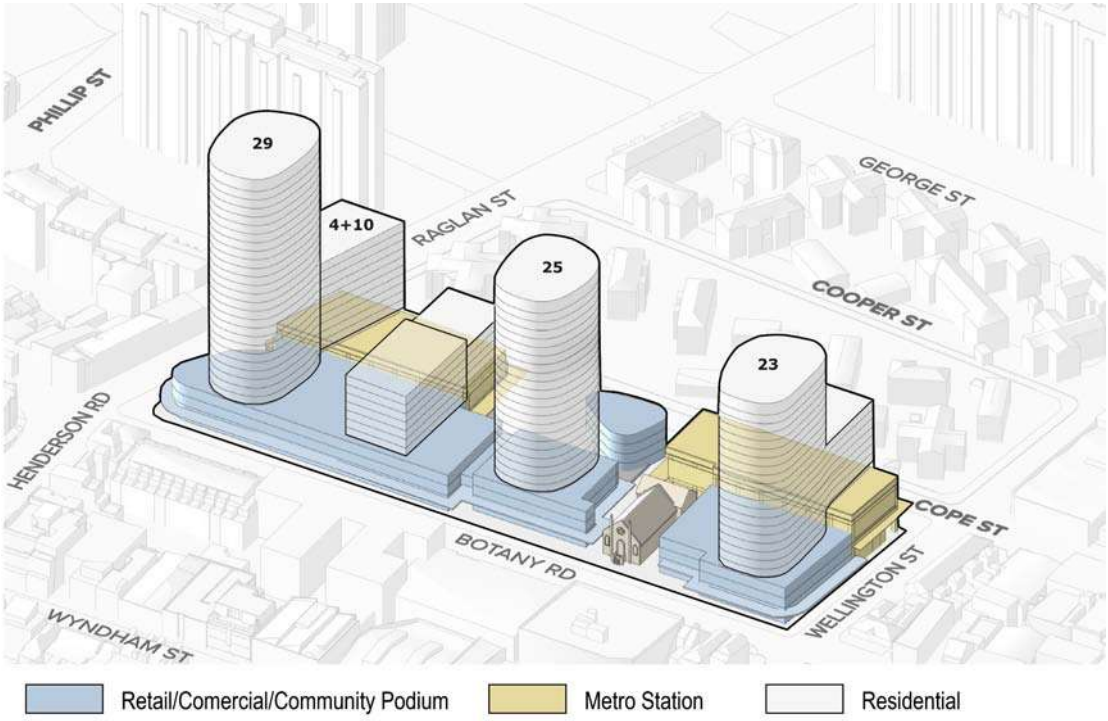

Figure 3.3 – Three-dimensional drawing of the Indicative Concept Proposal, viewed from the West (Source: Turner Studio)

3.3 Green Star Community Rating and Initiatives

Both the Waterloo Metro Quarter and the Waterloo Estate are attempting to achieve Green Star ratings, as developed by the Green Building Council of Australia. '**Green Star – Communities**' assesses the planning, design and construction of large scale development projects at a precinct, neighbourhood and community scale. It provides a rigorous and holistic rating across five primary impact categories. These categories are:

1. Governance
2. Liveability
3. Economic prosperity
4. Environment
5. Innovation

The urban forest study aligns with many of these rating criteria. The Liveability category encourages the development of healthy and active lifestyles, and rewards communities that have a high level of amenity, activity, and inclusiveness. The Environment category aims to reduce the impact of urban development on ecosystems. It encourages resource management and efficiency by promoting infrastructure, transport, and buildings, with reduced ecological footprints. The Environment category therefore seeks to reduce the impacts of projects on land, water, and the atmosphere. Although urban forestry and trees are not specifically outlined or assessed in the current rating system, the urban forest initiatives outlined within this study aim to support the requirements of the Green Star rating system. The way that this will be achieved includes most importantly:

- Increasing canopy coverage wherever possible to reduce greenhouse gas emissions by shading buildings, cars and pavements.
- Mitigating urban heat island effects by reducing ambient temperatures at ground level and improved cooling during extreme heatwave through evapotranspiration.
- Creating more comfortable and walkable streetscapes, thereby promoting liveability and activity.
- Utilising trees to capture and reduce gaseous and particulate pollutants and intercept and ameliorate stormwater flows.
- Improving biodiversity by advocating an appropriate and diverse mix of tree species throughout the wider estate and utilising, where sensible, endemic tree species that provide beneficial habitat and linkages.
- Adapting to climate change by recognising that a gradual change and adoption of potential species that may be better suited to warmer climates and increased heatwave extremes is needed. Also by promoting the use of water sensitive design strategies that may passively irrigate trees wherever possible to allow them to better deal with extremes and drought conditions.

Figure 3.4 – Trees have a great deal of influence over the environmental performance of an urban area. Good canopy cover, particularly over streets and fronting buildings can help mitigate urban heat island affects, lower ambient temperatures by several degrees during heatwaves and reduce the demands for air conditioning. The sensible use of deciduous species in key locations also allows solar access for sunlight and warmth during cooler months. (Photo: Arterra)

3.4 Place Making Initiatives

At the heart of the Waterloo Precinct development is the desire to create a resilient and connected community. As the precinct grows, 'place making' initiatives must amplify the community voice and support networks between people. During the consideration of the urban forest strategy several key place making principles have been woven into the strategies and objectives.

Particularly relevant to the Urban Forest Study, these place making initiatives include:

- Supporting the Metro station as a destination and as a gateway to surrounding neighbourhood.
- Embedding educational, recreational and productive programs into the public domain.
- Providing a rich tapestry of inclusive and informal gathering spaces.
- Delivering a fine grain urban grid, which supports a highly walkable place.
- Making nature a central theme, leveraging off Waterloo's existing trees to intensify the feeling and perception of greenery.
- Creating an engaging ground floor interface for pedestrian delight.

The ways the urban forest will contribute to the above initiatives include:

- Retaining and protecting a significant number of the existing high and moderate value trees.
- Prioritising new tree planting within all public areas and streets.
- Integrating the tree planting together with the urban grid and the retail needs.
- Using trees to help create comfort and shade, in a safe and beautiful way.
- Using granular, broken and eroded street edges to create special and diverse spaces for diverse and signature tree planting to promote social gathering.
- Advocating signature and relatively unique trees to highlight the significance of the Metro station.
- Promoting the use of the podium levels of new buildings for tree planting and potential productive gardens and community orchards.
- Utilising trees and the urban forest as a support and focus for temporary or permanent artistic and sculptural displays (in a non-injurious way) and promoting understanding and appreciation for the urban forest via community tours and community events.

Figure 3.5 – An artist's rendering of the potential Metro Quarter streetscape fronting Raglan Street and the contribution tree planting will make to the character of the spaces. (Source: Turner Studio)

3.5 Canopy Cover - Benchmarking

The CoS has committed in its *Urban Forest Strategy 2013* to increase its average total canopy coverage from 15.5% to 23.25% by 2030, and then to **27.13**% by 2050. This aligns with most other international cities that have all recognised the benefits of urban greening. The currently measured canopy coverage of the surrounding Waterloo and Alexandria area stands at 16%. This means that Waterloo Estate, with an existing canopy cover of 27%, is providing a very substantial contribution to the canopy coverage of the area as a whole. Any reduction in canopy cover within the Waterloo Estate will likely have a commensurate flow on effect to the wider area and the city as a whole. The project must maintain or increase the potential canopy cover.

Direct comparison between individual cities and areas is often difficult due to different methods and accuracy of calculating canopy coverage and the variations between different cities and their climates and land use mixes. There are also variations in the overall extent and areas that are being measured within the cities. However, as an example, for comparison, the following information is provided:

- **Melbourne** – the city is aiming to increase the public realm canopy cover from 22% (2012) to 40% by 2040.
- **Chicago** - at August 2012 the canopy cover was estimated at 15.5% using i-Tree software. They have a target of 20% by 2020.
- **Seattle** – established a target in 2007 to reach 30% by 2037. In 2016 a canopy study measured the coverage at 28%.
- **Vancouver** - mapped their coverage by LiDAR in 2013 at 18%. Their target is 22% by 2050.
- **Christchurch** - the current canopy cover from aerial imagery and LiDAR data collected during the summer of 2015/2016 was 15.59%.

Researchers at the Massachusetts Institute of Technology (MIT), in collaboration with the World Economic Forum, launched TREEPEDIA in 2016, which is a new platform that uses Google Street View data to measure and compare the green canopy in cities around the world. They have developed an innovative metric utilizing Google Street View (GSV) panoramas, called the **'Green View Index'** by which cities can evaluate and compare green canopy coverage as viewed from street level perception. (Project by the MIT Senseable City Lab - http://senseable.mit.edu/treepedia accessed May 2018).

The following graph displays where Sydney lies in terms of the Green View Index, as measured under the above system. It is important to note this measure is based on a street level assessment rather than actual plan view canopy coverage, so direct comparison to other measurements is not possible.

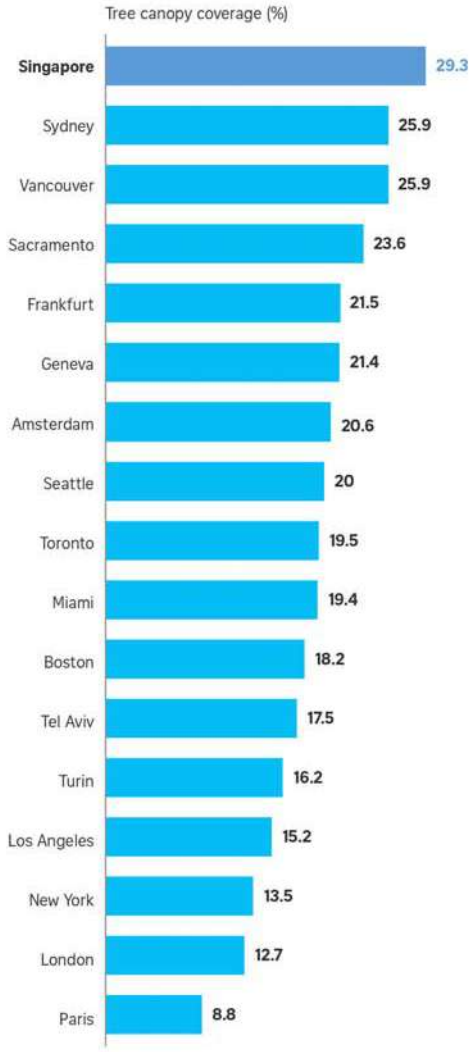

Figure 3.6 – A graph of the Green View Index canopy coverage score as presented in Singapore's Straits Times in 2017. Sydney is well placed in comparison to other global cities.
(Source: Treepedia and Straits Times Graphics. https://www.straitstimes.com/singapore/environment/singapore-tops-list-of-17-cities-with-highest-greenery-density -published 22 February 2017).

4.0 IMPLEMENTATION PLAN AND URBAN FOREST STRATEGIES

4.1 Overview

Research has consistently shown that medium to large trees provide the greatest ecological and community benefits, in comparison to small trees. They create more canopy spread and shading benefits, absorption of more gaseous pollutants, stormwater interception, lower levels of tree vandalism, and achieve higher canopy clearances. Medium and larger growing trees are also commonly longer lived than small trees. Large trees, however, do require larger soil volumes and more physical space above and below ground than small trees, which needs to be designed and factored into any new plantings. However, the ultimate benefits to the community are often exponentially increased over their lifetime.

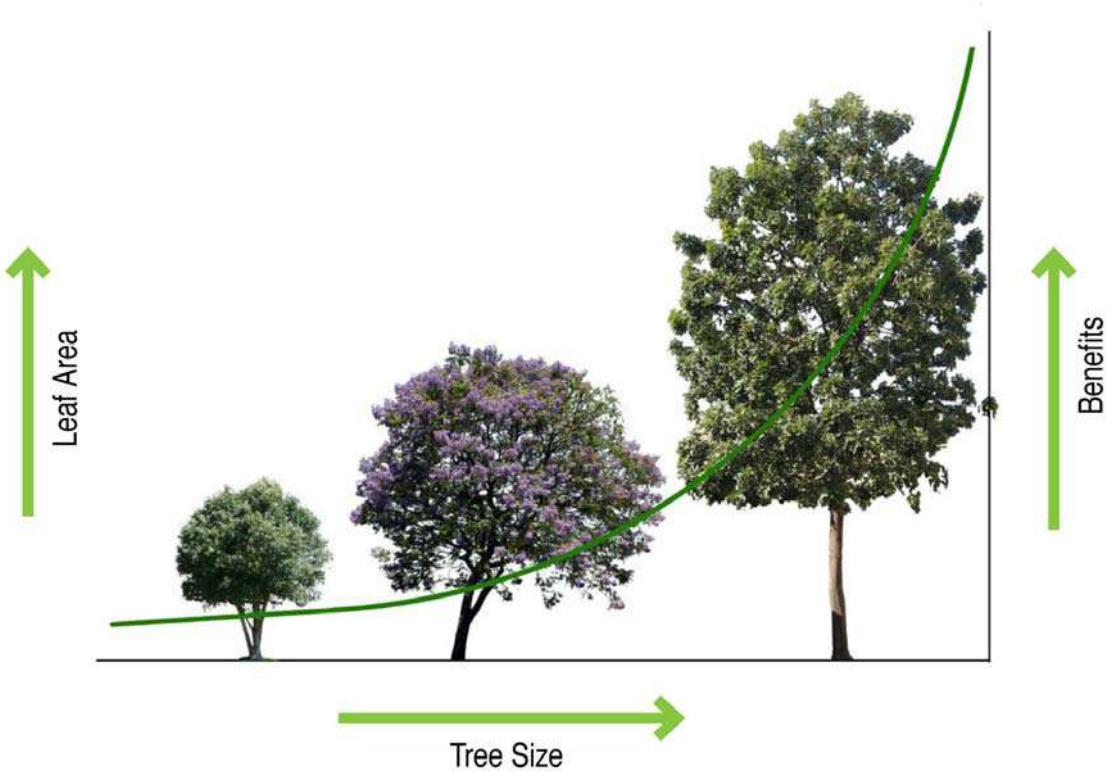

Figure 4.1 - Tree size does matter - the benefits of trees increase exponentially with size and increases in leaf area. (Adapted from Urban Tree Alliance http://www.urbantreealliance.org/why-trees/ accessed 12/7/2012)

Using the paradigm of 'right tree for the right location', a medium to large tree will only be specified and planted for an area where there is obviously sufficient space, and the growing conditions are suitable for the foreseeable life span of the tree. Smaller trees will also have a place in the urban forest for areas where physical space, overhead wires, parking and traffic restrictions or exposure present overriding factors.

The holistic planning of the Waterloo Estate provides some real opportunities and benefits for the creation of a sustainable and valuable urban forest. As part of this project there is a rare opportunity within an inner urban

area to design for trees and implement urban forest initiatives on a large scale. This document outlines the strategies and targets for the Metro Quarter required to:

- Retain important existing trees.
- Create opportunities for new and replacement trees.
- Maximise tree planting throughout the precinct.
- Implement successful new tree planting.
- Achieve objectives of precinct and other planning documents eg. Canopy coverage, species diversity.
- Plan for and plant trees with the end point in mind. Ensure the 'Right Tree for the Right Place'. This will minimise the pruning and future interventions required, maximise natural root development, and provide trees with improved resilience. This will minimise resource inputs and maximize the benefits.

Figure 4.2 – When properly considered, trees can be valuable contributors to urban ecosystem services with minimal ongoing resource inputs and minimal impacts to other hard infrastructure and human wellbeing. (Photo: Arterra)

4.2 Existing Trees – The Metro Quarter

The following summarises the general approaches to the existing tree population around the Metro Quarter:

- **Significant Trees**. As many large and significant trees should be retained as possible. Trees that have been allocated a 'High' retention value should form the priority for efforts to retain and protect. There are currently six (6) identified high value trees within the Metro Quarter precinct. One (1) on Wellington Street and five (5) on Cope Street. All of these high value trees are to be retained and protected. This recommendation has been incorporated into the design and the SSP proposal.
- **Poorly Formed Street Trees**. Many of the existing trees within the Metro Quarter are relatively small trees or trees that have been extensively pruned for overhead power line clearances. Although it may be possible to retain some of the trees in their current location, their form and long term health have been compromised and it may be a far better outcome in the future to replace them once power lines have been undergrounded or otherwise removed. It is the current recommendation to therefore remove many of the trees on Raglan Street and Wellington Street to allow a more holistic and realistic creation of better growing conditions and positioning of the future tree for a better long term outcome. Most trees are proposed to be retained on Botany Road along with 1 mature *Melaleuca quinquenervia* (Broad Leafed Paperbark) on Wellington Street, as they are capable of being integrated within the currently designed solution and realistically able to be protected.
- **Design and Realistic Expectations.** The best tree protection measure is to carefully consider the retention and physical requirements of the trees to be retained during the early design period for the project. Most importantly, a tree that is to be retained should be given the appropriate space to grow and continue to develop and flourish for many years to come. As much as possible, all work, including level changes, trenching, road construction and major landscaping should be avoided within the identified Tree Protection Zones (TPZ). The TPZ radius of each individual tree is provided in the schedule at Appendix 6.1.

4.3 Canopy Coverage Targets

The following summarises the opportunities and initiatives to achieve and increase the canopy coverage within Waterloo Estate and around the Metro Quarter.

- **Canopy Cover** Maintain, or ideally increase, the current 27.8% **canopy coverage** within the study area and achieve the CoS targets of 50% canopy to streets, 25% to parks, 25% to private property.
- **Retain and protect the most significant trees** on the site where feasible, and incorporate them as mature elements within the proposed landscape. They can provide an excellent framework for future parks and other green spaces.
- Recognise that **mature trees require space** around them to protect their root plates and therefore it will be necessary to minimise buildings, level changes or service trenching though any areas retaining large trees. The urban design team could look at suspended structures or walkways around existing trees if they are sensitively designed. Provision of surface areas around the tree is typically more important than soil depths.
- Take an holistic view to new **street profile design** to work new and existing trees in as one of the core elements of the design, not an after-thought. Space above and below ground is the key. Consider final sizes of the root plate, trunks, trunk flares and canopy, particularly around any existing or new Figs or other civic scale trees.
- **Incorporate new and existing trees into verge gardens and lawn areas,** wherever possible, to allow the maximum space for the trees trunks and structural roots to expand and allow infiltration of air and water into the root zones. Direct surface water and runoff towards existing and new trees to passively irrigate the trees in an ever-warming climate.
- **Utilise trees for wind amelioration**, by understanding the most desirable forms, sizes and densities of tree canopy in any given location. From experience and wind modelling, medium to large trees with a dense canopy are probably more important than small trees for wind amelioration.

4.4 Green Links, Ecology and Open Space

Trees provide shelter, roosting, food and other habitat resources for a range of fauna species. As outlined in *Urban Ecology: Theory Policy and Practice in NSW*, trees can benefit biodiversity in urban areas by making the matrix between surrounding core habitat patches or bushland more permeable and accessible to a range of species (Catterall et al., 1991). Trees are often described as keystone structures in highly modified urban landscapes because their ecological benefit, as defined by the value and ecosystem services they provide, is much greater than the land area they occupy. (Manning et al., 2009. Stragnoll et al., 2012)

Consideration has been given to recommending trees, which expand on, and provide a connection between, open spaces or other vegetated areas, particularly those identified as priority habitat areas. Although native trees are preferable in this regard, it is important to note that exotic species also have habitat value. A mix of species

is to be targeted throughout the Metro Quarter and the wider Waterloo Estate to achieve species diversity and other ecological and community outcomes.

Figure 4.3 – The existing and proposed urban trees within Waterloo Estate will also provide some benefits to common urban wildlife. Where appropriate native or endemic species will be utilised, but even exotic species play an important part in providing roosting, nesting and feeding opportunities for a range of fauna. (Photo: Arterra)

4.5 Resilience and Diversity

A key principle of a sustainable urban forest is an appropriately diverse mix of species – both native and exotic. This reduces the risk of loss should one species be susceptible to a new pest or disease. Diversity of tree species also provides benefits for biodiversity, aesthetic reasons, improves resilience and the provision of summer shade and winter sun. As we move into more uncertain times with regard to climate it is vital that any new tree planting considers proven past performances and potential resilience to the rigours of urban existence, climate change and a changing landscape of pests and diseases.

4.5.1 Climate Change Adaption

It is expected that potential water use restrictions and lower than average rainfalls that Sydney has previously periodically experienced will continue and worsen into the longer term. Street and other trees that are selected will need to be capable of surviving an average drought period, in reasonable condition, without reliance on potable water supplies. Passive irrigation through the use of Water Sensitive Urban Design will be designed into many of the new tree planting areas and will assist with additional water being available to trees in times of drought and during normal times. The use of some species of trees that thrive in slightly warmer climates and provide good shading such as Leopardwood (*Caesalpinina ferrea*), Tulipwood (*Harpullia pendula*) and Araucaria sp. would be very wise.

4.5.2 Pest and Disease Resilience

Overseas experience shows that widespread infestations of harmful pests and diseases can have devastating consequences on parts of our urban tree populations. The impact of pest and disease on our urban forests is only likely to increase. This is due to a range of factors, such as increased temperatures (particularly over winter),

storm events, greater or lower levels of rainfall events and the increase in international travel with the risk of a pest 'hitching a ride' to Sydney.

The recommended tree species for the Metro Quarter and wider Waterloo Estate shall be chosen to be resistant to currently known pests and disease. A diversity of species will be important in reducing any potential impact of future widespread or devastating diseases on specific tree species. Where reasonable and practical to do so, a designed mixture of 2 or more species from different botanic families should be chosen for many of the major streets to prevent the likelihood of any catastrophic canopy loss due to climate change, droughts and pests.

4.5.3 Biodiversity

There is often much debate about the use of locally indigenous species, that is, species that originally grew within the area. Whilst locally indigenous species may be the most appropriate for local environmental conditions, the growing conditions within the urban environment are often now very different, particularly in a street situation. We must also consider the natural vegetation assemblage in this part of Sydney would have been low woodlands and heath. Many of the species that grew in the Waterloo area naturally would not contribute to the wider urban forest goals or relate well to the built forms. Disturbed soil profiles, soil compaction, higher nutrient status, altered drainage patterns and paved surfaces are just a few of the other problems with which urban trees must contend.

When addressing this issue, a more useful division may be to view this point three ways:-

- Locally indigenous natives;
- Natives from other parts of Sydney or Australia;
- Exotic species from other areas of the world.

Local natives have the advantage of being climatically suited and live in some degree of equilibrium with pest natural organisms such as insects and fungi. Use of local natives promotes biodiversity and the creation of wildlife corridors, reinforces an 'Australian' sense of place, and can be very drought resistant.

Natives from other regions are less likely to be climatically adapted and they may enjoy freedom from local pest organisms but if they become infested may succumb faster. Exotics may be almost completely free of native pests and diseases but run the risk of being devastated if others are accidentally introduced.

Regarding local, or at least NSW east coast native species, and their suitability as inner urban street trees, the species that are best adapted are usually from the drier rainforest and rainforest margins, particularly littoral rainforests where most trees are long lived, shade tolerant and shade producing. They also often continue to transpire during prolonged heat-waves, which provide important cooling effects through evapotranspiration. Some other species like many of our Eucalypt species tend to shut down their metabolic processes during the heat of the day and therefore make only modest contributions to mitigating the urban heat island affects. They are often not as successful as other species at providing shade to pavements and parks.

The other highly successful species come from freshwater swamps and other areas that are poorly drained and aerated. Species from these environments are often highly resistant to root rot organisms and their root systems are well adapted to adverse soil conditions.

Many of the familiar natives such as Eucalypt trees are from the more open and drier vegetation communities. These species seem to perform poorly as street trees in inner urban areas due to their highly adapted and more specialised physiology. They are often adapted to soils of very low nutrient status with perfect drainage where rot organisms are at a disadvantage. Consequently these species are less tolerant to interference with their root systems, including compaction, waterlogging and construction damage. Depending on the design principles sought, natives can also display a variable habit or form which makes it difficult to establish and maintain a consistently planted avenue.

They are also highly adapted to natural fire regimes and a consequence is they often 'bolt' in growth for brief periods when post-fire soil nutrients are temporarily higher. As this increased growth continues in a high nutrient, fire free environment the tree may become structurally weak and the foliage and bark becomes susceptible to attack by insects and other pests.

An important advantage of many exotics in the inner urban context is that they include numerous useful deciduous trees, which provide greater sun access to the streets and residential apartments through the winter months. Some natives are deciduous but generally in spring or early summer (an inheritance of their monsoonal origins). The red and white cedars (*Toona ciliata, Melia azedarach*) are the closest native trees we have to winter deciduous but both suffer from severe pest problems under urban conditions and are often unreliable performers.

Many exotic deciduous species have the advantage of hundreds of years of selective breeding, which ensures quality stock. They are normally pollution tolerant, are more resilient to cope with interference with roots or

damage during construction works. The canopy shape and architecture of many exotics are able to tolerate the pruning and shaping required for urban infrastructure and street clearances.

In summary, both natives and exotics have their strengths and weaknesses for use as trees within the Metro Quarter and the Waterloo Estate. The urban forest strategy aims to plant the right tree for the right location, for the right reasons and to continually strike an appropriate balance between the many competing objectives.

4.6 Proposed Tree Species and Forest Composition

To address many of the key policy documents and the design outcome and 'place making' directions for the precinct, it is proposed to incorporate a relatively large range of species into the final designs. This will increase resilience and diversity and work towards the CoS targets of no more than 40% in any one family, 30% in any one genus, and 10% in any one species. It will also help achieve a diversity of sizes with a target of 10% small trees, 45% medium, 35% large trees and 10% civic scale (extra large). Consideration has been given to incorporating species that currently prosper in slightly warmer climates to cater for climate change. (eg. *Caesalpinia ferrea, Harpullia pendula, Araucaria heterophylla* and *Araucaria columnaris*).

Figure 4.4 – Leopardwood (Caesalpinia ferrea) is a common and successful tree in the warmer parts of NSW and Qld. It has been successfully used as a street tree and grows well in Sydney in frost free areas. As part of our climate change adaptation it will be very sensible to look to species such as this to grace the streets and parks within the wider Waterloo Estate (Photo: Arterra)

It is recommended that some exotic deciduous trees be utilised for better solar access during cooler months, particularly to lower apartments and key retail areas. It will be necessary to carefully consider any further large-scale introduction of species from the Myrtaceae family as the current population is already above the target of 40% for any one family. Given the general dominance of this family throughout Australia, this may always be difficult to achieve and compromises of this target may inevitably be required.

The selection of proposed new tree species being used throughout the Metro Quarter and Waterloo Estate precinct has considered many factors and aims to be a balanced approach that considers:

- Basic Suitability For Urban Area – fruiting, forms, failure risk, bark and leaf shedding, hardiness, proven performance in an urban context.
- Known pest and disease tolerance.
- Tree management requirements of both CoS and LAHC.
- Spread of different sizes - preference for medium to large trees wherever they are possible and suitable to the positions provided.

- Overall forest composition and diversity.
- Tree architecture and aesthetics.
- Solar access – a mixture of deciduous and evergreen species will be required.
- Allergy and irritation considerations.
- Wind and overshadowing tolerance from surrounding buildings.
- Commercial availability and nursery sizing.

Figure 4.5 – Japanese Zelkova (Zelkova serrata 'Green Vase') is a common and successful tree in the numerous urban centres around the world including Sydney and Melbourne. It has been successfully used as street trees and grows well in Sydney. This tree will provide many benefits with a similar form and character to the much over-used London Plane trees. (Photo: Arterra)

4.7 Proposed New Tree Planting Strategies

The following points outline the broad strategies that are currently recommended for adoption throughout the Metro Quarter.

- Incorporate trees into the upper levels of the future built forms and podiums and on roof tops to improve canopy coverage and increase peoples' connection to nature and greenery. The urban design teams should explore opportunities for **community orchard style** planting in semi-public open spaces/ roof terraces and podiums to provide urban food and community engagement with trees. This is not recommended in very public or major street contexts where management, access and ownership issues prove difficult to manage.
- Consider much increased use of **in-road planting (blisters)** that provide opportunities to move trees away from below ground services and future building facades and allow them to fully develop their canopies and ultimate sizes. This is also the best way to fully shade street pavements and parked cars and achieve the stated canopy coverage targets. The urban design teams and engineers should consider utilising structural soil systems and vaulted tree pit designs to allow soil volumes for vigorous and healthy tree growth in the long term, and under pavements. This also serves to calm traffic and improves the general perceptions and use of the street environment.
- Utilise generous tree **setbacks** near the streets to allow planting of larger trees away from street kerbs. Always consider their ultimate sizes.

4.8 Designing For Trees

Trees are long term assets and investments that may live for between 50 to 150 years, so species selection is vitally important. In contrast, most residents will only occupy their houses, on average, for a 5-15 year period.

Trees must be given the necessary requirements to sustain life - that is, space, air, water, nutrients, light and soil. Trees, to survive all trees must grow, and in doing so will inevitably shed leaves, bark, fruit, flowers and even branches. Their roots will grow and their trunks will expand. The challenge is to select the right tree for the right location within the urban forest that maximises the benefits and minimises the negative impacts to residents, infrastructure and road users. Careful planning, innovative design solutions and compromise are always needed when considering trees in a busy and densely populated, urban environment.

One of the key roles of streets is to convey vehicles, pedestrians and utility services throughout the community. While there is often opportunity for tree planting as well, this is not so in all cases. It must be remembered that poor and or inappropriate tree planting may actually detract from a street's function and residents' enjoyment, and potentially create a serious burden on tree management resources both now, and well into the future.

Figure 4.6 – Good opportunity exists in providing productive landscapes and tree planting on the semi-public and controlled access areas of the raised tower podiums. These on-structure environments with good solar access provide the perfect arena for small scale and mixed orchard style tree planting that will offer not only amenity but facilitate locally sourced food and community based activity (Photo: Arterra)

Tree species will be selected so that the ultimate mature size of the tree canopy is appropriate to the particular street or space available and gives appropriate consideration to the site constraints, such as verge width, building alignments and vehicle clearances.

Some of the key considerations will be:

- Street profile designs that accommodate and focus on trees as a key component of the street infrastructure.
- Street orientations with care to allow solar access to nearby residents and parks using exotic deciduous trees where appropriate.
- Street hierarchy – utilise species selections and signature trees to define key nodes and help define street hierarchy.
- Verge and reduced carriage ways – reduce the perceived width of road carriage ways to slow and calm traffic through appropriate and measured use of median and blister planting.
- Integration of trees within parking lanes.
- Undergrounding of power lines to avoid the need for future clearance pruning.
- Building and street setbacks/ deep soil areas. Provide space for trees particularly between all buildings and the public areas. This will help alleviate the de-humanising influence of very tall towers.
- Street level gardens to provide interest and delight at street level but also accommodating wider and longer trees pits and spaces for tree trunks to grow and expand without damage to surrounding infrastructure.

Blister planting can allow tree planting where verges are otherwise too narrow and where there would otherwise be no trees at all in a street. They do not have to be regularly or closely spaced, as even a few trees can make a huge difference to how a street looks and feels, reduce the apparent width of the road carriageway, calming traffic and/or providing a more aesthetically pleasing street. This also allows trees to be planted further away from nearby urban developments and residential apartments.

Don't over plant. We would recommend a measured approach to planting for only short term or instant effects. We would generally advocate that designers allow future trees to mature with full and symmetrical canopies wherever possible. This generally makes the trees easier to manage in the long term, with better health and the ability to replace them more easily when the time comes. Such forethought often gives the trees more ability to seek adequate resources rather than completing with each other, above and below ground.

4.8.1 Soil Volumes for Sustainable Tree Growth

Tree growth and fertility are strongly influenced by soil structure, as it affects the movement of air, water and nutrients for trees to flourish. Well-constructed soil functions like a reservoir, enabling trees to accept store and transmit water, nutrients and energy and provide room for roots to propagate. (Carpani, 2016, Lindsey and Bassuk, 1991)

Tree roots typically grow in a shallow and wide plate-like arrangement (Refer Figure 4.8). They do this to maintain appropriate access to water, nutrients and most importantly oxygen. It is therefore more appropriate to provide wide and shallow rooting areas for all new trees. Tree pits with depths greater than 1.2m will typically be wasted as the tree will rarely access soil volumes at these lower depths. This is particularly relevant for the soils associated with the Metro Quarter as the water table is quite shallow and trees will not develop roots in saturated soil. Tree pit design shall typically be required to achieve the minimum soil volumes specifies below and have available minimum soil depths of 700mm. The maximum depth of soil that should be calculated is 1200mm.

The typical methods to achieve tree soil volumes include such systems as:

- Providing large open soil areas such as grass or garden areas surrounding the tree.
- Vaulted soil pits where pavements surrounding the trees are suspended above the tree pit soils via suspended and reinforced concrete sub-pavements and piers and/or beams.
- Structurally supportive systems such as Strata vault and Strata Cells.
- Structurally supportive soils (specifically designed and manufactured aggregate and soil mixes).

The opportunity exists for these systems to be utilised, where necessary, within the Metro Quarter during detailed design.

Any new trees should ideally be located within designated gardens or planting areas with sufficient space around the base of the trunk to allow for proper ultimate expansion of the trunk, root flare and structural root zones. Trees should typically be planted at least 1.5 – 2.0m away from any walls, buildings or pavement edges, and even further for larger trees.

If planted within a paved area, the tree should be planted within a well-designed and designated tree pit with sufficient soil volumes and drainage to prevent excessive infrastructure damage or premature tree failure and poor conditions in the future. When planting new trees within pavement areas or restricted areas the soil volume should be to sufficient to enable the tree to reach its mature size in a healthy full state. To survive indefinitely a mature tree requires a minimum of 0.6m^3 of soil for every m^2 of projected canopy area.

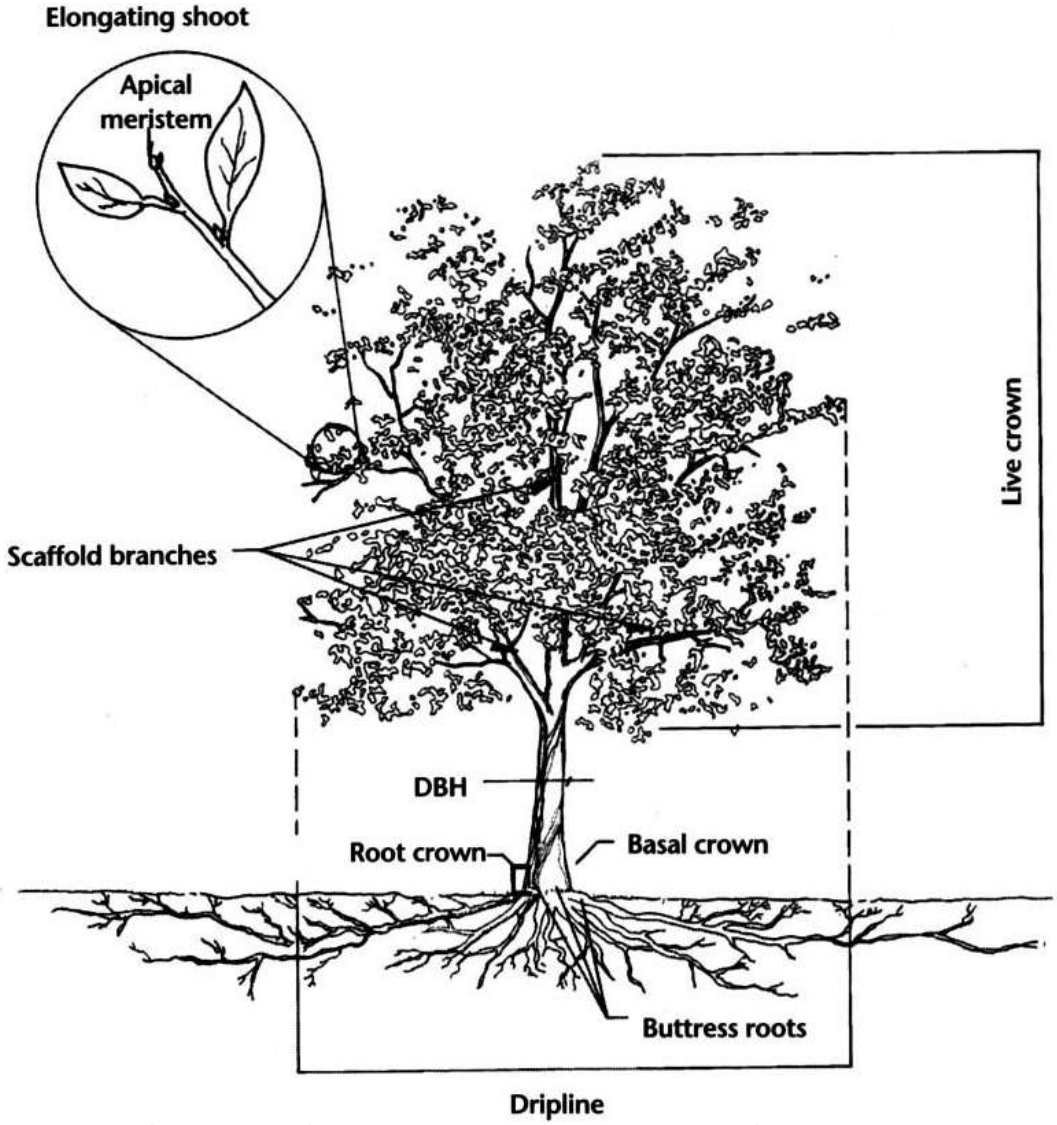

Figure 4.7 – Typical form and structure of a tree illustrating the typical form, location and extent of root growth (Source: Matheny and Clark, 1998)

As a guide, for trees that are likely to achieve the following canopy spreads they should be provided with the following soil volumes:-

- 4m spread needs approx. 8-10m^3 of soil
- 6m spread needs approx. 20-25m^3 of soil
- 8m spread needs approx. 30-40m^3 of soil
- 10m spread needs approx. 50-70m3 of soil

The above guidance is in a normal street / landscape setting. The needs per tree can be marginally reduced if the trees can share soil volume with other adjoining trees or if the soil is subject to regular irrigation. In order to provide these volumes it may be necessary to consider the following strategies:-

- Use of expanded sized tree pits / planting areas
- Use of structural soil systems (structural soils or plastic support mechanisms)
- Use of 'vaulted' soil pits with pavement bridging over the root zones

An important consideration for Waterloo Metro Quarter, however, is the **naturally sandy soil conditions** that exist throughout the area. This means, that in terms of soil volumes, most trees that will be planted will have ready access to sufficient soil volumes for longer term growth. Unlike more constrained environments where rock or heavy or compacted sub-soils can radically inhibit tree root development, tree root growth below the roads and shallow pavements will not be as constrained. The above guidance with regard to soil volumes becomes much more pertinent to areas where the trees are over buried structures or on raised podiums or where other major infrastructure or building basements may inhibit the available rooting volume.

It is critical that all new trees are planted at the correct depth with any new soil and mulch carefully placed and allowing the top of the pre-existing root flare to just remain visible.

For trees planted within grassed areas, the base of the trunks should be surrounded with a minimum 3m diameter of recycled hardwood coarsely chipped mulch. This prevents the otherwise avoidable impacts to the trunk and root flare from mower and whipper snipper damage. It is important the mulch is not too deep and is of a free draining nature. Excessively thick mulches or very organic mulches can become hydrophobic and actually prevent water from reaching the soil zone or introduce unwanted pathogens to the soil or tree.

Figure 4.8 –Numerous methods are now available of integrating trees and the necessary soil volumes within urban environments while still allowing pavements and roads to continue successfully above. The above illustrates the proprietary system Strata Vault by Citygreen being used at Barangaroo Sydney.

4.9 Community Engagement and Education

An equally important component of the Urban Forest Strategy for Waterloo is to also ensure that the proponents of the development educate the community and promote the benefits of the urban forest. It will be important that as part of the ongoing implementation of the long term development that the following are achieved:

- Promotion of the Value of Urban Forestry.
- Key Stakeholder Awareness of the importance of Urban Forest initiatives.
- Encouragement of Community Stewardship of the Urban Forest.

Figure 4.9 – Examples of some of the methods for encouraging community interaction and support for the urban forest including sculptural installation that celebrate trees, utilise material from former trees, and highlighting their morphology and spiritual connections. (Photo: Arterra)

Some of the suggested ways this community outcome could be achieved include:

- Investigate and support grants for community engagement and stakeholder collaborative projects such as community gardens, bush tucker gardens and orchards (for research and tree planting).
- Organise awareness strategies such as "Great Tree Hunts" to look for significant trees or commemorative trees.
- Provide brochures and information within public information centres.
- Collaborate with universities and local schools on research and involvement in urban forest studies. Particularly health and wellbeing indicators to benchmark the role of urban forests in contributing to human health over long term studies.
- Ensure proper records are maintained for all private area tree planting (what species, numbers and sizes when installed). Insist on a Work as Executed drawing and schedule for all installed trees as the project progresses and maintain a centralised repository of information.
- Undertake annual resident workshops to educate community about the local trees and conduct precinct tours.
- Utilise community tree planting days and celebrations.
- Organise 'Urban Forest' exhibitions that focus on ideas and artistic reflections of the trees and the urban forest (eg. non-destructive sculptural installations within trees and lighting of trees, photographic exhibitions of trees within the precinct).
- Celebrity presentation and demonstration of gardens and urban forest planting (eg. ABC Gardening Australia hosts and specials)
- Create outreach and education strategies such as:
    - Flyers / Brochure
    - Educational field trips for local schools
- Provide a mulch delivery service to relevant local community groups of pruned or removed tree material to promote urban forestry and educate community on benefits and lifecycle of trees.
- Investigate a community "Adopt a Tree" program
- Investigate opportunity for citizen training programs (pruning and maintenance) eg. in NYC an exam qualifies residents to legally look after street trees (with some excluded areas). Volunteer groups receive work assignments and suggest further projects. 'Citizen Pruners' meet with Council to review tasks and receive training.

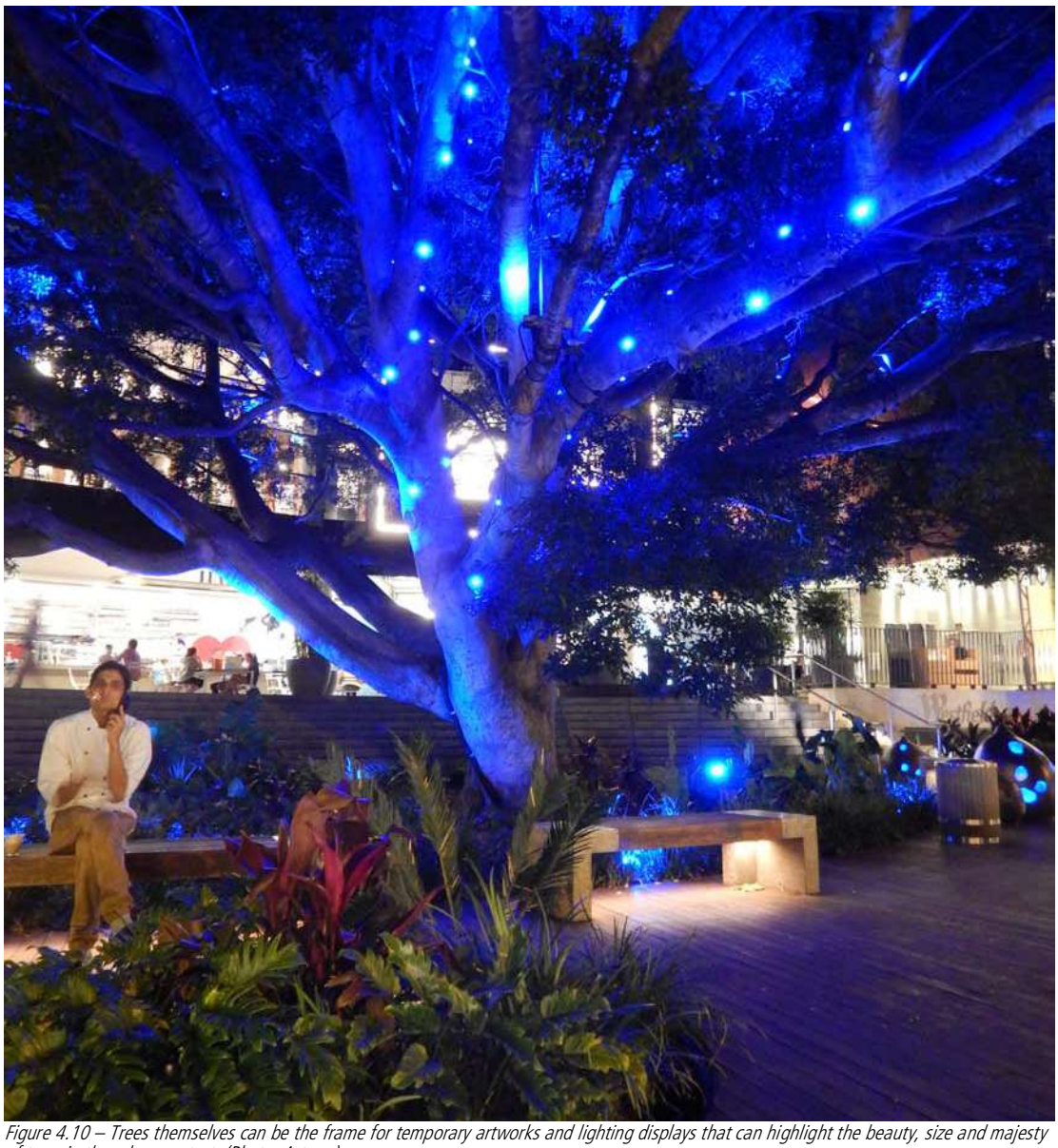

Figure 4.10 – Trees themselves can be the frame for temporary artworks and lighting displays that can highlight the beauty, size and majesty of trees in the urban context. (Photo: Arterra)

5.0 ASSESSMENT OF EXISTING TREE IMPACTS AND URBAN FOREST OUTCOMES – METRO QUARTER

5.1 Overview

Why wait 30-40 years for shade and other benefits to develop when a mature tree already exists in the landscape. If there are existing trees that are healthy, stable and well placed, the primary objective shall be to preserve them.

The assessment of the tree related impacts and proposed protection measures within this document is 'high level' and put forward to assist with the appropriate assessment and approval of the Metro Quarter SSDA – Concept proposal. It should also provide overarching guidance to consultants and developers who may be responsible for the more detailed and site specific designs. The realization of the wider Waterloo Estate master plan is considered to take 20-30 years to complete. The construction of the Metro Quarter underground station has, however, already commenced. It is expected that the remaining construction of the Metro Quarter will commence within the next 1-2 years and will be one of the first components of the re-development delivered.

It is, therefore, anticipated and expected that a more detailed and very site specific assessment of the existing trees identified to be retained as part of this overall assessment will be carried out and lodged with the detailed and site specific SSD applications. It is important to note that trees are dynamic and living organisms and changes in their condition over time or relatively small changes to the proposed layouts or methods of construction may have significantly lesser or greater impacts on individual trees.

5.2 Existing Trees – Retention and Removal

The proposed construction of the Metro Quarter will result in a major site disturbance. It is therefore necessary to remove many of the trees that currently exist. The design team have worked very hard to focus on the retention of the most important trees including:-

- The suitable smaller *Lophostemon confertus* (Brush Box) along Botany Road that are in an appropriate position for the new development and have not been currently overly affected by overhead power-line clearance pruning.
- The larger *Melaleuca quinquenervia* (Broad-leave Paperbark) on Wellington Street
- The mixed Eucalypt street trees along the eastern side of Cope Street.

Out of the 45 trees assessed within or adjacent to the Metro Quarter study area it is proposed to:-

- Retain 28 trees;
- Remove 17 trees, the majority of which are low retention value trees. These will be replaced with new appropriately scaled and placed trees;

The following table summarises the trees to be removed and retained compared with their relative retention values. Refer also to the plans in Appendix 6.4 and 6.5 for the location and graphical representation of the trees.

Table 13 Tree Disposition Versus Their Retention Value – Metro Quarter

Tree Disposition	Totals	High Retention Value	Moderate Retention Value	Low Retention Value	Very Low Retention Value
Trees to be retained and protected	**28**	6	7	15	-
Trees to be removed due to being within the footprint of the proposed building or major street landscape works	**4**	-	-	4	-
Trees removed due to other reasons such as poor health, being a weed, inappropriate location, or small or malformed specimen	**13**	-	1	12	-
Trees proposed to be transplanted	**0**	-	-	-	-
Total	**45**	**6**	**8**	**31**	**0**

5.2.1 Tree Impact Assessment

Of the 28 trees currently to be retained on the Metro Quarter precinct area:-

- 27 have no, or very minimal, foreseeable impacts from the construction related activity;
- 0 have what may be considered minor and acceptable encroachments as defined under AS 4970.
- 1 will have what may be considered a major encroachment as defined under AS 4970.

For major encroachments it will normally be proposed that more site specific investigations are carried out by a qualified Consulting Arborist and submitted as part of any detailed Development Applications to verify and hopefully support the retention of the tree(s). This impact specifically relates to the larger *Melaleuca quinquenervia* (Broad-leaved Paperbark) on Wellington Street, near the corner of Cope Street. This is a good quality tree. The area to the north of the tree that is subject to the incursion has been previously covered by buildings and structures. It is reasonable to assume the extent of root development in this northern area may have been impaired. It is the authors opinion that the proposed incursion, which represents approximately 15% of the nominal tree protection zone is acceptable. The tree is currently in good health and is of a species that is typically tolerant of root impacts. Provided the other contiguous areas of the root area remain unimpacted, the tree should be able to be successfully retained.

It is unrealistic for any further investigation to be undertaken at this time as construction work and piling for the Metro station is already approved and underway. Care should simply be taken from here that the design of the remaining ground level works takes note of this tree and that levels around the tree are maintained and traditional service trenching is avoided through the nominal TPZ (Refer Appendix 6.5).

5.3 Existing Trees – Proposed Protection Measures

Any future tree protection measures to be imposed as part of the development of the Waterloo Metro Quarter cannot be fully explored until the exact nature and extent of any future development is fully known. The following broad guidelines, however, can be given as an indication of the **likely measures** that would be required to protect the tree assets as part of the design development.

The proposed construction of the roads, buildings and high-rise developments would result in major site disturbances. This would potentially have a significant impact on the trees within and adjacent to buildings, roads and other civil and building works.

Specifically the proposed development will involve:-

- Major demolition works;
- Use of large scale civil work, piling rigs and earthmoving equipment;
- Access to and from the construction sites with large trucks and construction plant;
- Excavations for the upgrading and placement of new road profiles;
- Excavations for the creation of improved tree planting soil profiles;
- Large stockpiles/ storage of construction materials;
- Re-grading and filling of the surface levels;
- Major services upgrades and infrastructure works;
- Use of large cranes;
- Parking for site personnel and deliveries;

- New roads, paving and retaining walls and
- Landscaping and new tree planting.

5.3.1 Design and Realistic Expectations

The best tree protection measure is to consider the retention and physical requirements of the trees to be retained during the design stage. Most importantly a tree to be retained should be given the appropriate space to grow below ground and above ground and continue to develop and prosper for many years to come. As much as possible, all work, including trenching, building construction and landscaping should be avoided within the identified TPZ limits.

Where an incursion is required and the design cannot be modified or amended, this should be limited and appropriate compensatory areas applied elsewhere, contiguous to the remaining TPZ around the tree.

Where adequate protection is not possible, or is unlikely or unable to be rigorously defended, then serious thought should be given to removing the tree and ultimately replacing it with new tree planting at the completion of the development. This is preferable to wasting a lot of time, resources and development energy on retaining a tree that will almost inevitably decline and die.

5.3.2 Services Upgrades and Installations

Apart from physical road and building locations, services installation and upgrades are likely to have the next greatest impact on the trees and tree retention. There will be a need to carefully consider the location and extent of all trenching, particularly for major service upgrades.

There may be need to **consider service re-alignments or under-boring** techniques to manage impacts to existing trees.

Most existing power is currently provided by overhead cabling. The redevelopment of the Metro Quarter will consider the undergrounding of all electrical **power lines and communication cables** but only with due consideration to existing trees that are planned to be retained. Trenching past well established trees with traditional methods could have significant impacts on tree health. This is particularly relevant to the retention of the existing trees on Botany Road and Wellington Street.

Typically new services impacting trees are to be under-bored, where required, thereby minimising incursion to any retained trees' root zones where a new service is to be run through a nominated TPZ. Alternatively new services are to be located within the central portion of the existing roads to maximise the distance away from existing street trees.

5.3.3 Soils, Excavation and Demolition

In naturally sandy soils, such as those found within the study area, trees often develop extensive root systems, spreading wide and potentially growing deeply, to provide structural stability and maintain adequate nutrient and water uptake to enable the trees to flourish.

- **Sandy soils and tree roots**. The sandy soil allows aeration, and therefore root development at greater depths. Therefore it is possible, and very likely, that roots have travelled large distances away from the trees and under existing pavements and structures.
- **The extensive root systems** can be clearly seen, particularly in the vicinity of the many large Figs, Plane Trees and Melaleucas. Very large roots are clearly visible on the ground surface, often wrapped around exposed building infrastructure and disappearing under footpaths and driveways.
- **Demolition.** The normal premise that roots may have been inhibited by retaining walls and road pavements does not apply in this study area and it is highly likely that roots will be found in relatively radial patterns around the trees and even under adjoining structures and roadways. This will make demolition of existing structures particularly difficult when close to existing trees. In some instances, existing infrastructure may need to be partially retained close to the trees to ensure trees are not disturbed and they remain structurally stable.
- **Exploratory, Non-destructive Root Investigations** – Where necessary undertake exploratory, non-destructive root mapping and investigations (ie: using air spades, water jets or hand excavation) for all large or significant trees to verify location of any major roots and to guide final pavement levels and subgrade preparations where major incursions are proposed into any nominated TPZ areas.
- **Construction period**. The non-cohesive soil structure also has implications for construction work in the vicinity of trees. Stable batters will be difficult to construct and shoring or piling will be required to retain any excavations and maintain the structural integrity of the soil surrounding the trees' root systems if the existing trees are to be retained. Excavations undertaken near mature trees to be retained are to be undertaken and retained using suitable sheet, soldier or contiguous piling techniques. Even relatively small excavations, when done near trees are to be retained using soldier piling or similar to prevent excessive battering into tree root zones. On the positive side, soil compaction or waterlogging caused by construction activities will be less of a concern.

5.3.4 Tree Protection Fencing and Definition of TPZs

Prior to any works, including demolition, establish a clearly defined tree protection zone as indicated in Appendix 6.5 "Tree Protection and Removal Plan". This shall be via a 1.8m high temporary fence with either plywood hoarding or temporary steel mesh or chain wire fencing with adequate lateral bracing. Fencing shall comply with the requirements of *AS 4687-2007 Temporary fencing and hoardings*. These areas around the trees shall be delineated as a "Tree Protection Zone" during the remaining construction process, via appropriate weatherproof signage. Access will typically be excluded from these zones and the levels will be left largely at the existing levels with the exception of the installation of new topsoils (where approved) and 75mm of mulch. No stockpiling, excavation, trenching, re-fuelling or material storage shall be allowed in this area.

If work is required with in a TPZ, this work should be done with small tracked equipment or by hand, with care to limit damage and disturbance of the root zone. All work within TPZ zones must be supervised and overseen by a qualified arborist.

Figure 5.1 – Example of appropriate tree protection and construction fencing (Photo: Arterra)

5.3.5 Ground Protection within TPZs

Vehicular movement and access shall typically not be required or approved through the TPZ areas. If it is necessary and it is proposed to create any access or haul road, or similar, within the TPZ of a retained tree, the Contractor shall install rumble strips / boards over the TPZ ground surface. No excavation shall be allowed. Contractor shall first place a suitable permeable geotextile to the extent required and then a 100mm thick layer of wood chip mulch or coarse no-fines gravel over the extent to be covered with the rumble strip / boards. Then place hardwood boards (minimum 3600 x 200 x 75mm) on their flat edge, side by side, with a 30 - 50mm gap to form a rumble strip. These boards are to be held together with three galvanised metal bracing straps nailed to each board. The two outer straps are to be approximately 200mm in from the ends of the boards. The third strap is to be along the centre line of the boards.

5.3.6 Trunk and Lower Branch Protection

A trunk protection barrier is to be erected around the circumference of the tree trunk, trunk flare and root buttress where indicated on relevant plans. This barrier will consist of a double layer of suitable 'used' artificial grass matting, carpet or carpet underfelt placed around the trunk. A layer of battens is to be placed over the underfelt. The battens are to have a maximum spacing of 50-100mm. The height of the battens is to be 2 metres or to the height of the first branches. Lower large branches may require the same protection if they are likely to be damaged by passing vehicles or equipment. Secure in place with galvanised steel bracing straps. Do not nail into or otherwise injure the trunk or bark. Battens may be made from any suitable waste timber of similar sizes and depths. All sharp or protruding edges are to be properly covered with tape or similar padding.

5.3.7 Temporary Irrigation Systems During Construction for Key Trees.

The provision of supplementary irrigation would be very beneficial to sustain good tree health while construction activities are undertaken, particularly given the permeability of the soil and its naturally poor water-holding capacity. A temporary and automated (battery powered timer is sufficient) watering system is to be placed within specific and nominated TPZs to maintain adequate water to the retained trees and help maintain and even

improve their health and condition. This shall be a simple surface mounted hose and/or surface sprinkler system. It is to be visible and spray delivered so that its operation can be easily visible and verified. It should be on a designated supply line, separate from all other construction related water supplies to minimise its likelihood of being disconnected. Typically, during spring and summer months it should be set to run for a minimum of 30 minutes every day, in the early morning. During, autumn and winter months it should be set to run for 1 hour once every week. The operation can be suspended temporarily in periods of extensive and prolonged rain. The system is to remain in place for the duration of civil and major construction, or until a suitable Consulting Arborist approves its removal. It may be removed to allow final landscape treatments to proceed. If accidentally disturbed or damaged by construction activities, it is to be reinstated as soon as practicable.

Figure 5.2 – Example of a temporary irrigation system provided to trees during construction periods. This can be a very valuable way of ensuring tree health and vitality is maintained and also promote new fibrous root growth closer to the trees. (Photo: Arterra)

5.3.8 Controlled Construction Access and Parking

Construction access points and stockpiling and storage areas shall be clearly identified and fenced where appropriate. Uncontrolled access points and parking of vehicles outside of designated areas is to be avoided. If temporary access is required through a tree protection zone, ground protection shall be employed to limit soil compaction and root damage and disturbance.

5.3.9 Clearing and Removal of Trees to be Removed

Removal and clearing of existing trees shall be done by qualified arboricultural staff with care not to impact or damage other surrounding trees throughout the process. Existing stumps should be grubbed out or ground out in a controlled fashion to remove wood that may decay and promote unwanted pathogens.

5.3.10 Communication - Tool Box Meetings and Construction Inductions

All contractors and subcontractors shall be inducted prior to working on the site. All inductions shall include description and identification of the Tree Protection Zones and the restriction on work and activities with regard to trees. The site foreman shall ensure that all new staff and contractors are appropriately inducted and that brief "tool box" meetings are conducted daily to ensure Tree Protection is maintained at the forefront of all construction workers' minds.

5.4 Analysis of Key Urban Forest Performance Measures and Targets

The principle objectives for the Waterloo Estate and Metro Quarter, that relate to the urban forest initiatives are to create a safe welcoming and healthy place to live, high quality public spaces, and a sustainable and adaptable urban environment. The objectives for the urban forest, therefore, are to:

- Provide a resilient, healthy and diverse urban forest.

- Provide an integrated and systematic long-term strategy that promotes trees as critical infrastructure and assets.
- Retain and protect existing trees and canopy cover.
- Educate the community and promote the benefits of the urban forest.
- Undertake appropriate and targeted additional tree planting to meet CoS and industry best practice targets.

The targets that are considered particularly relevant in achieving these objectives and that can be measured at this stage of the project are outlined in the table below. (Refer also to Figure 5.3 and Appendix 6.3)

Table 14 Comparison of Key Performance Indicators – Metro Quarter

Urban Forest Consideration	Baseline Condition (Entire Estate)	Baseline Condition (MQ)	CoS or Other Target	Proposed Designed Solution for MQ	Compliance/ Trend
Canopy Coverage Overall	28%	**6%**	27%	**23%**	No (but very positive increase from baseline)
Canopy Coverage					
Street	32%	**6%**	50%	**53%**	Target Achieved
Parks	0%	**0%**	25%	**n/a%**	n/a
Private	26%	**<1%**	25%	**11%**	No (but very positive increase from baseline)
Existing Trees Identified for Retention (Metro Quarter only)					
High Value Trees	n/a	**6**	n/a	**6**	(100%)
Moderate Value Trees	n/a	**8**	n/a	**7**	(88%) Good
Species Diversity					
Family	46%	**64%**	<40%	**57%**	No (but small sample)
Genus	28%	**24%**	<30%	**17%**	Target Achieved
Species	7%	**17%**	<10%	**17%**	No (but small sample)
Size Class					
Civic	2%	**0%**	10%	**0%**	No
Large	34%	**31%**	35%	**9%**	No (but acceptable)
Medium	45%	**58%**	45%	**58%**	Target Achieved
Small	17%	**11%**	10%	**33%**	No (but acceptable)
Ecological Contribution / Diversity					
Naturally Endemic	2%	**7%**	20%	**36%**	Target Achieved
Sydney Region	34%	**20%**	30%	**19%**	Acceptable Balance
Australian Native	45%	**40%**	25%	**35%**	Acceptable Balance
Exotic	17%	**33%**	24%	**10%**	Acceptable Balance
Weed/Non-desirable			<1%	**0%**	Target Achieved

We note the figures and comparisons shown above are for a very highly urbanised transport node. In some respects it would be difficult for the Metro Quarter development to achieve many of the criteria due to the lack of surrounding landscape area and the inability to provide a wide range of tree types. It is also a relatively small development footprint and therefore some statistics are going to be very skewed due to the low sample numbers. Further commentary on the above performance measures are therefore provided below.

Canopy Coverage – most pleasingly, and importantly, is the ability for the Metro Quarter precinct to come close to achieving the canopy coverage targets overall, and exceed them for the street area. Given the highly urbanised and almost CBD style development it is potentially unrealistic for the private area to achieve the target of 25% canopy cover. The contribution of green roofs and other planting area on the podium levels of the building should sufficiently compensation for the potential short fall of this particular tree canopy cover target. The extent of this other supplementary planting is currently unknown and therefore cannot be commented on definitively.

Species Diversity – the relatively small sample size and area undoubtedly skews the figures for this measure. There is a heavy reliance on Myrtaceae family, which is very common and is reflective of the proposed street tree species that are desired under the current CoS street master plan and the extensive Eucalyptus and Corymbia species already existing along Cope Street. The diversity for the overall Estate should moderate these figures towards the desired outcome. In the authors opinion it is more important to ensure the right type of tree is proposed for the given urban situation and the spaces available and provided.

Size Class – again the relatively small sample size and area skews the figures for this measure. There is a proposed heavy reliance on medium and small sized trees, which is reflective of the spaces and type of landscape

created around the Metro Quarter. Minimal capacity exists for extensive use of larger trees in this precinct. The dominance of medium sized trees compared to small trees is welcome and preferred. Again, in the authors opinion, it is more important to ensure the right type of tree is proposed for the given urban situation and spaces provided.

Diversity – again the relatively small sample size and area skews the figures for this measure. There is a heavy reliance on native trees that are not necessarily endemic to the area, which is again reflective of the spaces and type of landscapes to be created around the Metro Quarter. Minimal capacity exists for extensive use of endemic trees in this area, as they are potentially unsuitable for such heavily used, highly urban spaces in fully paved environments. The proportion of endemic and Sydney based native trees over exotic and non-Sydney based native trees is welcomed. In the authors opinion the selection of trees is balanced and appropriate. The diversity for the overall Waterloo Estate should moderate these figures towards the desired population wide outcome.

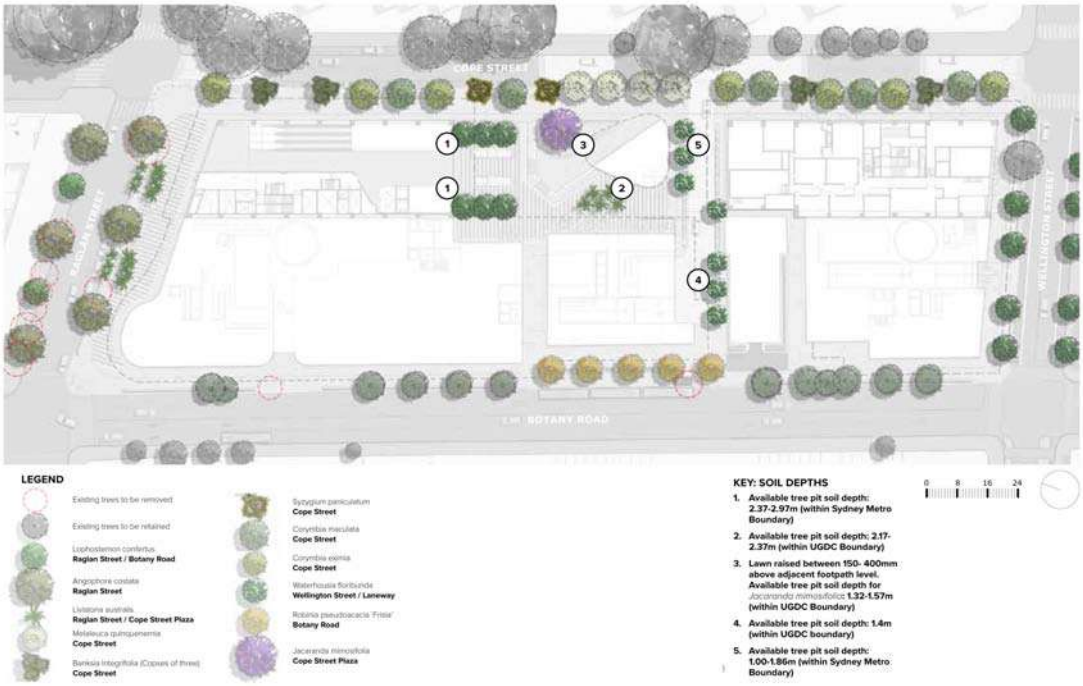

Figure 5.3 – Plan of the proposed tree planting around the Waterloo Metro Quarter (Source: Turf Design – July 2018)

5.5 Suitability of Proposed Tree Species

The public domain plans prepared for the Waterloo Metro Quarter have been reviewed and are illustrated in Figure 5.3. There is a range of tree species proposed with approximately 90 new trees . There are currently 12 different species proposed. They are considered appropriate to the constraints and conditions of their proposed urban surroundings and positively contribute to the implementation of the objectives of the UFS and the Waterloo Estate.

Specifically the proposed species are considered appropriate for the following reasons:

- There is a range of species that provide both deciduous and evergreen trees.
- They are all hardy proven performers within the local urban context.
- The species generally comply and align with the CoS Street Tree Master Plan 2015 but with some additional diversity provided to the streets for civic, place making and cultural purpose.
- A few deciduous trees are appropriately positioned to provide solar access during the cooler months to some parts of the public open spaces and also facilitate seasonal views to the important heritage item (the church building), *Robinia pseudoacacia 'Frisia'* (Black Locust) *& Pyrus ussuriensis* (Manchurian Pear)
- The *Livistona australis* (Cabbage Tree Palms) are considered appropriate to this particular context due to their relatively uniqueness, their distinctive and vertical forms, their aboriginal associations, suitability to the underlying sandy soils and their suitability to tolerate potential climate change impacts.
- The collection of trees provides a holistic improvement to the streets surrounding the Waterloo Metro Quarter and replacing smaller trees that have been previously impacted by clearance pruning or that are inappropriately positioned with regard to their ultimate size and habit.
- Provides a balanced approach to diversity with a predominance of trees native to the NSW coastal region with the *Corymbia* sp. providing a strong correlation with the other species along Cope Street and spring flowering nectar food sources for native fauna and insects.

- Provides trees that provide reliable shading and canopy coverage with a large proportion of the trees providing excellent shade and evapotranspiration rates that will help mitigate urban heat island effects (eg. *Lophostemon confertus, Waterhousea floribunda, Syzygium paniculatum* and *Elaeocarpus eumundi*).

Any future detailed designs should generally align with the proposed current species selections, the proposed road setbacks and horizontal spacings. Any proposed modifications should require endorsement by CoS.

5.6 Proposed DCP Provisions

The following are the proposed Urban Forest DCP provisions that should be adopted for the Metro Quarter.

1. Any existing trees identified and proposed to be retained are to be assessed and then protected as per the requirements outlined in the *Australian Standard 4970 – Protection of Trees on Development Sites.*
2. Overhead power lines and communication cables are to be undergrounded within all streets adjacent to the Metro Quarter to remove the current conflict between overhead cabling and existing and proposed trees. If existing trees occur within the planned undergrounding routes then the routes shall be modified to avoid incursions into the tree(s) calculated Tree Protection Zones, as defined under *Australian Standard 4970 – Protection of Trees on Development Sites*. Where this cannot be reasonably accommodated, alternative methods of construction must be used such as under-boring, directional drilling or non-destructive trenching to install the cabling without impact to the trees' health or stability.
3. Tree species selection shall be as per the endorsed Public Domain Plan as prepared by Turner Studio / Turf Design September 2018. (Refer Figure 5.3) Any departures from these selections must be approved in writing by the CoS Urban Forest Manager, or their designated representative, prior to implementation.
4. All new trees shall be installed in accordance with new tree planting requirements contained within Section 5.7 of the *Waterloo Metro Quarter Urban Forest Study* unless this is contradicted by future CoS codes, whereby the relevant CoS code shall prevail.
5. When planted within a potentially constrained soil environment (eg. on-structure or where other subsurface conditions would be expected to constrain root development and available rooting volumes) all trees are to be planted in accordance with the soil volume requirements contained within Section 4.8.1 of the *Waterloo Metro Quarter Urban Forest Study.*

5.7 New Tree Planting

5.7.1 Planting Program and Timing

The implementation of any new tree planting needs to be carefully planned and considered. This will involve the critical elements below:-

- The quality and species of the trees planted;
- The size at which they are planted and
- The way they are physically planted and cared for in the first few weeks and months.

The following outlines the minimum requirements that should be adopted for tree planting around the Metro Quarter.

- All new street tree planting shall be a minimum of 200L container sizes with this increased to 400L-for the key feature trees being preferred. Sizes of >800L should be considered where suitable and quality advanced stock is available.
- All trees shall be grown to the minimum standards of *AS2303 – 2015 Tree Stock For Landscape Use* with certification provided by the supplying nurseries. Trees shall be true to type and the species and cultivars specified.
- Tree planting ideally should be undertaken in either Autumn or Winter. This will greatly increase the success of the planting and reduce the establishment maintenance burdens.
- Soil volumes provided shall be consistent with the requirements for the size and species of the tree as outlined in this document.
- Surrounding pavements and tree grates shall allow for proper expansion of the trees base over time.
- Trees shall be planted a minimum of 675mm from the back of adjoining kerbs. Distances greater than are 1000mm preferred.
- Trees shall be transported, lifted and planted in a manner that limits any possibility of physical damage.
- Trees shall be regularly maintained for a minimum of 12 months from the date of planting to ensure adequate establishment maintenance. This is to include pest and disease monitoring and control, watering and timely replacement if required.

5.7.2 Tree Stock Quality and Sourcing

Considerable effort and resources can be spent in planting new trees. This considerable effort can be wasted if the tree dies shortly after planting, or if the tree is supplied in a substandard form or condition that may ultimately lead to poor performance or the later development of serious structural defects and poor health. As outlined by authors such as Gilman (Gilman 2012), most tree defects that occur in mature trees were present and identifiable at the time a tree was initially planted. It is therefore essential that the tree and its roots be in optimal condition when delivered and planted.

An important aspect of the implementation is in the planning and procurement of nursery stock. Implementing a 'forward-thinking' and pre-planned approach to plant procurement has numerous benefits, which include: -

- Securing favourable contract growing prices.
- Ability to prepare and coordinate planting at optimum times of the year.
- Ability to purchase trees of the required species and cultivars.
- Ability to purchase trees of the required sizes and dimensions and formatively pruned to suit street tree installation.
- Assurance of the required quantities, including allowance for replacements when necessary.
- Ability to inspect and demand high quality stock, free of above and below ground defects.

In summary, all trees should be sourced and supplied as part of an advanced plant supply contract with one or more reputable commercial suppliers and they should conform to the *NATSPEC "Guide for assessing the quality of and purchasing of landscape trees*" by Ross Clark 2003 and AS *AS2303 – 2015 Tree Stock For Landscape Use*.

5.7.3 Early Establishment and Maintenance

Most defects that lead to tree problems and failures are present in the tree upon delivery from the nursery and the planting. If stock is properly sourced, as noted above, most of the issues noted below should not present themselves. For example:-

1. Included branches
2. Co-dominant and Tri-dominant stems
3. Congested branching architecture
4. Crossing and rubbing branches
5. Leans

If these issues do occur, however, they are to be properly managed through formative pruning. At an early age these problems seem insignificant and unimportant. The tree, branches and defects are relatively small. These branches however are often the trunks and branches that are the major branches of the tree when it matures and as it grows so do the size of the trunks and these branches. A 50mm branch today will be the 200mm branch in 10 years time. Branches are typically at the same point in the tree in the future as they are when young. Plants elongate from the ends, and the early trunks and stems just expand in girth, they do not move upwards in the tree. That is, if the tree currently has a major branch at 1.5m high, that major branch will always be emanating from about 1.5m high on the tree. When it is small that may not be an issue, but when the tree is mature this may not be desirable for clearances under the tree.

The defects, if present, can become more serious and due to their size, the damage they may inflict, if failure occurs become substantial. When a tree is mature the ability to rectify these defects become substantially more difficult and costly. It also involves removing potentially very large branches and pruning into heartwood and leaving substantial wounds that the tree expends substantial reserves trying to compensate for and seal around the wounds.

Formative pruning, although straightforward in theory, does require individual assessment and decisions based on each trees' specific needs. It is both 'art' and 'science' and should be conducted by an experienced arboricultural professional and in line with *AS4373 Pruning of Amenity Tree*s. Experiences from professionals such as Gilman indicate that in some younger trees foliage removal in the order of 40-50% is not an unacceptable figure and may be necessary in achieving the longer term desired outcomes.

5.8 References

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6.0 APPENDICIES

6.1 Schedule of Existing Trees – Metro Quarter

Waterloo Metro Quarter, Waterloo - Existing Tree Assessment Schedule

Tree ID	Tree Species	Common Name	Family	Height (m)	Trunk Diameter Breast Height (dbh) (m)	Trunk Diameter at base (dgl) (m)	Nominal TPZ radius (m) 12xdbh (AS 4970)	Nominal SRZ radius (m) (AS 4970)	Age Class	Current Vigour	Current Form	SULE Rating	Retention Value	Tree Origin	Ultimate Tree Size	Tree Type	Recommendation
5318	*Platanus orientalis*	**Oriental Plane Tree**	**PLATANACEAE**	7.0	0.20	0.25	2.40	1.85	Mature	Good	Suppressed	Long (>40 years)	**Low**	Exotic	Large	Deciduous	Retain
5319	*Lophostemon confertus*	**Brush Box**	**MYRTACEAE**	7.0	0.20	0.30	2.40	2.00	Semi-mature	Good	Suppressed	Long (>40 years)	**Low**	Native	Medium	Evergreen	Retain
5320	*Lophostemon confertus*	**Brush Box**	**MYRTACEAE**	7.0	0.20	0.30	2.40	2.00	Semi-mature	Good	Average	Long (>40 years)	**Moderate**	Native	Medium	Evergreen	Retain
5321	*Lophostemon confertus*	**Brush Box**	**MYRTACEAE**	7.0	0.20	0.30	2.40	2.00	Semi-mature	Good	Suppressed	Long (>40 years)	**Low**	Native	Medium	Evergreen	Retain
5322	*Platanus orientalis*	**Oriental Plane Tree**	**PLATANACEAE**	6.0	0.30	0.40	3.60	2.25	Mature	Good	Suppressed	Long (>40 years)	**Low**	Exotic	Large	Deciduous	Remove
5323	*Lophostemon confertus*	**Brush Box**	**MYRTACEAE**	7.0	0.30	0.35	3.60	2.13	Mature	Fair	Suppressed	Long (>40 years)	**Low**	Native	Medium	Evergreen	Retain
5324	*Platanus orientalis*	**Oriental Plane Tree**	**PLATANACEAE**	6.0	0.30	0.40	3.60	2.25	Semi-mature	Fair	Suppressed	Long (>40 years)	**Low**	Exotic	Large	Deciduous	Retain
5342	*Robinia pseudoacacia 'Frisia'*	**Black Locust**	**FABACEAE**	5.0	0.15	0.15	2.00	1.49	Semi-mature	Good	Suppressed	Medium (15-40 years)	**Low**	Exotic	Medium	Deciduous	Retain
5343	*Robinia pseudoacacia 'Frisia'*	**Black Locust**	**FABACEAE**	5.0	0.15	0.15	2.00	1.49	Semi-mature	Good	Suppressed	Medium (15-40 years)	**Low**	Exotic	Medium	Deciduous	Retain
5344	*Robinia pseudoacacia 'Frisia'*	**Black Locust**	**FABACEAE**	5.0	0.20	0.20	2.40	1.68	Semi-mature	Good	Suppressed	Medium (15-40 years)	**Low**	Exotic	Medium	Deciduous	Retain
5345	*Robinia pseudoacacia 'Frisia'*	**Black Locust**	**FABACEAE**	5.0	0.20	0.20	2.40	1.68	Semi-mature	Good	Suppressed	Medium (15-40 years)	**Low**	Exotic	Medium	Deciduous	Retain
5347	*Lophostemon confertus*	**Brush Box**	**MYRTACEAE**	5.0	0.10	0.10	2.00	1.26	Young	Good	Average	Replaceable (Small/Young)	**Low**	Native	Medium	Evergreen	Retain
5348	*Robinia pseudoacacia 'Frisia'*	**Black Locust**	**FABACEAE**	6.0	0.15	0.15	2.00	1.49	Semi-mature	Good	Suppressed	Medium (15-40 years)	**Low**	Exotic	Medium	Deciduous	Remove
6835	*Eucalyptus sideroxylon*	**Mugga Ironbark**	**MYRTACEAE**	6.0	0.30	0.30	3.60	2.00	Semi-mature	Good	Average	Long (>40 years)	**Moderate**	Native	Medium	Evergreen	Retain
6836	*Eucalyptus camaldulensis*	**River Red Gum**	**MYRTACEAE**	12.0	0.50	0.50	6.00	2.47	Mature	Good	Good	Long (>40 years)	**Moderate**	Native	Large	Evergreen	Retain
6837	*Eucalyptus sideroxylon*	**Mugga Ironbark**	**MYRTACEAE**	8.0	0.30	0.40	3.60	2.25	Mature	Fair	Poor	Long (>40 years)	**Low**	Native	Medium	Evergreen	Retain
6838	*Eucalyptus microcorys*	**Tallowood**	**MYRTACEAE**	16.0	0.80	1.10	9.60	3.44	Mature	Excellent	Good	Long (>40 years)	**High**	Native	Large	Evergreen	Retain
6839	*Eucalyptus microcorys*	**Tallowood**	**MYRTACEAE**	20.0	0.90	1.10	10.80	3.44	Mature	Excellent	Good	Long (>40 years)	**High**	Native	Large	Evergreen	Retain
6840	*Eucalyptus sideroxylon*	**Mugga Ironbark**	**MYRTACEAE**	8.0	0.40	0.50	4.80	2.47	Mature	Good	Average	Long (>40 years)	**Moderate**	Native	Medium	Evergreen	Retain
6841	*Eucalyptus microcorys*	**Tallowood**	**MYRTACEAE**	15.0	0.80	1.00	9.60	3.31	Mature	Excellent	Average	Long (>40 years)	**High**	Native	Large	Evergreen	Retain
6842	*Corymbia eximia*	**Yellow Bloodwood**	**MYRTACEAE**	3.5	0.10	0.10	2.00	1.26	Young	Good	Good	Replaceable (Small/Young)	**Low**	Native	Medium	Evergreen	Retain
6843	*Eucalyptus microcorys*	**Tallowood**	**MYRTACEAE**	14.0	0.60	0.80	7.20	3.01	Mature	Excellent	Average	Long (>40 years)	**High**	Native	Large	Evergreen	Retain
6844	*Eucalyptus microcorys*	**Tallowood**	**MYRTACEAE**	17.0	0.60	0.80	7.20	3.01	Mature	Excellent	Good	Long (>40 years)	**High**	Native	Large	Evergreen	Retain
6845	*Corymbia eximia*	**Yellow Bloodwood**	**MYRTACEAE**	6.0	0.20	0.20	2.40	1.68	Young	Good	Good	Replaceable (Small/Young)	**Low**	Native	Medium	Evergreen	Retain
6846	*Corymbia eximia*	**Yellow Bloodwood**	**MYRTACEAE**	6.0	0.10	0.15	2.00	1.49	Young	Good	Good	Replaceable (Small/Young)	**Moderate**	Native	Medium	Evergreen	Retain
6847	*Corymbia eximia*	**Yellow Bloodwood**	**MYRTACEAE**	5.0	0.10	0.10	2.00	1.26	Young	Good	Good	Replaceable (Small/Young)	**Low**	Native	Medium	Evergreen	Retain
6851	*Eucalyptus sideroxylon*	**Mugga Ironbark**	**MYRTACEAE**	9.0	0.40	0.45	4.80	2.37	Mature	Fair	Poor	Long (>40 years)	**Low**	Native	Medium	Evergreen	Retain
6852	*Eucalyptus sideroxylon*	**Mugga Ironbark**	**MYRTACEAE**	14.0	0.50	0.60	6.00	2.67	Mature	Good	Average	Long (>40 years)	**Moderate**	Native	Medium	Evergreen	Retain
13290	*Lophostemon confertus*	**Brush Box**	**MYRTACEAE**	7.0	0.20	0.30	2.40	2.00	Semi-mature	Good	Suppressed	Long (>40 years)	**Low**	Native	Medium	Evergreen	Remove
13291	*Lophostemon confertus*	**Brush Box**	**MYRTACEAE**	5.0	0.20	0.30	2.40	2.00	Semi-mature	Good	Suppressed	Long (>40 years)	**Low**	Native	Medium	Evergreen	Remove
13292	*Lophostemon confertus*	**Brush Box**	**MYRTACEAE**	6.0	0.11	0.15	2.00	1.49	Young	Good	Good	Long (>40 years)	**Moderate**	Native	Medium	Evergreen	Retain
13293	*Ficus benjamina*	**Weeping Fig**	**MORACEAE**	6.0	0.11	0.15	2.00	1.49	Semi-mature	Good	Average	Long (>40 years)	**Low**	Exotic	Large	Evergreen	Remove
13294	*Ficus benjamina*	**Weeping Fig**	**MORACEAE**	3.0	0.11	0.15	2.00	1.49	Semi-mature	Good	Average	Long (>40 years)	**Low**	Exotic	Large	Evergreen	Remove
13295	*Ficus benjamina*	**Weeping Fig**	**MORACEAE**	5.0	0.11	0.15	2.00	1.49	Semi-mature	Good	Average	Long (>40 years)	**Low**	Exotic	Large	Evergreen	Remove
13296	*Ficus microcarpa var. hillii*	**Hills Weeping Fig**	**MORACEAE**	5.0	0.11	0.15	2.00	1.49	Young	Good	Average	Long (>40 years)	**Low**	Native	Large	Evergreen	Remove
13297	*Ficus benjamina*	**Weeping Fig**	**MORACEAE**	6.0	0.13	0.18	2.00	1.61	Semi-mature	Good	Average	Long (>40 years)	**Low**	Exotic	Large	Evergreen	Remove
15101	*Tristaniopsis laurina*	**Water Gum**	**MYRTACEAE**	4.0	0.15	0.25	2.00	1.85	Semi-mature	Fair	Average	Long (>40 years)	**Low**	Native	Small	Evergreen	Remove
15102	*Tristaniopsis laurina*	**Water Gum**	**MYRTACEAE**	3.0	0.10	0.15	2.00	1.49	Young	Poor	Average	Replaceable (Small/Young)	**Low**	Native	Small	Evergreen	Remove
15103	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	**MYRTACEAE**	15.0	0.80	1.00	9.60	3.31	Mature	Good	Good	Long (>40 years)	**High**	Endemic	Medium	Evergreen	Retain
15104	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	**MYRTACEAE**	12.0	0.48	0.48	5.76	2.43	Mature	Good	Poor	Long (>40 years)	**Moderate**	Endemic	Medium	Evergreen	Remove
15105	*Robinia pseudoacacia 'Frisia'*	**Black Locust**	**FABACEAE**	8.5	0.16	0.22	2.00	1.75	Mature	Fair	Poor	Medium (15-40 years)	**Low**	Exotic	Medium	Deciduous	Remove
15106	*Melaleuca quinquenervia*	**Broad Leafed Paperbark**	**MYRTACEAE**	11.0	0.70	0.70	8.40	2.85	Mature	Fair	Poor	Long (>40 years)	**Low**	Endemic	Medium	Evergreen	Remove
15107	*Tristaniopsis laurina*	**Water Gum**	**MYRTACEAE**	3.0	0.10	0.10	2.00	1.26	Young	Fair	Good	Replaceable (Small/Young)	**Low**	Native	Small	Evergreen	Remove
15108	*Fraxinus griffithii*	**Griffith's Ash**	**OLEACEAE**	7.0	0.20	0.30	2.40	2.00	Mature	Good	Average	Long (>40 years)	**Low**	Exotic	Small	Evergreen	Remove
15109	*Fraxinus griffithii*	**Griffith's Ash**	**OLEACEAE**	5.0	0.40	0.40	4.80	2.25	Mature	Fair	Average	Long (>40 years)	**Low**	Exotic	Small	Evergreen	Remove

6.2 Schedule of Proposed Tree Species – Metro Quarter and Waterloo Estate

Recommended New Tree Selection Schedule - Waterloo Estate Urban Forest Study

Family	Genus	Species	Common Name	Potential Height Reached in Street	Ultimate Size Class	Typical Ultimate Canopy Extent (Canopy Cover)	Native/ Exotic	Evergreen/ Deciduous	Typical Waterloo Estate Street or Usage
FABACEAE (sub. fam. MIMOSOIDEAE)	*Acacia*	*binervia*	**Coastal Myall**	8-12m	Small	38m2	Endemic	Evergreen	
ACERACEAE	*Acer*	*buergeranum*	**Trident Maple**	8-12m	Small	38m2	Exotic	Deciduous	
ACERACEAE	*Acer*	*negundo 'Sensation'*	**Box Elder**	8-12m	Medium	78m2	Exotic	Deciduous	
MYRTACEAE	*Acmena*	*smithii*	**Creek Lilly-Pilly**	10-15m	Medium	78m2	Endemic	Evergreen	
PODOCARPACEAE	*Afrocarpus*	*falcatus*	**Outeniqua Yellow Wood**	20-25m	Civic	314m2	Exotic	Evergreen	
ARAUCARIACEAE	*Agathis*	*robusta*	**Queensland Kauri**	20-25m	Civic	78m2	Native	Evergreen	
SAPINDACEAE	*Alectryon*	*tomentosus*	**Woolly Rambutan**	10-15m	Medium	78m2	Native	Evergreen	
MYRTACEAE	*Angophora*	*costata*	**Smooth-barked Apple**	12-20m	Large	175m2	Endemic	Evergreen	
MYRTACEAE	*Angophora*	*floribunda*	**Rough-barked Apple**	12-20m	Large	175m2	Native	Evergreen	
MYRTACEAE	*Angophora*	*hispida*	**Dwarf Apple**	5-7m	Small	38m2	Endemic	Evergreen	
ARAUCARIACEAE	*Araucaria*	*columnaris*	**Cook Pine**	20-28m	Civic	78m2	Exotic	Evergreen	
ARAUCARIACEAE	*Araucaria*	*heterophylla*	**Norfolk Island Pine**	20-28m	Civic	175m2	Exotic	Evergreen	
MYRTACEAE	*Backhousia*	*citriodora*	**Lemon-scented Myrtle**	7-10m	Small	38m2	Native	Evergreen	
PROTEACEAE	*Banksia*	*integrifolia*	**Coast Banksia**	7-10m	Small	38m2	Endemic	Evergreen	
MALVACEAE	*Brachychiton*	*acerifolius*	**Illawarra Flame Tree**	15-20m	Medium	78m2	Native	Deciduous	
MALVACEAE	*Brachychiton*	*discolor*	**Queensland Lacebark**	15-20m	Medium	78m2	Native	Deciduous	
FABACEAE (sub. fam. CAESALPINIOIDEAEDEAE)	*Caesalpinia*	*ferrea*	**Leopardwood**	10-15m	Medium	78m2	Exotic	Deciduous	
MYRTACEAE	*Callistemon*	*salignus*	**Willow Bottlebrush**	7-10m	Small	38m2	Native	Evergreen	
MYRTACEAE	*Callistemon*	*viminalis cv.*	**Bottlebrush**	7-10m	Small	38m2	Native	Evergreen	
FABACEAE (sub. fam. CAESALPINIOIDEAEDEAE)	*Castanospermum*	*australe*	**Black Bean**	15-18m	Large	175m2	Native	Evergreen	
ULMACAEAE	*Celtis*	*australis*	**European Nettle Tree**	10-15m	Medium	78m2	Exotic	Deciduous	
MYRTACEAE	*Corymbia*	*citriodora*	**Lemon-Scented Gum**	18-25m	Civic	314m2	Native	Evergreen	
MYRTACEAE	*Corymbia*	*eximia*	**Yellow Bloodwood**	10-18m	Medium	78m2	Native	Evergreen	CoS STMP - Cope St
MYRTACEAE	*Corymbia*	*gummifera*	**Red Bloodwood**	10-18m	Medium	78m2	Native	Evergreen	
MYRTACEAE	*Corymbia*	*maculata*	**Spotted Gum**	18-25m	Large	175m2	Native	Evergreen	
SAPINDACEAE	*Cupaniopsis*	*anacardioides*	**Tuckeroo**	8-15m	Small	38m2	Endemic	Evergreen	CoS STMP - Cooper St
ELAEOCARPACEAE	*Elaeocarpus*	*eumundi*	**Eumundi Quondong**	10-20m	Small	38m2	Native	Evergreen	
ELAEOCARPACEAE	*Elaeocarpus*	*reticulatus*	**Blue Berry Ash**	8-12m	Small	38m2	Endemic	Evergreen	CoS STMP - Reeve St & Gibbson St
MYRTACEAE	*Eucalyptus*	*botryoides*	**Bangalay**	18-25m	Medium	78m2	Endemic	Evergreen	
MYRTACEAE	*Eucalyptus*	*haemastoma*	**Scribbly Gum**	10-15m	Medium	78m2	Endemic	Evergreen	
MYRTACEAE	*Eucalyptus*	*microcorys*	**Tallowood**	20-25m	Large	175m2	Native	Evergreen	
MYRTACEAE	*Eucalyptus*	*pilularis*	**Blackbutt**	20-25m	Civic	314m2	Endemic	Evergreen	
MYRTACEAE	*Eucalyptus*	*punctata*	**Grey Gum**	18-25m	Medium	78m2	Native	Evergreen	
MYRTACEAE	*Eucalyptus*	*robusta*	**Swamp Mahogany**	10-15m	Medium	78m2	Endemic	Evergreen	
MYRTACEAE	*Eucalyptus*	*saligna*	**Sydney Bluegum**	20-28m	Civic	314m2	Native	Evergreen	
MYRTACEAE	*Eucalyptus*	*sideroxylon*	**Red Ironbark**	18-25m	Medium	78m2	Native	Evergreen	
MORACEAE	*Ficus*	*macrophylla*	**Morton Bay Fig**	20-25m	Civic	314m2	Native	Evergreen	
MORACEAE	*Ficus*	*microcarpa var. hillii*	**Hills Weeping Fig**	20-25m	Civic	314m2	Native	Evergreen	
MORACEAE	*Ficus*	*rubiginosa*	**Port Jackson Fig**	15-20m	Large	175m2	Native	Evergreen	
RUTACEAE	*Flindersia*	*australis*	**Crows Ash**	15-20m	Medium	78m2	Native	Evergreen	
OLEACEAE	*Fraxinus*	*griffithii*	**Evergreen Ash**	7-10m	Small	38m2	Exotic	Deciduous	
OLEACEAE	*Fraxinus*	*oxycarpa 'Raywood'*	**Claret Ash**	10-15m	Small	38m2	Exotic	Deciduous	
OLEACEAE	*Fraxinus*	*pennsylvanica*	**Red Ash**	12-18m	Medium	78m2	Exotic	Deciduous	
GINKGOACEAE	*Gingko*	*biloba*	**Maidenhair Tree**	12-18m	Medium	78m2	Exotic	Deciduous	
CAESALPINIACEAE	*Gleditsia*	*triacanthos 'Sunburst'*	**Honey Locust**	10-15m	Medium	78m2	Exotic	Deciduous	
EUPHORBIACEAE	*Glochidion*	*ferdinandi*	**Cheese Tree**	8-12m	Medium	78m2	Endemic	Evergreen	
THEACEAE	*Gordonia*	*axillaris*	**Gordonia**	5-8m	Small	38m2	Exotic	Evergreen	
SAPINDACEAE	*Harpullia*	*pendula*	**Tulipwood**	8-12m	Medium	78m2	Native	Evergreen	
MALVACEAE	*Hibiscus*	*tiliaceous*	**Coast Cottonwood**	8-10m	Small	38m2	Native	Evergreen	
BIGNONIACEAE	*Jacaranda*	*mimosifolia*	**Jacaranda**	10-15m	Medium	78m2	Exotic	Deciduous	CoS STMP - Phillip St
SAPINDACEAE	*Koelreutaria*	*bipinnata*	**Chinese Rain Tree**	10-15m	Medium	78m2	Exotic	Deciduous	
SAPINDACEAE	*Koelreutaria*	*paniculata*	**Golden Rain Tree**	7-9m	Small	38m2	Exotic	Deciduous	
LYTHRACEAE	*Lagerstroemia*	*indica cv.*	**Crepe Myrtle**	8-10m	Large	175m2	Exotic	Deciduous	
HAMAMELIDACEAE	*Liquidambar*	*styraciflua*	**Liquidambar**	15-22m	Medium	78m2	Exotic	Deciduous	
MAGNOLIACEAE	*Liriodendron*	*tulipifera*	**Tulip Tree**	15-20m	Medium	78m2	Exotic	Deciduous	
ARECACEAE	*Livistona*	*australis*	**Cabbage Tree Palm**	15-20m	Small	38m2	Endemic	Evergreen	
MYRTACEAE	*Lophostemon*	*confertus*	**Brush Box**	20-25m	Medium	78m2	Native	Evergreen	CoS STMP - McEvoy St, Raglan St, George St & Botany Rd
MAGNOLIACEAE	*Magnolia*	*grandiflora 'Exmouth'*	**Bull-bay Magnolia**	12-15m	Small	38m2	Exotic	Evergreen	
MYRTACEAE	*Melaleuca*	*leucadendra*	**Weeping Paperbark**	15-18m	Medium	78m2	Native	Evergreen	
MYRTACEAE	*Melaleuca*	*quinquinervia*	**Broad-Leaf Paperbark**	18-20m	Medium	78m2	Endemic	Evergreen	
MYRTACEAE	*Melaleuca*	*styphelioides*	**Prickly Paperbark**	8-12m	Small	38m2	Endemic	Evergreen	
ARECACEAE	*Phoenix*	*dactylifera*	**Date Palm**	8-12m	Small	38m2	Exotic	Evergreen	
ANACARDIACEAE	*Pistacia*	*chinensis*	**Chinese Pistachio**	7-12m	Medium	78m2	Exotic	Deciduous	
PLATANACEAE	*Platanus*	*x acerifolia 'Bloodgood'*	**London Plane**	18-25m	Large	175m2	Exotic	Deciduous	
SALICACEAE	*Populus*	*simonii*	**Simons Poplar**	15-20m	Medium	78m2	Exotic	Deciduous	
ROSACEAE	*Prunus*	*cerasifera 'Nigra'*	**Purple-leaf Cherry Plum**	6-8m	Small	38m2	Exotic	Deciduous	
ROSACEAE	*Pyrus*	*calleryana 'Chanticleer'*	**Callery Pear**	6-8m	Small	38m2	Exotic	Deciduous	
ROSACEAE	*Pyrus*	*ussuriensis*	**Machurian Pear**	8-12m	Medium	78m2	Exotic	Deciduous	
FAGACEAE	*Quercus*	*ilex*	**Holm Oak**	12-15m	Medium	78m2	Exotic	Evergreen	
FABACEAE	*Robinia*	*pseudoacacia 'Frisia'*	**Black Locust**	10-12m	Medium	78m2	Exotic	Deciduous	CoS STMP - Pitt St & Botany Rd
EUPHORBIACEAE	*Sapium*	*sebiferum*	**Chinese Tallow Tree**	10-12m	Medium	78m2	Exotic	Deciduous	
ANACARDIACEAE	*Schinus*	*areira*	**Peppercorn Tree**	10-12m	Medium	78m2	Exotic	Evergreen	
PROTEACEAE	*Stenocarpus*	*sinuatus*	**Firewheel Tree**	8-12m	Small	38m2	Native	Evergreen	
MYRTACEAE	*Syzygium*	*leuhmannii*	**Riberry**	8-12m	Small	38m2	Native	Evergreen	
MYRTACEAE	*Syzygium*	*paniculatum*	**Brush Cherry**	8-12m	Medium	78m2	Native	Evergreen	
MYRTACEAE	*Tristaniopsis*	*laurina*	**Water Gum**	7-10m	Small	38m2	Native	Evergreen	
MYRTACEAE	*Tristaniopsis*	*laurina 'Luscious'*	**Glossy-Leaved Water Gum**	7-10m	Small	38m2	Native	Evergreen	
ULMACAEAE	*Ulmus*	*parvifolia 'Todd'*	**Chinese Elm**	10-12m	Large	175m2	Exotic	Deciduous	
ARECACEAE	*Washingtonia*	*robusta*	**Mexican Fan Palm**	20-25m	Small	38m2	Exotic	Evergreen	
MYRTACEAE	*Waterhousea*	*floribunda 'Green Avenue'*	**Weeping Lilly Pilly**	18-25m	Medium	78m2	Native	Evergreen	CoS STMP - John St, Wellington St, Mead St
SALICACEAE	*Xylosma*	*senticosum*	**Xylosma**	6-10m	Small	38m2	Exotic	Evergreen	
ULMACAEAE	*Zelkova*	*serrata 'Green Vase'*	**Japanese Zelkova**	10-12m	Medium	78m2	Exotic	Deciduous	

6.3 Existing Tree Canopy Cover Plan – Metro Quarter and Waterloo Estate

Legend

- Precinct boundary - Estate
- Precinct boundary - Metro Quarter
- Cadastre

	Site Area	Total Area
	Park	0m2
	Private	154,633m2
	Street	68,151m2
	Total	**222,784m2**

Canopy Extent	Canopy Type	Canopy Coverage	% of Area
	Park	0m2	0%
	Private	39,794m2	25.7%
	Street	21,805m2	32.0%
	Total	**61,599m2**	**27.6%**

Note:-
Site area calculations include immediately adjoining streets where they are Council controlled roads but only to the centre line for RMS roads (e.g. Botany Rd & McEvoy St)

0 40 100 200m

Waterloo Estate
& Metro Quarter
Urban Forest Study

Existing Tree Canopy Cover

Drawing: UFS-Plan01
Revision: C
Date: 21.09.2018

Note:-
Site area calculations include immediately adjoining streets to the centre line of the road carriageway

Legend

Existing Canopy Cover - Metro Quarter

- Precinct boundary - Estate
- Precinct boundary - Metro Quarter
- Cadastre

	Area	Total Area
	Park	0m2
	Private	13,684m2
	Street	5,809m2
	Total	**19,493m2**

Canopy Extent	Canopy Type	Canopy Coverage	% of Total Area	% of Relative Area
	Park	0m2	0%	0%
	Private	17m2	<1%	<1%
	Street	353m2	2%	6%
	Total	**370m2**	**2%**	—

0 20 40

Waterloo Estate
& Metro Quarter
Urban Forest Study

MQ-Existing Tree Canopy Coverage

Drawing: MQ02
Revision: C
Date: 21.09.2018

6.4 Existing Tree Retention Value Plan – Metro Quarter and Waterloo Estate

Legend

- Precinct boundary - Estate
- Precinct boundary - Metro Quarter
- Cadastre
- High Retention value
- Moderate Retention value
- Low Retention value
- Very Low Retention value (should remove)

0 40 100 200m

Waterloo Estate
& Metro Quarter
Urban Forest Study

Existing Tree Retention Values

Drawing: UFS-Plan02
Revision: C
Date: 21.09.2018

Legend

- Precinct boundary - Estate
- Precinct boundary - Metro Quarter
- Cadastre
- High Retention value
- Moderate Retention value
- Low Retention value
- Very Low Retention value (should remove)

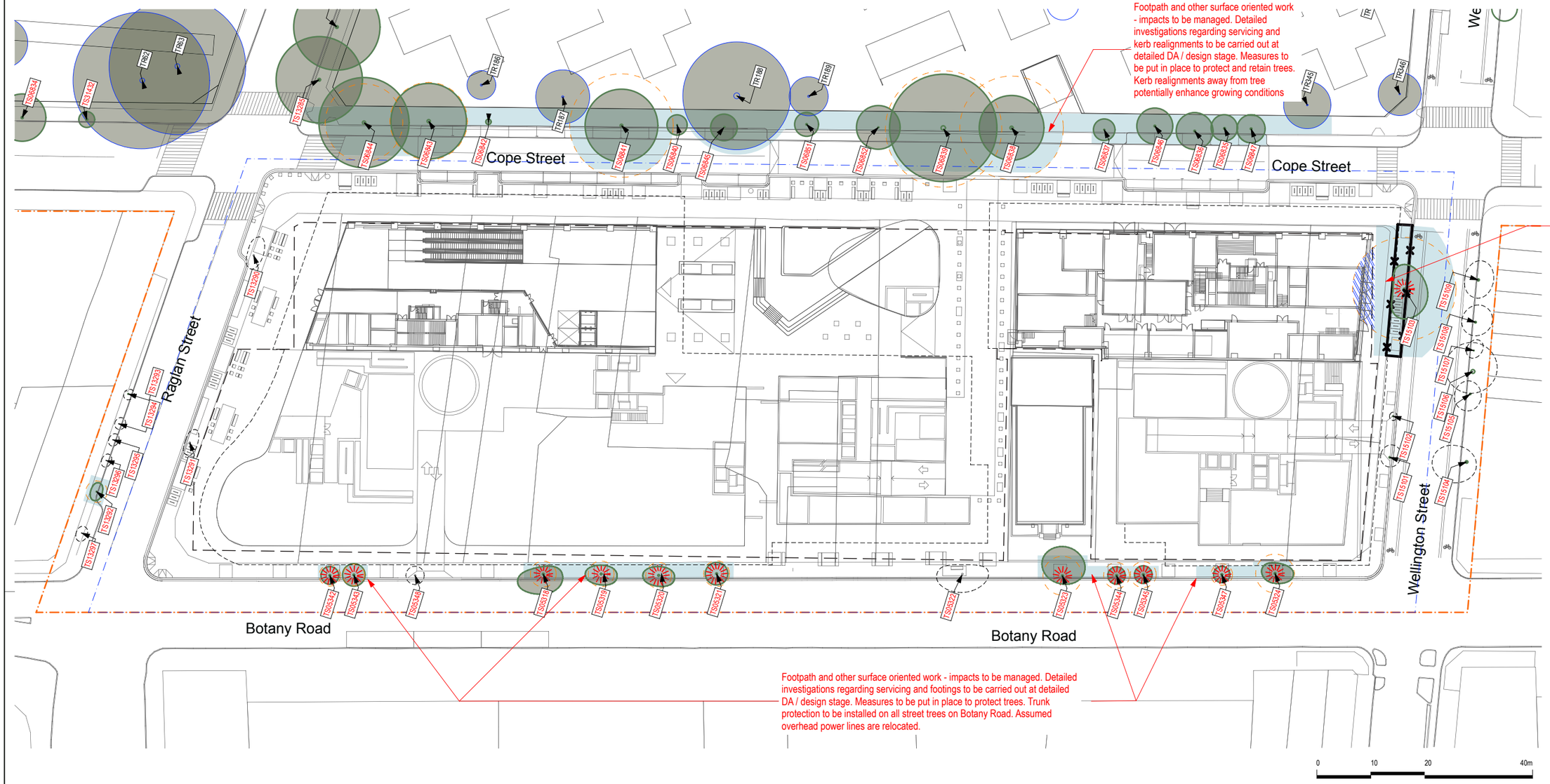
0 20 40 100m

Waterloo Estate
& Metro Quarter
Urban Forest Study

MQ-Existing Tree Retention Values

Drawing: MQ01
Revision: C
Date: 21.09.2018

6.5 Tree Protection and Removal Plan – Metro Quarter



Example image of acceptable tree trunk protection battens

Example image of acceptable tree protection fencing measures to be applied. (1.8m high rigid metal fencing with appropriate lateral bracing)

Tree Protection Legend

- Precinct boundary - Waterloo Estate
- Precinct boundary - Metro Quarter
- Existing Cadastre
- Tree ID Number (TS05323)
- Existing Tree to be Retained & Protect
- Nominal Tree Protection Zone radius (TPZ)
- Existing Tree to be Removed
- Construction Period Tree Protection Zone
- Construction Period Tree Protection - Temporary fencing
- Trunk Protection Battens to be installed
- Likley loss of roots due to excavation or trenching

arterra

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REVISION	DESCRIPTION	CHKD	DATE
C	For Authority Submission	RWS	21/09/18
B	For Authority Submission	RWS	13/09/18
A	For Authority Submission	RWS	19/07/18

PROJECT & CLIENT

Waterloo-Urban Forest Study

Urban Growth NSW

DRAWING TITLE

Waterloo Metro Quarter Tree Protection & Removal

Project No : 17.07
Designed : RWS
Drawn : RWS
Scale : 1:250@A1 , 1:500@A3

DRAWING NUMBER MQ04
REVISION C

Plotted at : 2:13 pm 21/9/18

6.6 Plan of Likely Potential Canopy Coverage – Metro Quarter

Note:-
Canopy calculations are based on conservative estimates of ultimate mature canopy spreads for the species of tree expected to be used. Final species selections subject to detailed design resolution.

Note:-
Site area calculations include immediately adjoining streets to the centre line of the road carriageway.

Legend

Potential Canopy Cover - Metro Quarter

- Precinct boundary - Estate
- Precinct boundary - Metro Quarter
- Cadastre

Area		Total Area
	Park	0m2
	Private	13,684m2
	Street	5,809m2
	Total	**19,493m2**

Canopy Extent	Canopy Type	Canopy Coverage	% of Total Area	% of Relative Area
	Park	0m2	0%	0%
	Private	1,492m2	7%	11%
	Street	3,049m2	16%	53%
	Total	**4,903m2**	**23%**	—

0 20 40

Waterloo Estate
& Metro Quarter
Urban Forest Study

MQ-Potential Tree Canopy Coverage

Drawing: MQ03
Revision: C
Date: 21.09.2018

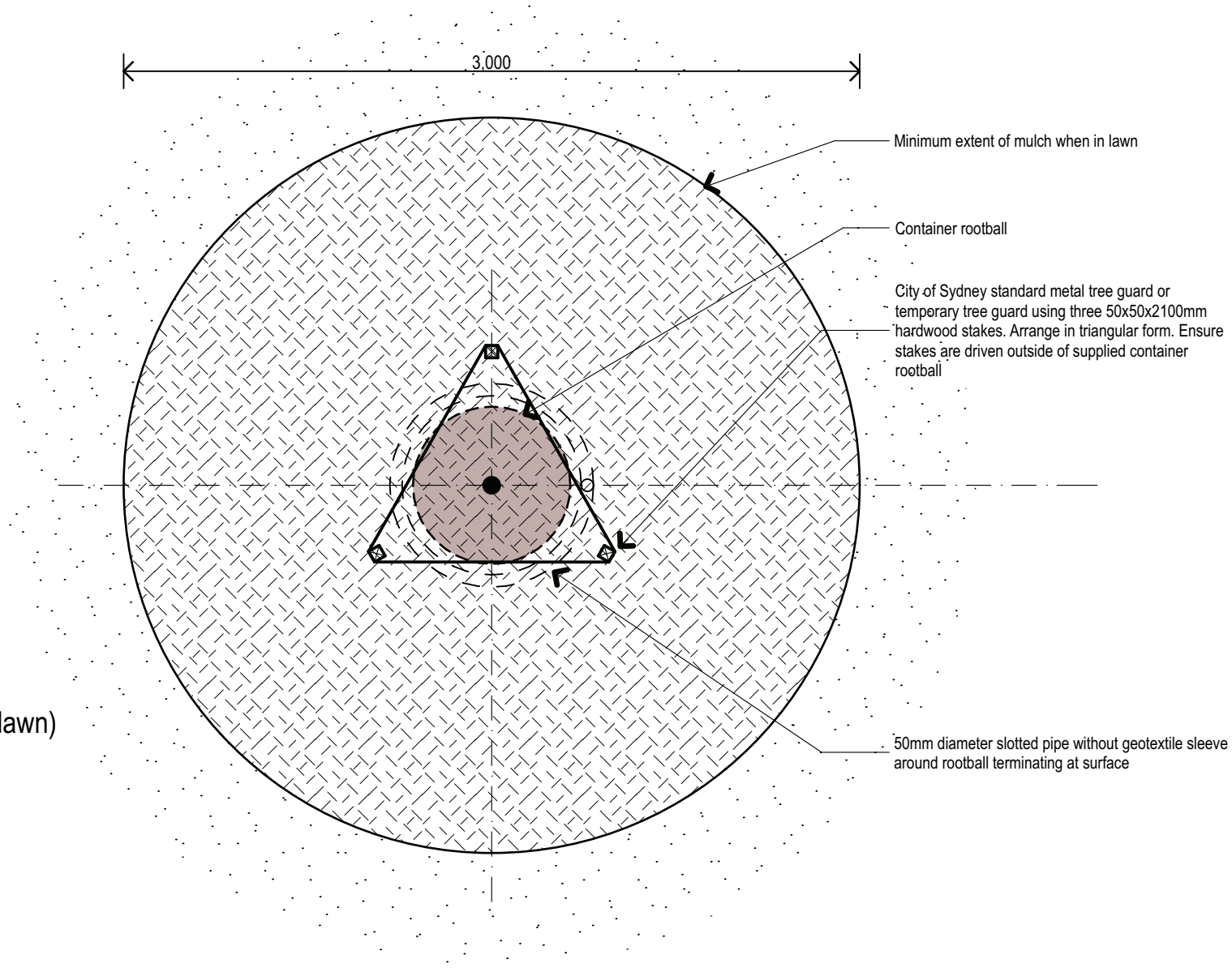
6.7 Typical Planting Details to be Adopted for the Project

The following pages are the currently unpublished but standard tree planting details for the CoS. They have been reproduced here with the permission of the CoS to assist and facilitate appropriate installation of public trees. These supersede the current planting details that are contained within the current CoS Street Tree Master Plan 2015.

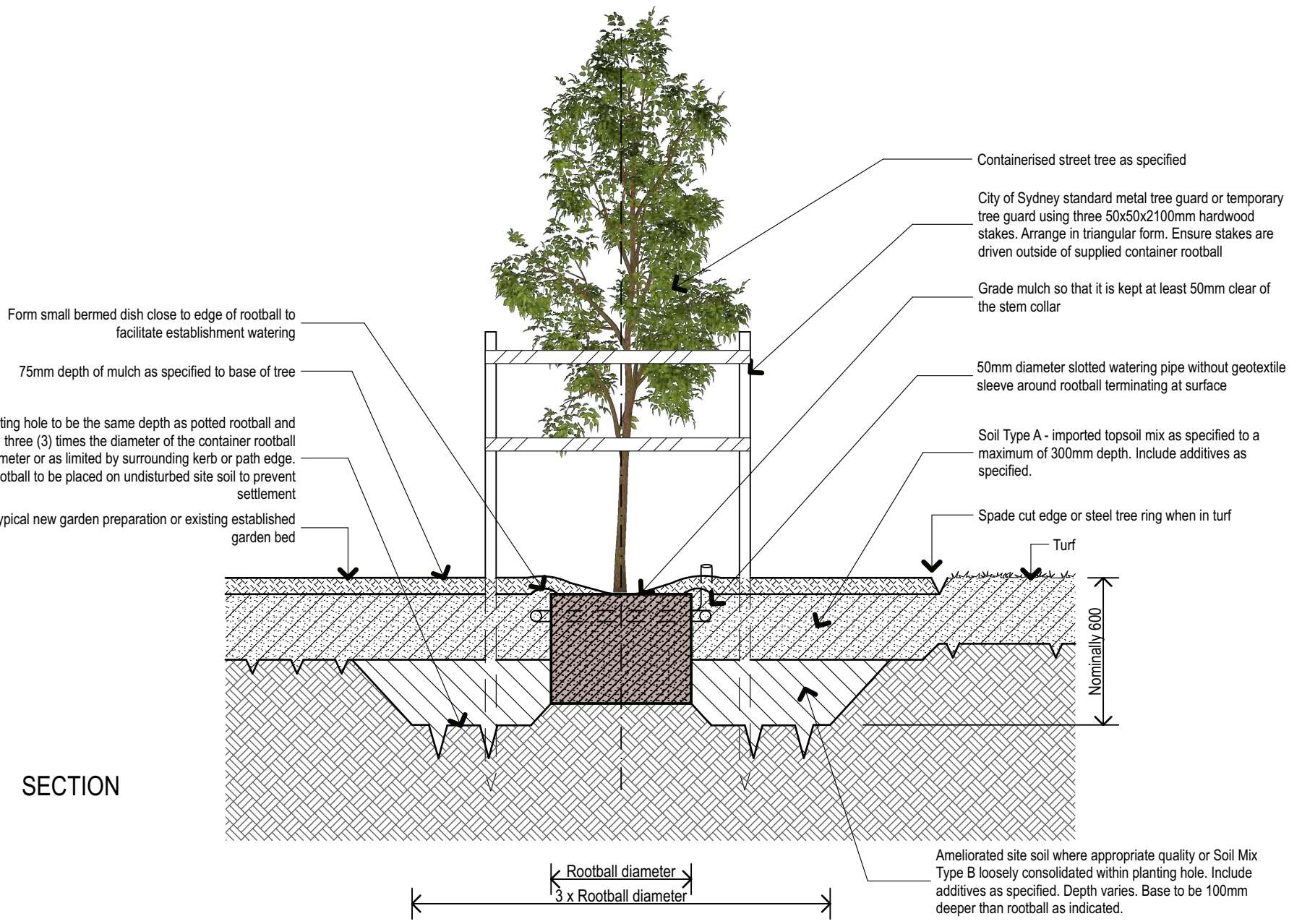
These details are generic and standard details. They should be referred to as a guide to appropriate tree planting and proper resolution of elements related to street and public area tree planting. Detailed and site specific details will be expected to be produced during refinement and detailed design stages of the proposed new development. Future appointed designers and developers are encouraged to refer to these details for guidance on the minimum standards and general approaches that will expected.

These details may be subsequently superseded by later revisions to policy, codes and plans that may be prepared by CoS.

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.



PLAN (When in lawn)



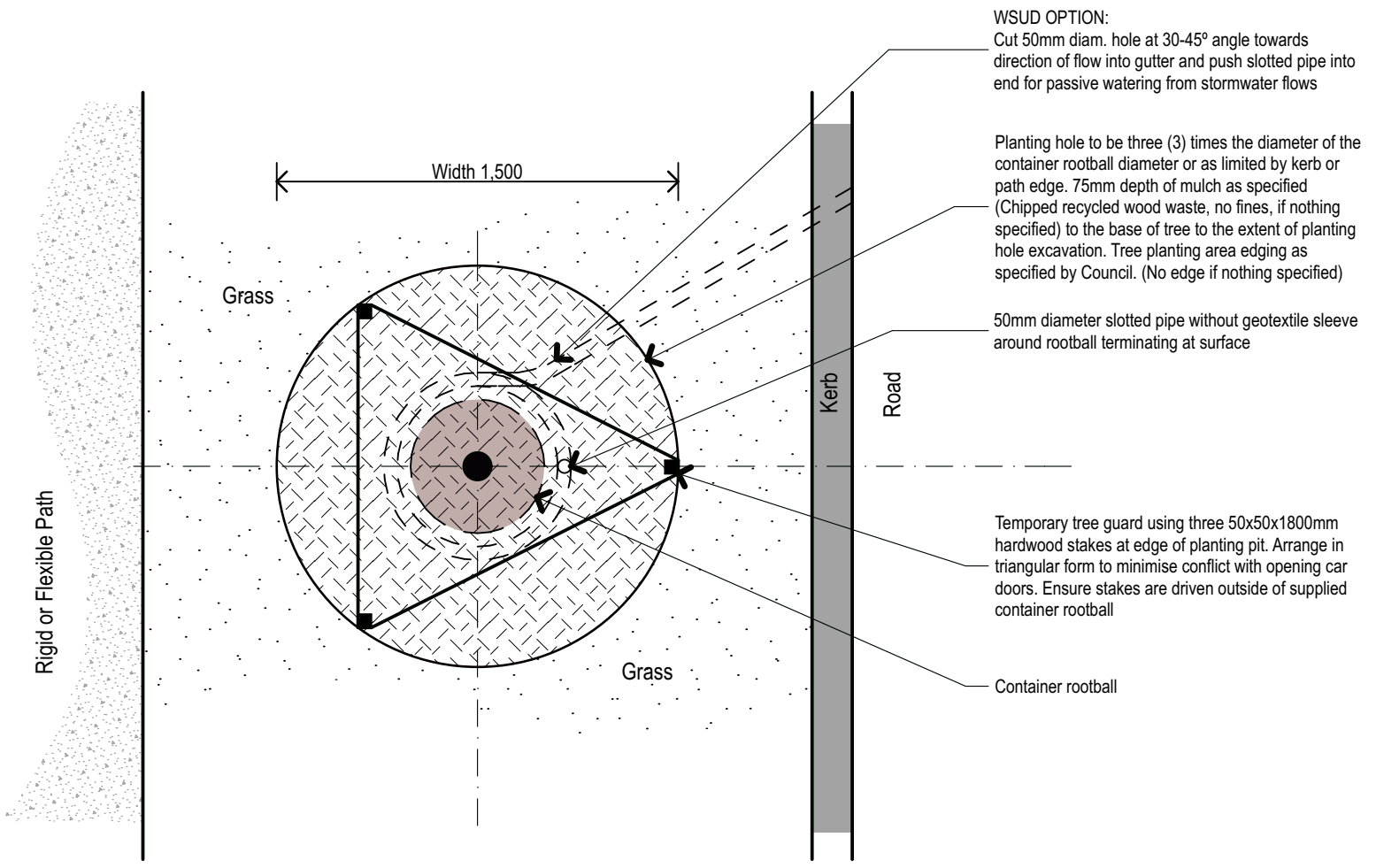
SECTION

Scale 1: 25 @ A3 0 500 1000mm

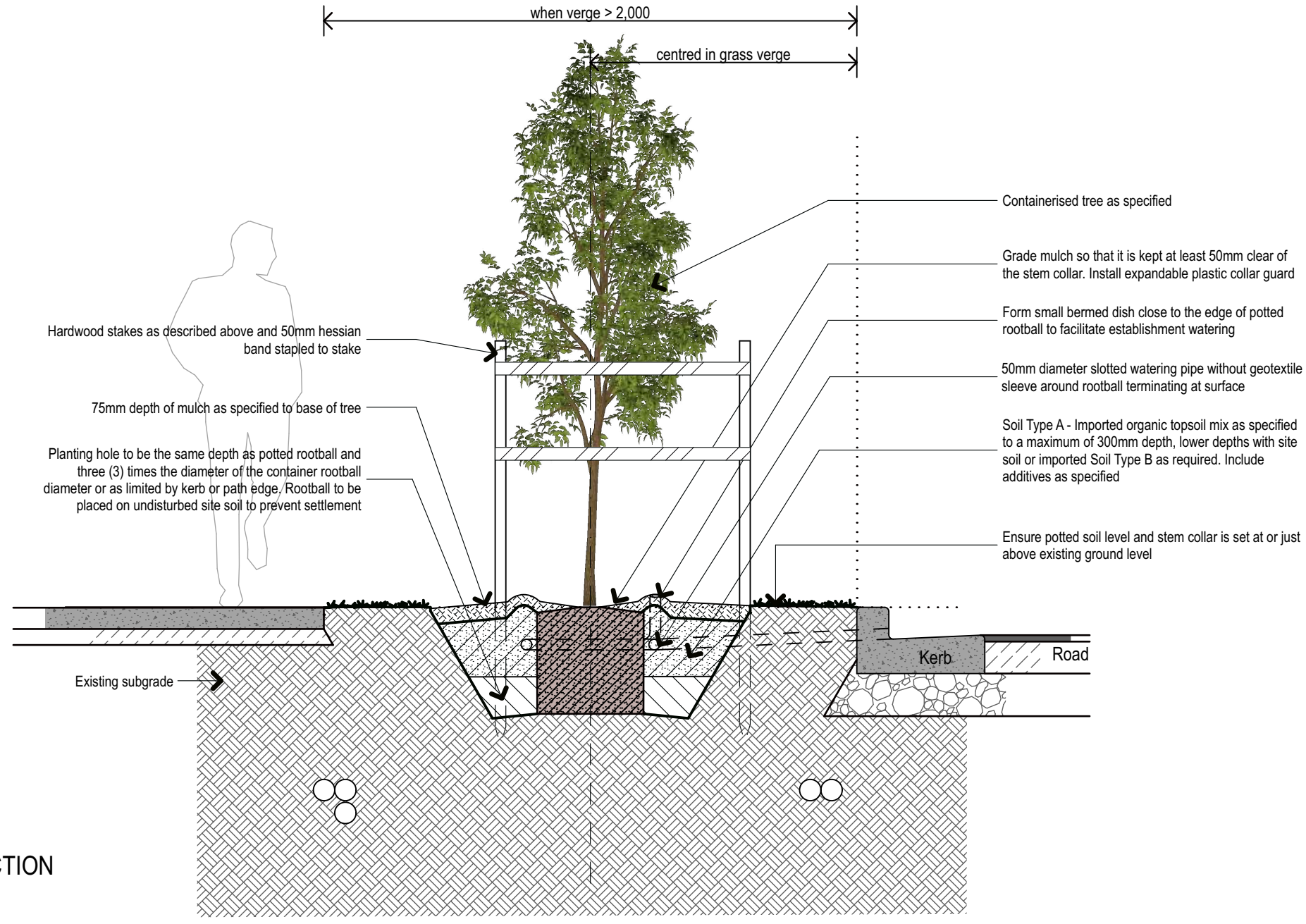
City of Sydney

TYPE 1 - TREE PLANTING IN WIDE OPEN TURF

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.



PLAN



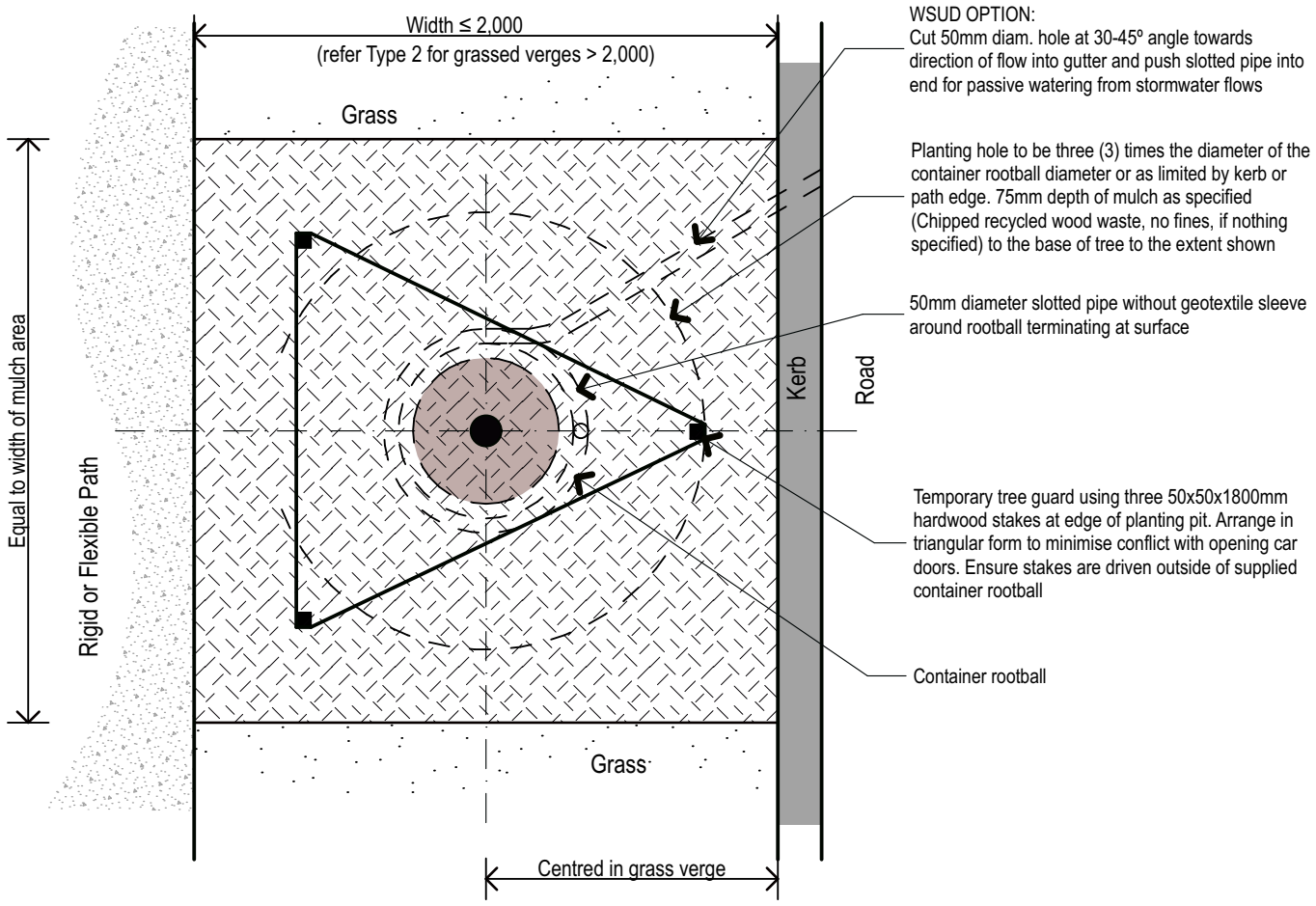
SECTION

Scale 1: 25 @ A3 0 500 1000mm

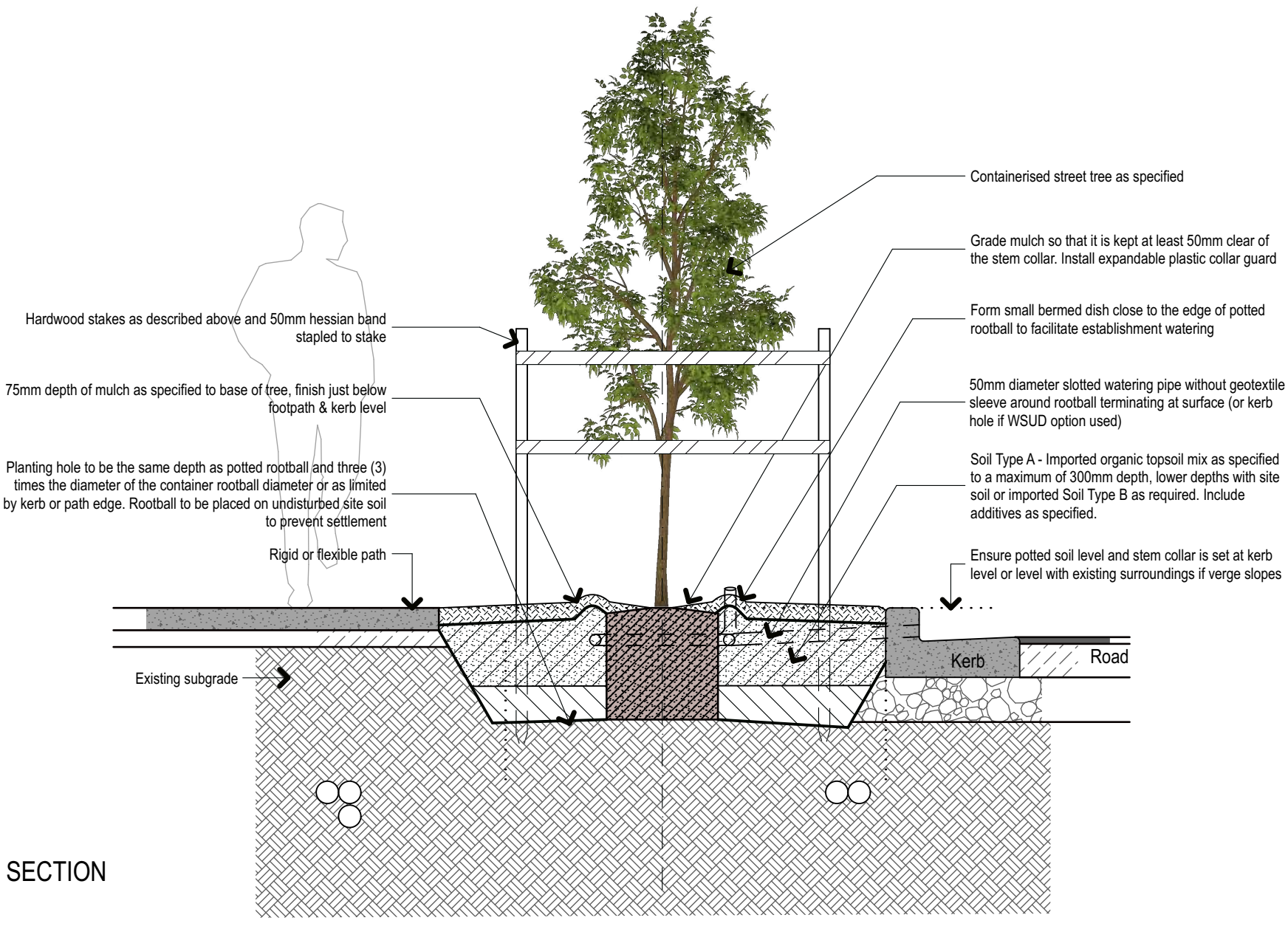
TYPE 2 - TREE PLANTING IN WIDE GRASSED VERGE

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.

PLAN



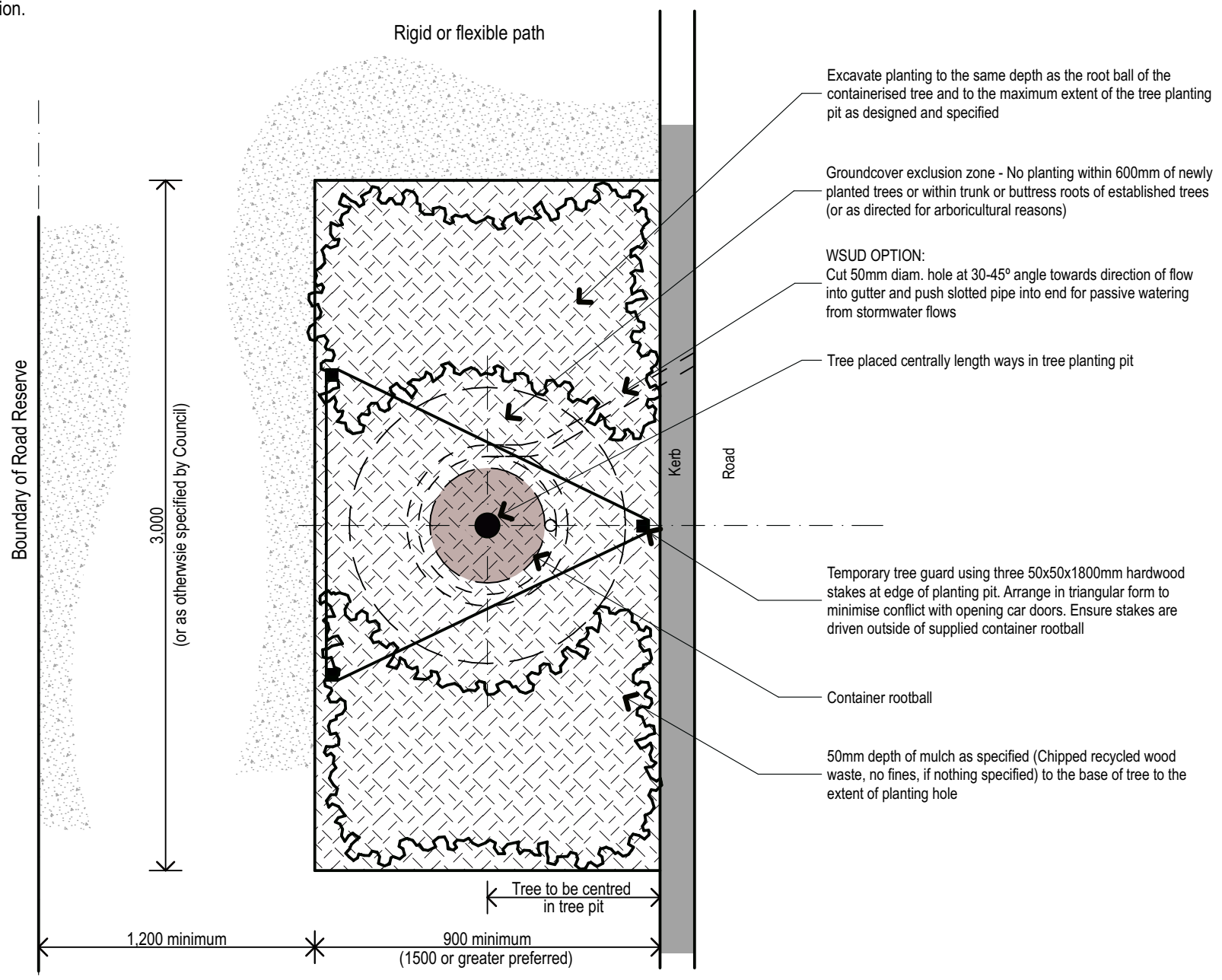
SECTION



Scale 1: 25 @ A3 0 500 1000mm

TYPE 3 - TREE PLANTING IN NARROW GRASSED VERGE

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.



PLAN

Excavate planting to the same depth as the root ball of the containerised tree and to the maximum extent of the tree planting pit as designed and specified

Groundcover exclusion zone - No planting within 600mm of newly planted trees or within trunk or buttress roots of established trees (or as directed for arboricultural reasons)

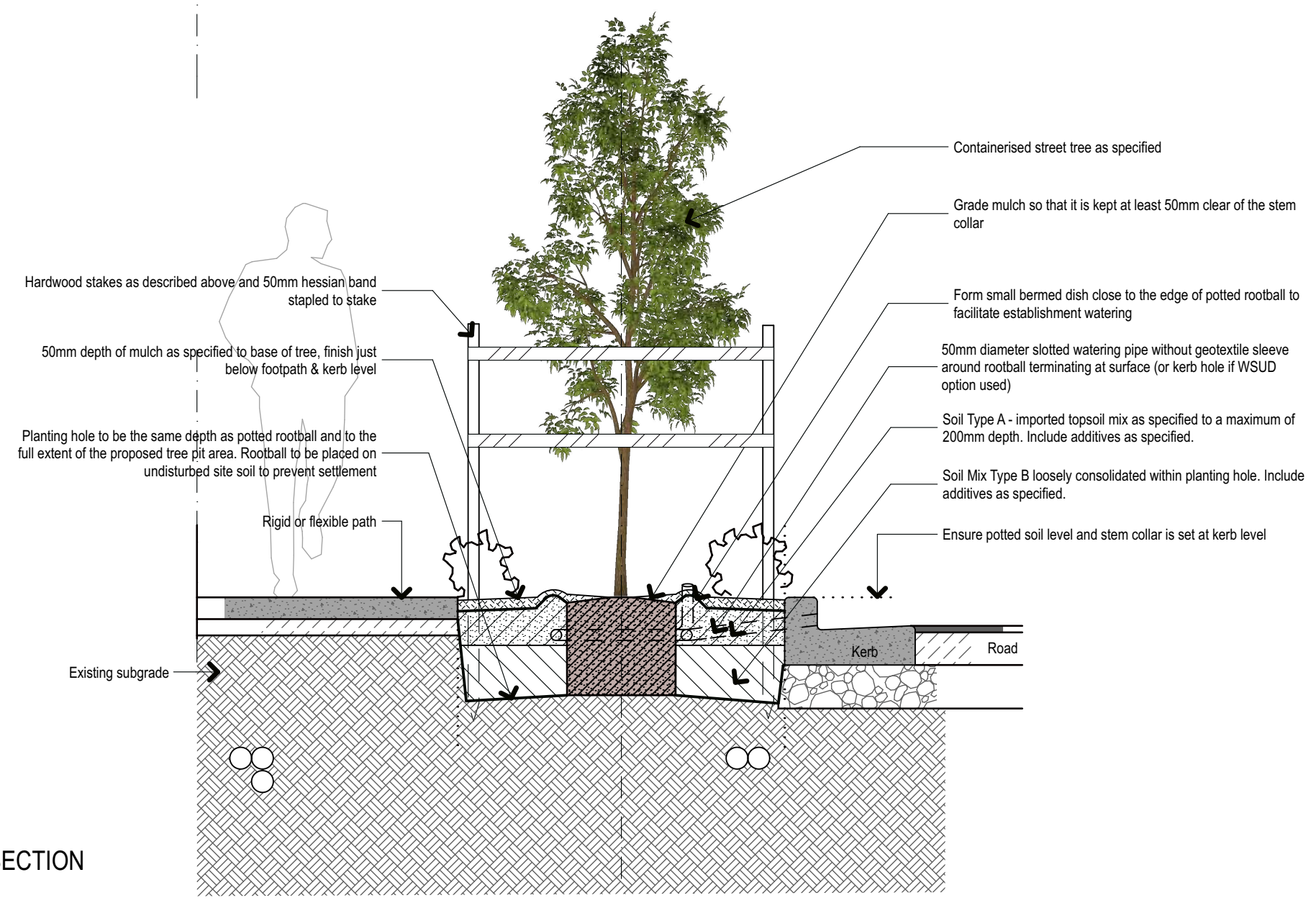
WSUD OPTION:
Cut 50mm diam. hole at 30-45º angle towards direction of flow into gutter and push slotted pipe into end for passive watering from stormwater flows

Tree placed centrally length ways in tree planting pit

Temporary tree guard using three 50x50x1800mm hardwood stakes at edge of planting pit. Arrange in triangular form to minimise conflict with opening car doors. Ensure stakes are driven outside of supplied container rootball

Container rootball

50mm depth of mulch as specified (Chipped recycled wood waste, no fines, if nothing specified) to the base of tree to the extent of planting hole



SECTION

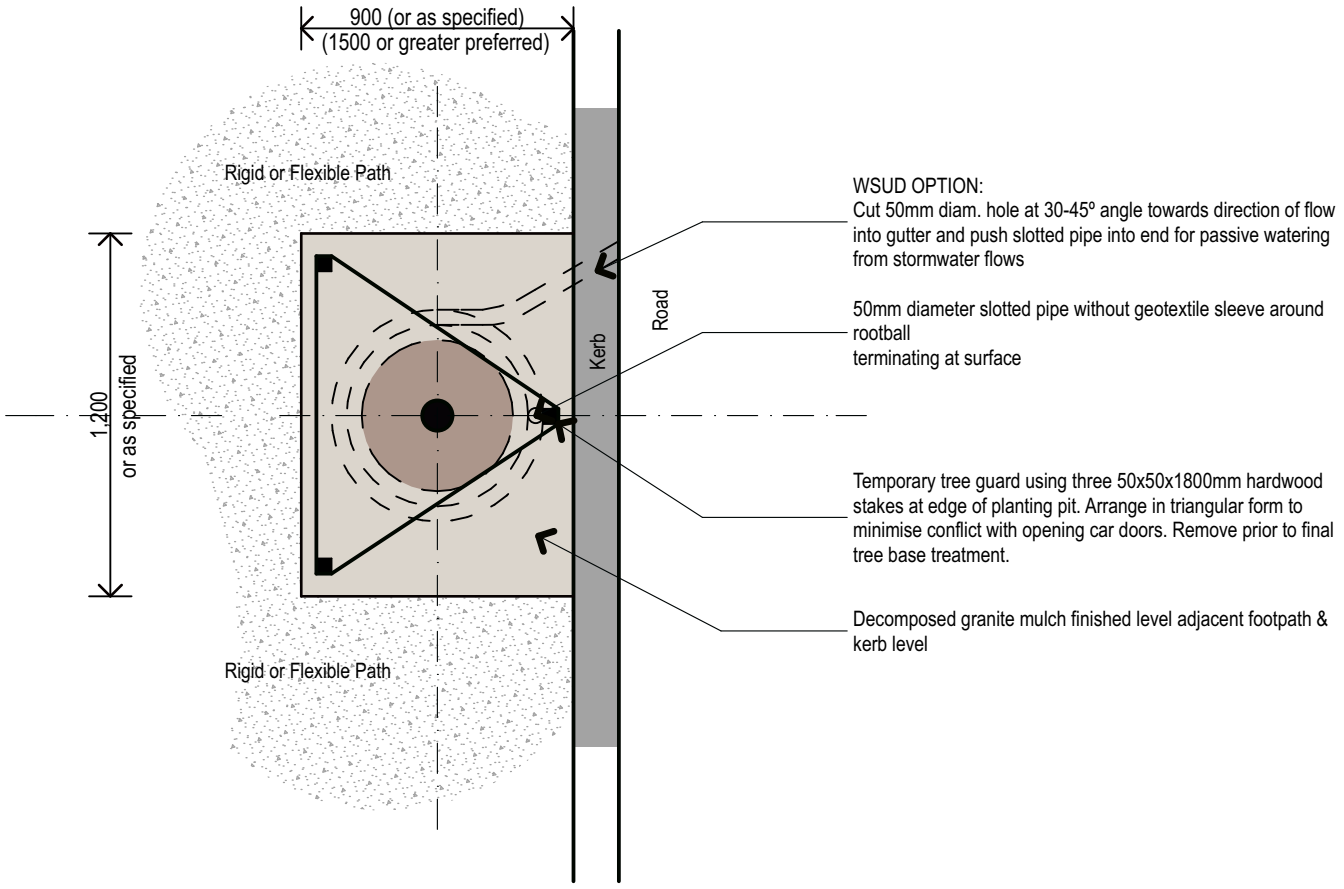
Scale 1: 25 @ A3 0 500 1000mm

City of Sydney

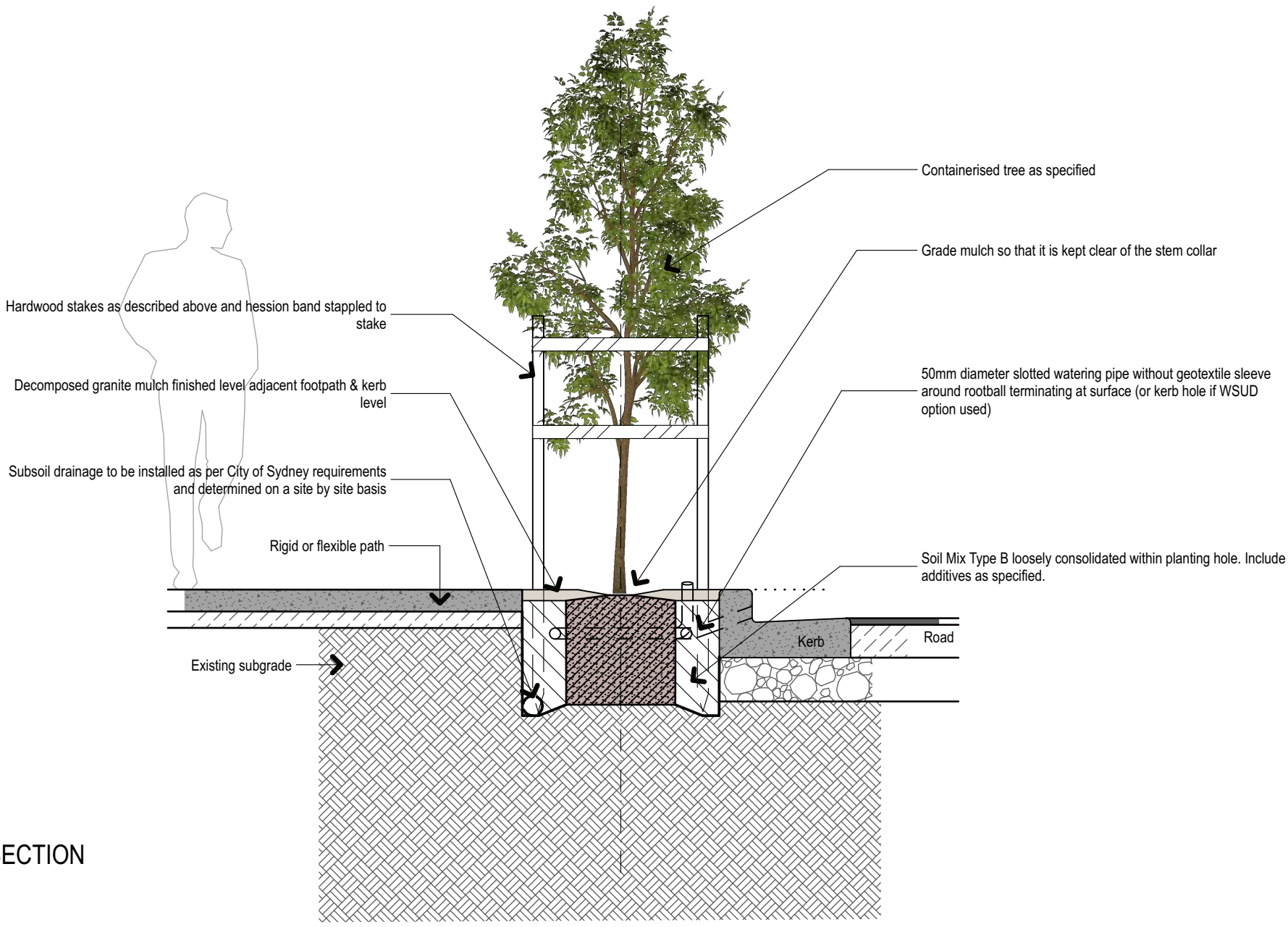
TYPE 4 - TREE PLANTING IN FULLY PAVED VERGE WITHIN STREET GARDEN

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.

NOTE 2: Existing Trees
a. Size of tree pit may vary depending on depth of surface roots or trunk flare of mature trees.
b. Paving construction may be altered to accommodate tree roots at the direction of Council.
c. Tree pit surface to be installed level with surrounding paving, leaving surface roots exposed where necessary.



PLAN



SECTION

Scale 1: 25 @ A3 0 500 1000mm

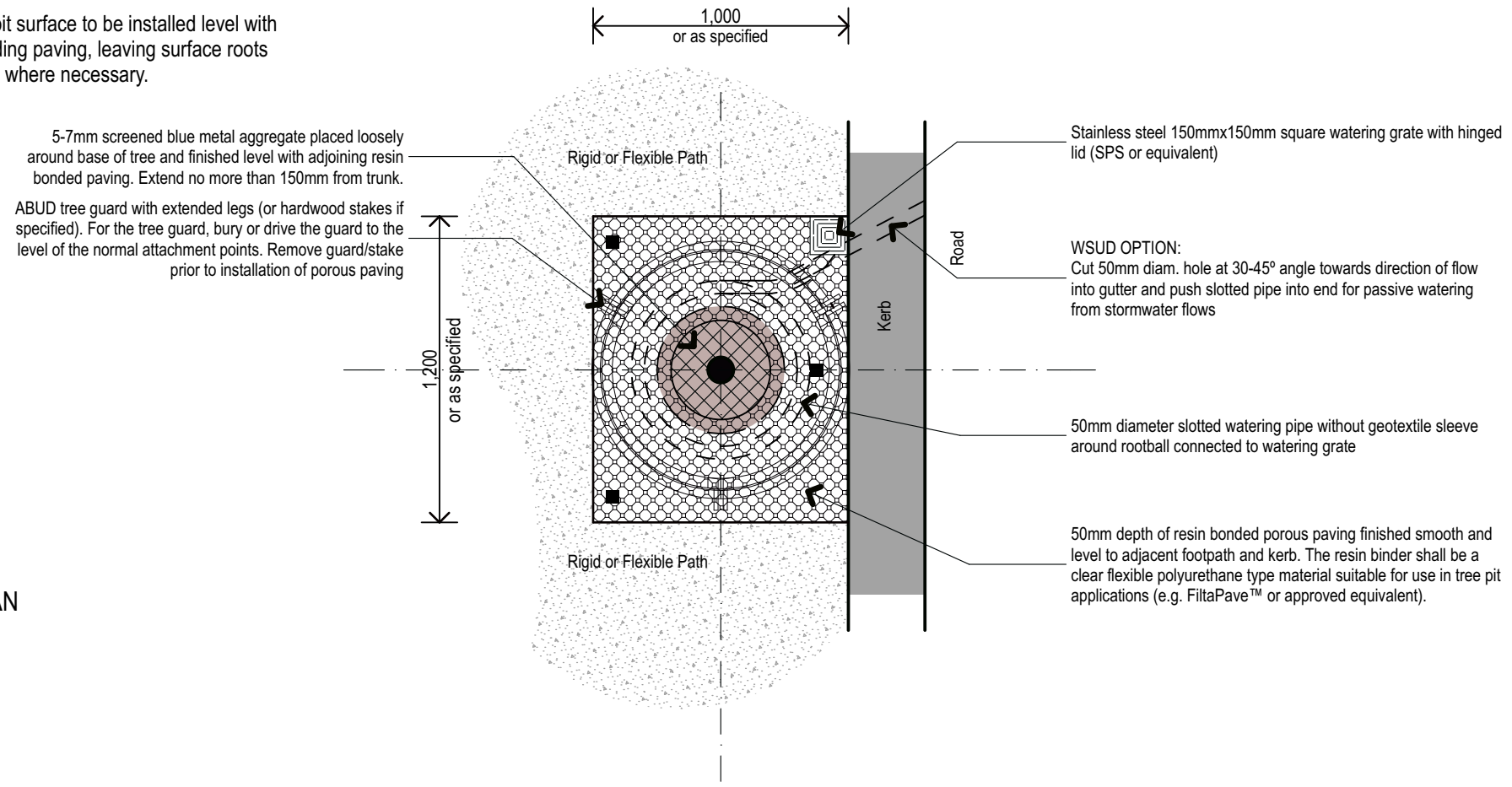
City of Sydney

TYPE 5 - TREE PLANTING WITH DECOMPOSED GRANITE SURROUND

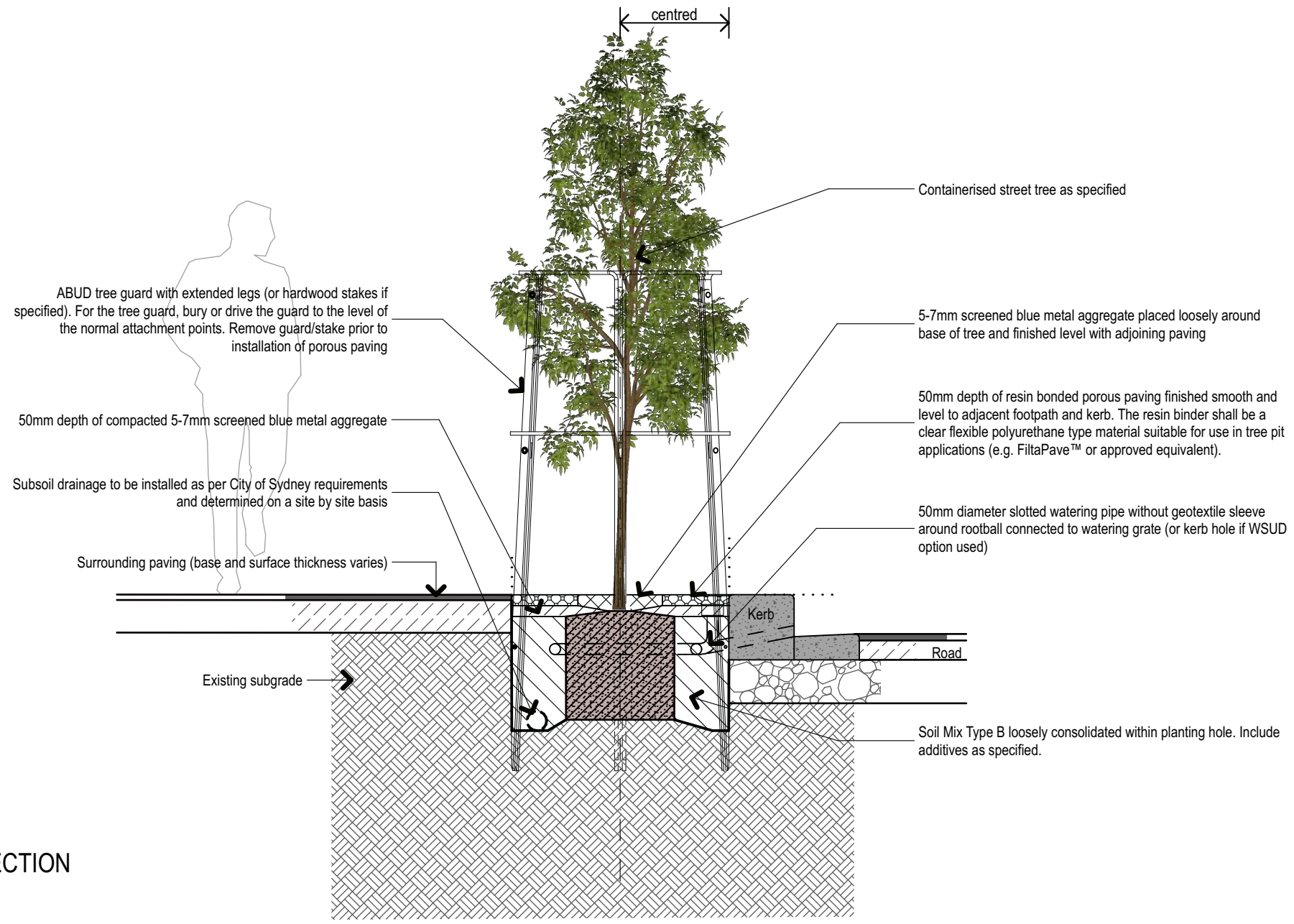
NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.

NOTE 2: Existing Trees
a. Size of tree pit may vary depending on depth of surface roots or trunk flare of mature trees.
b. Paving construction may be altered to accommodate tree roots at the direction of Council.
c. Tree pit surface to be installed level with surrounding paving, leaving surface roots exposed where necessary.

PLAN



SECTION

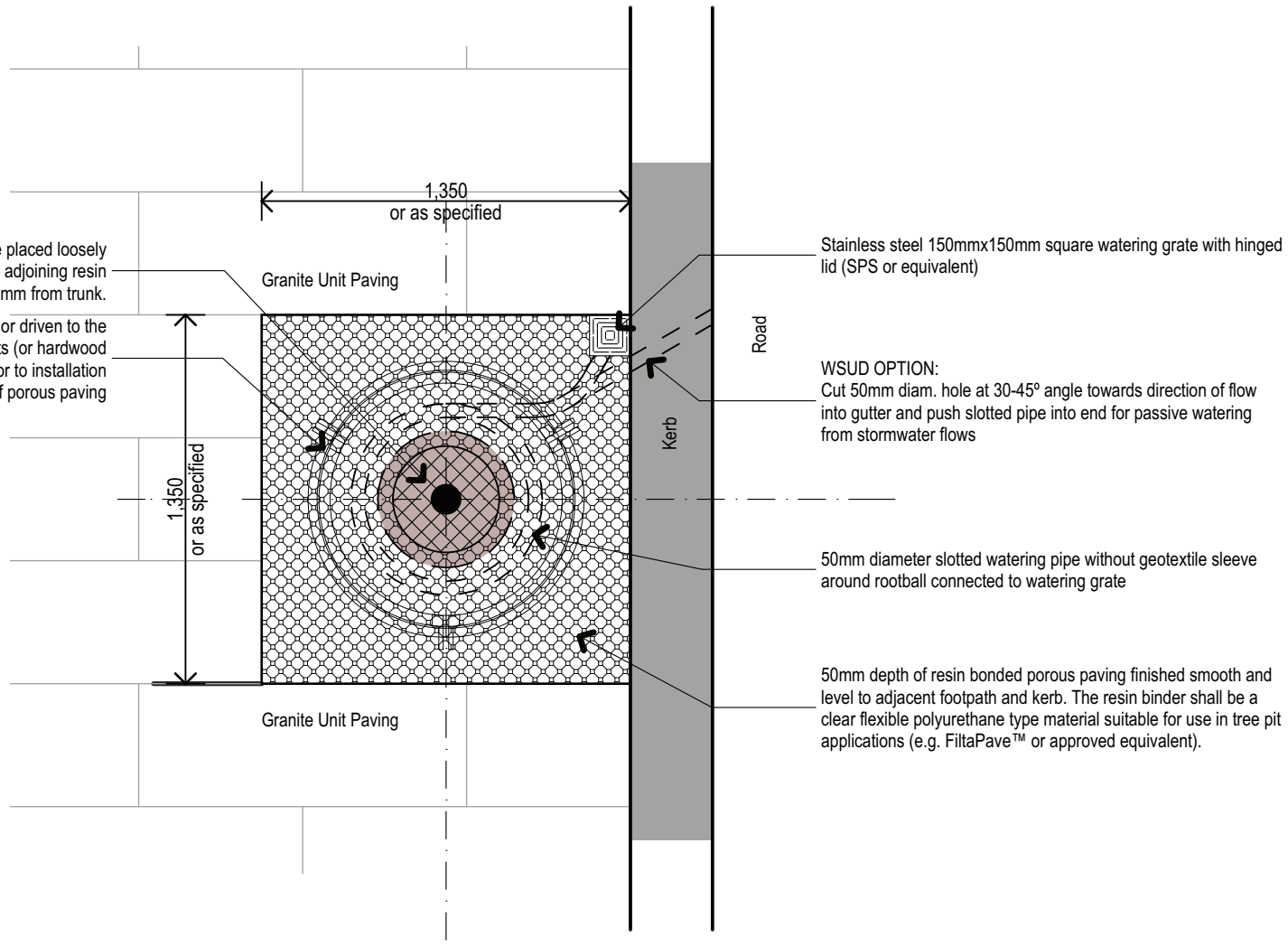


Scale 1: 25 @ A3 0 500 1000mm

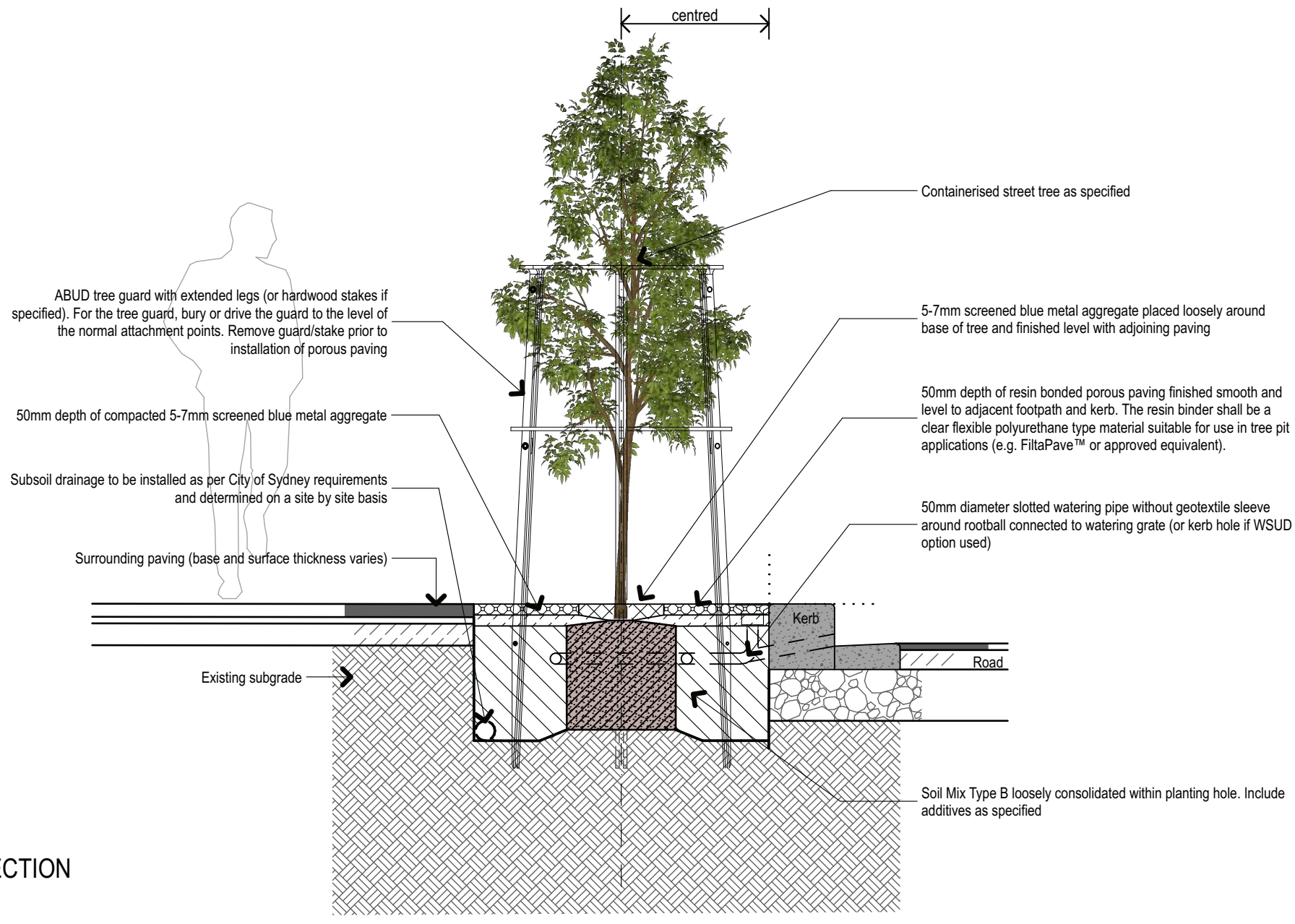
TYPE 6 - TREE PLANTING WITH POROUS PAVING SURROUND

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.

NOTE 2: Existing Trees
a. Size of tree pit may vary depending on depth of surface roots or trunk flare of mature trees.
b. Paving construction may be altered to accommodate tree roots at the direction of Council.
c. Tree pit surface to be installed level with surrounding paving, leaving surface roots exposed where necessary.



PLAN

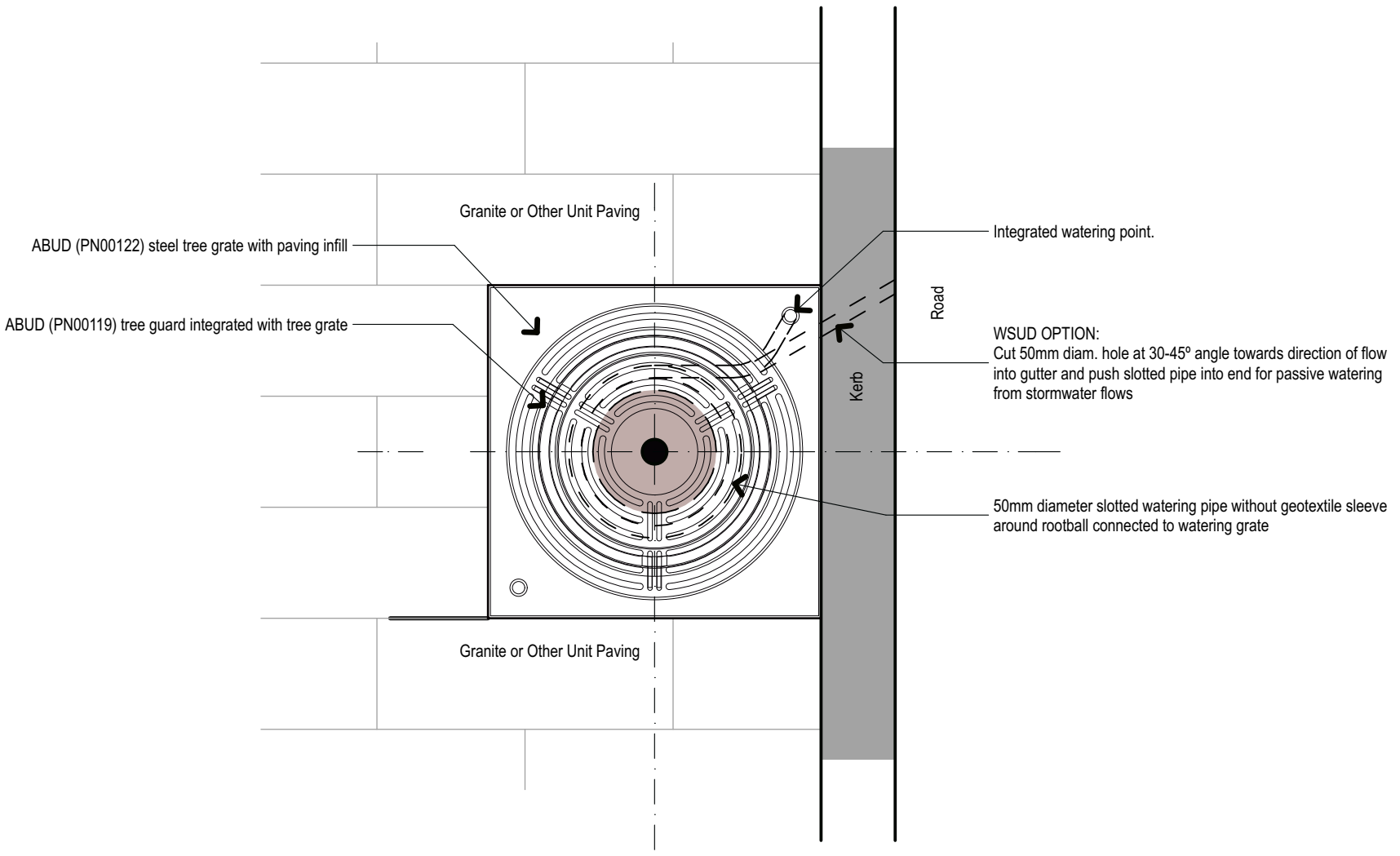


SECTION

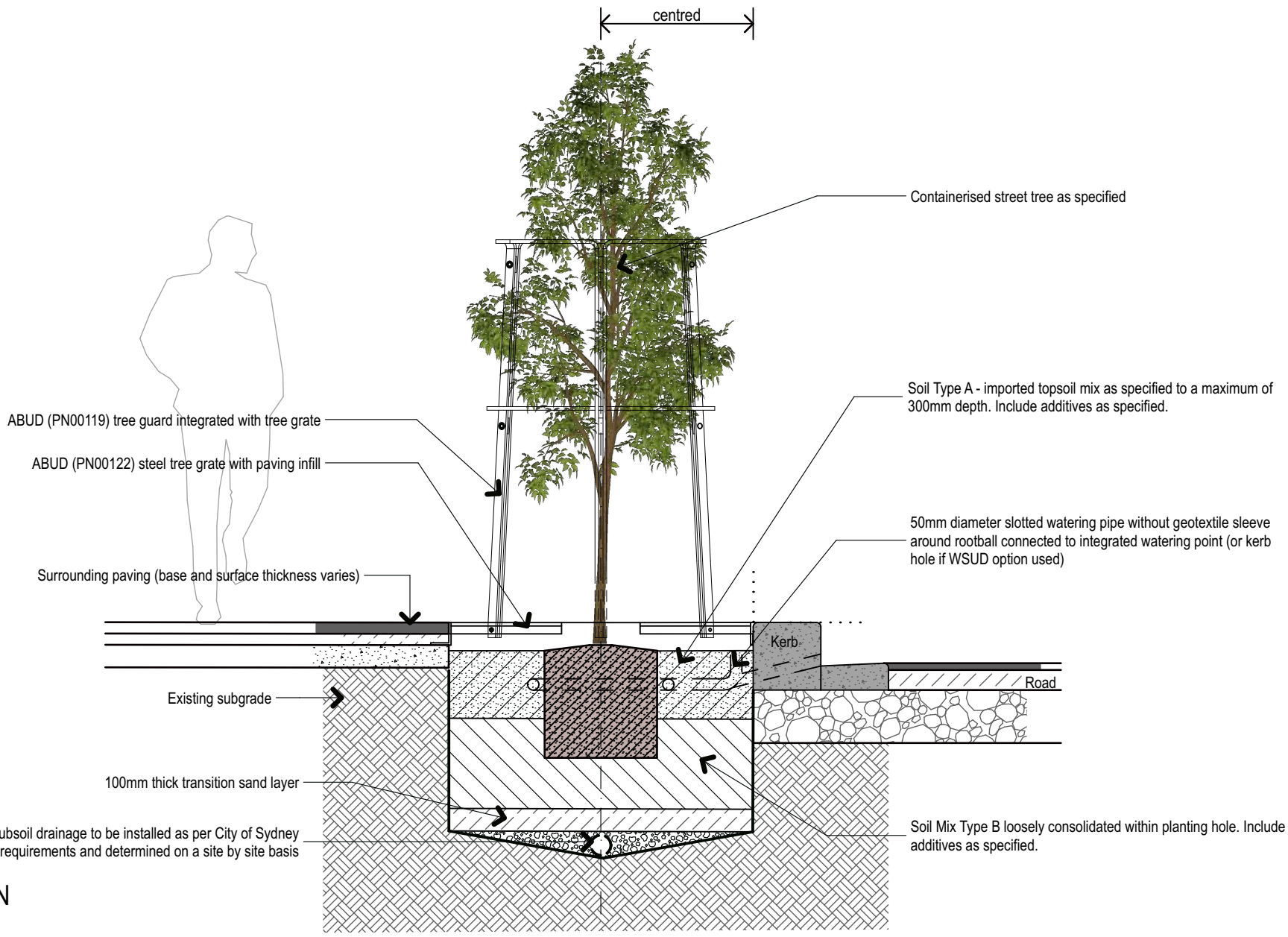
Scale 1: 25 @ A3 0 500 1000mm

TYPE 7 - TREE PLANTING IN CBD OR OTHER SPECIFIED LOCATIONS - POROUS PAVING

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.



PLAN

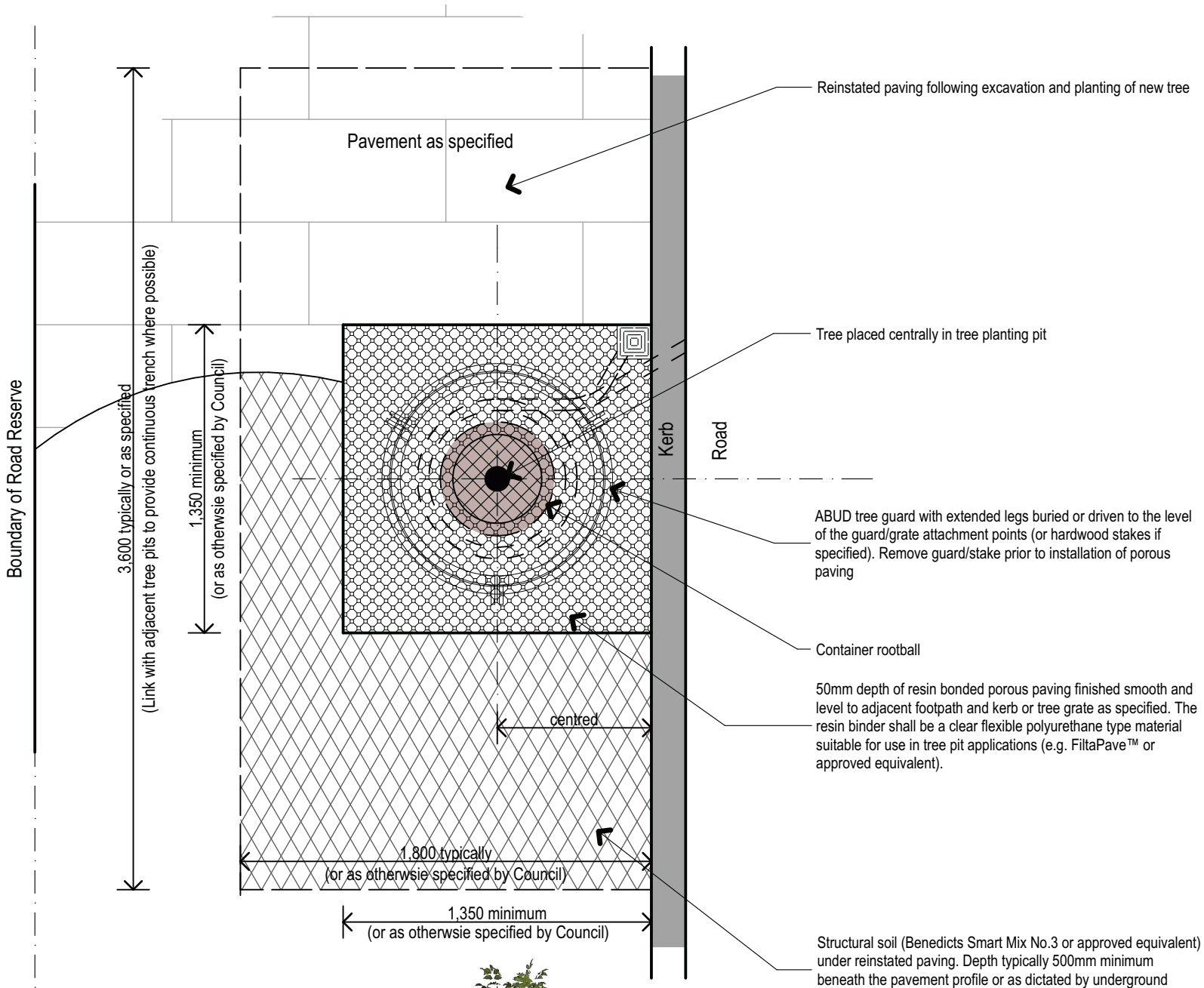


SECTION

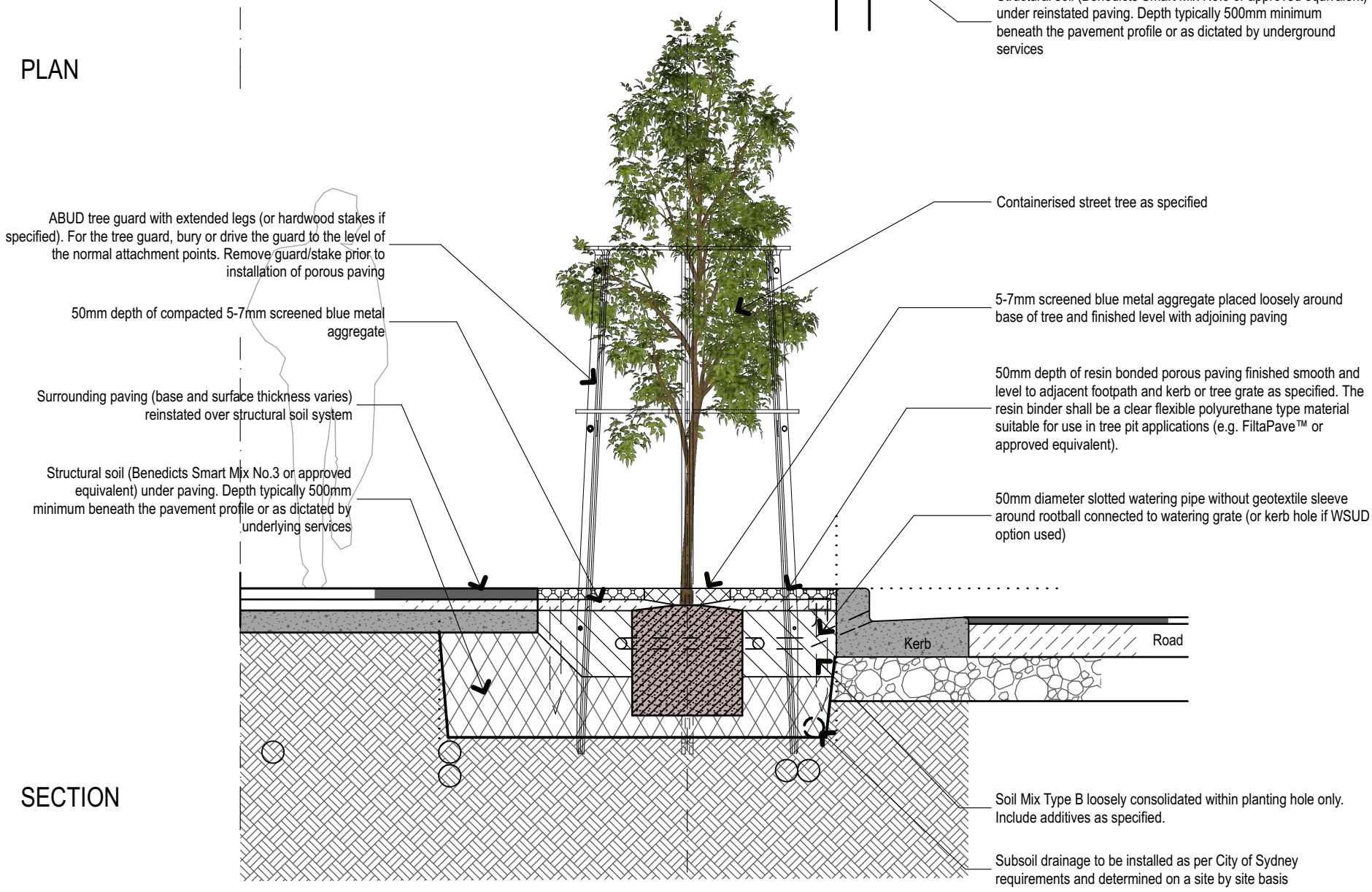
Scale 1: 25 @ A3 0 500 1000mm

TYPE 8 - TREE PLANTING IN CBD OR OTHER SPECIFIED LOCATIONS - TREE GRATE

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.



PLAN



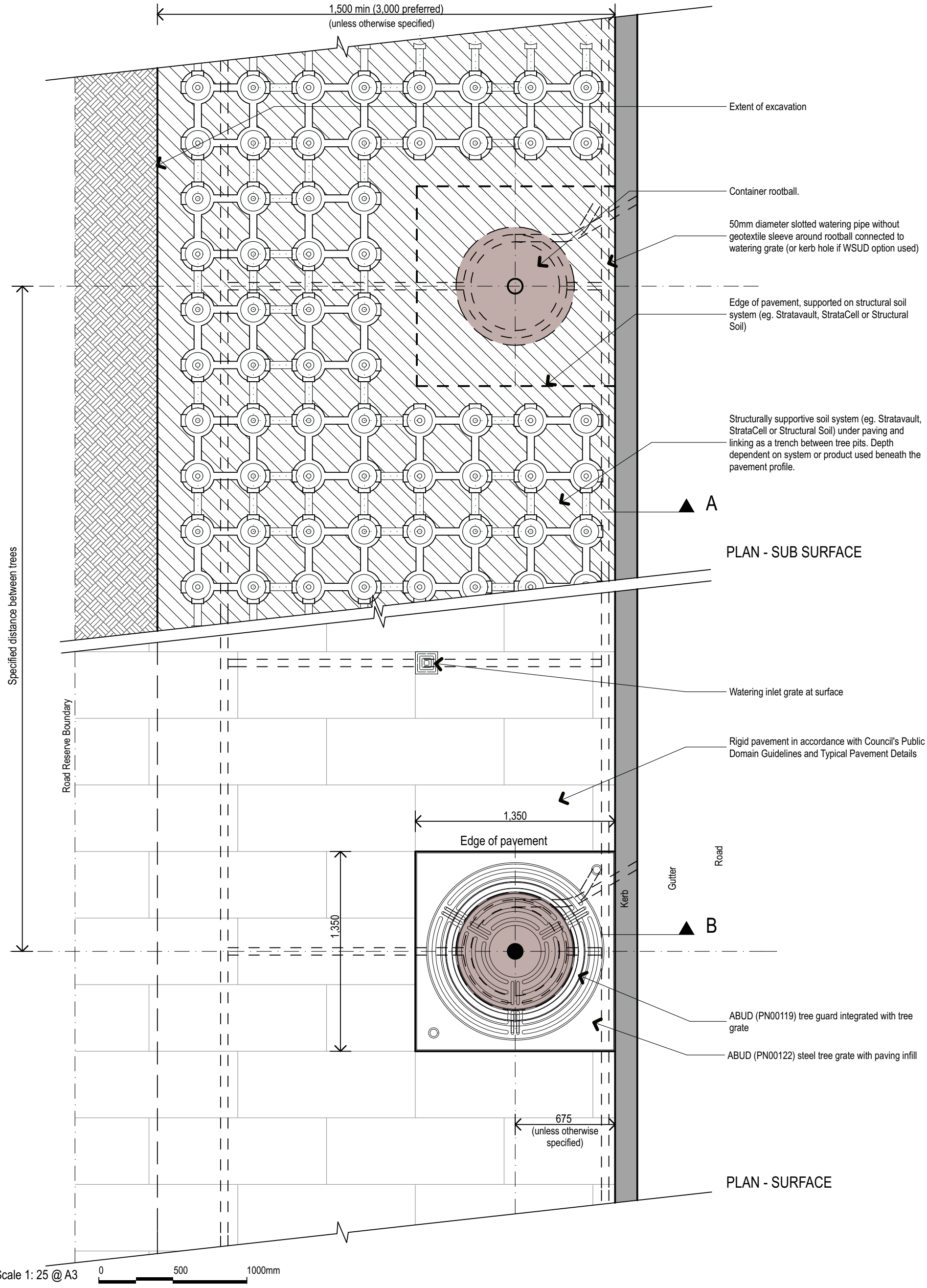
SECTION

Scale 1: 25 @ A3 0 500 1000mm

City of Sydney

TYPE 9 - TREE PLANTING IN FULLY PAVED VERGE WITH EXPANDED SOIL VOLUME

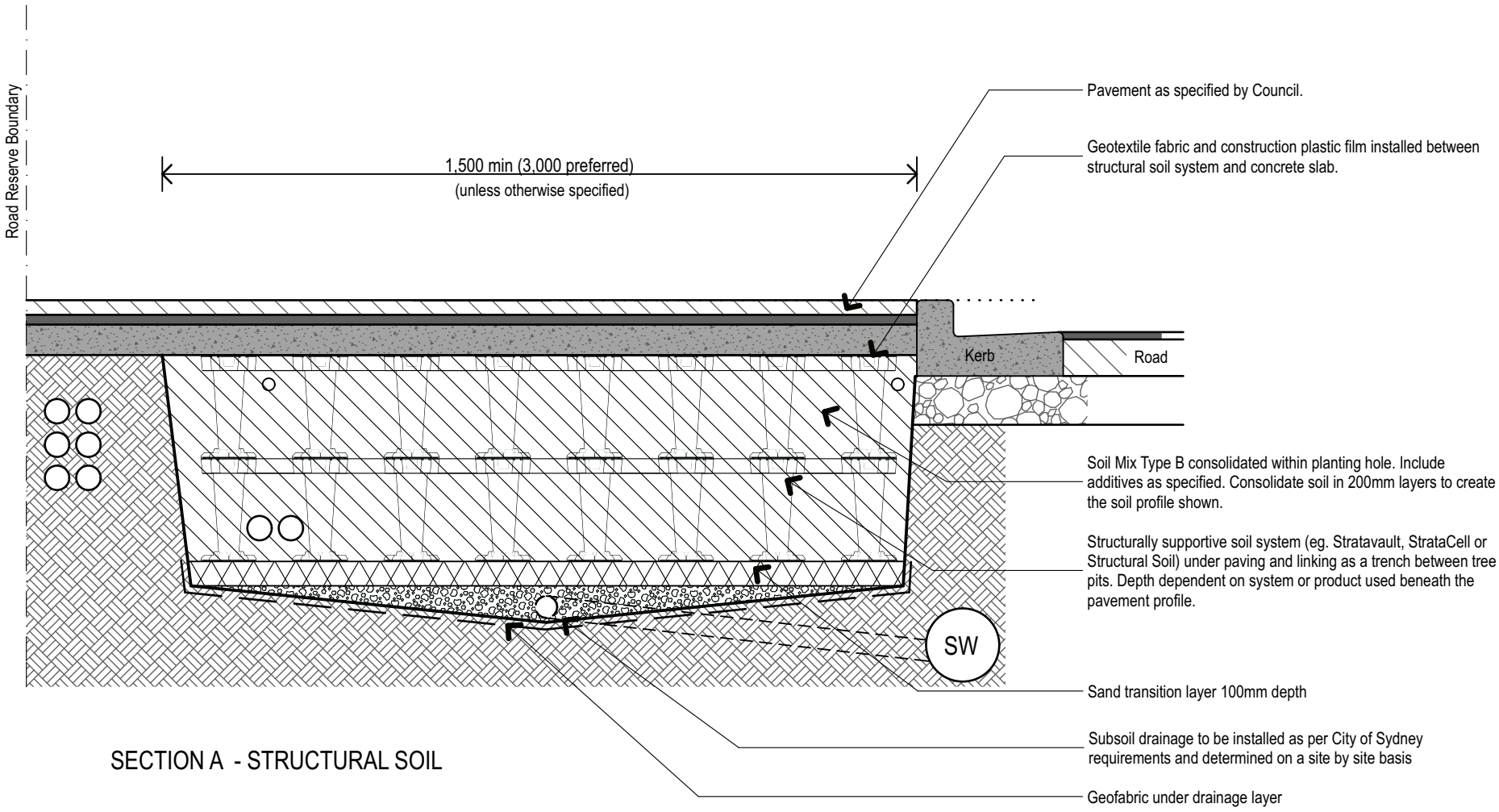
NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.



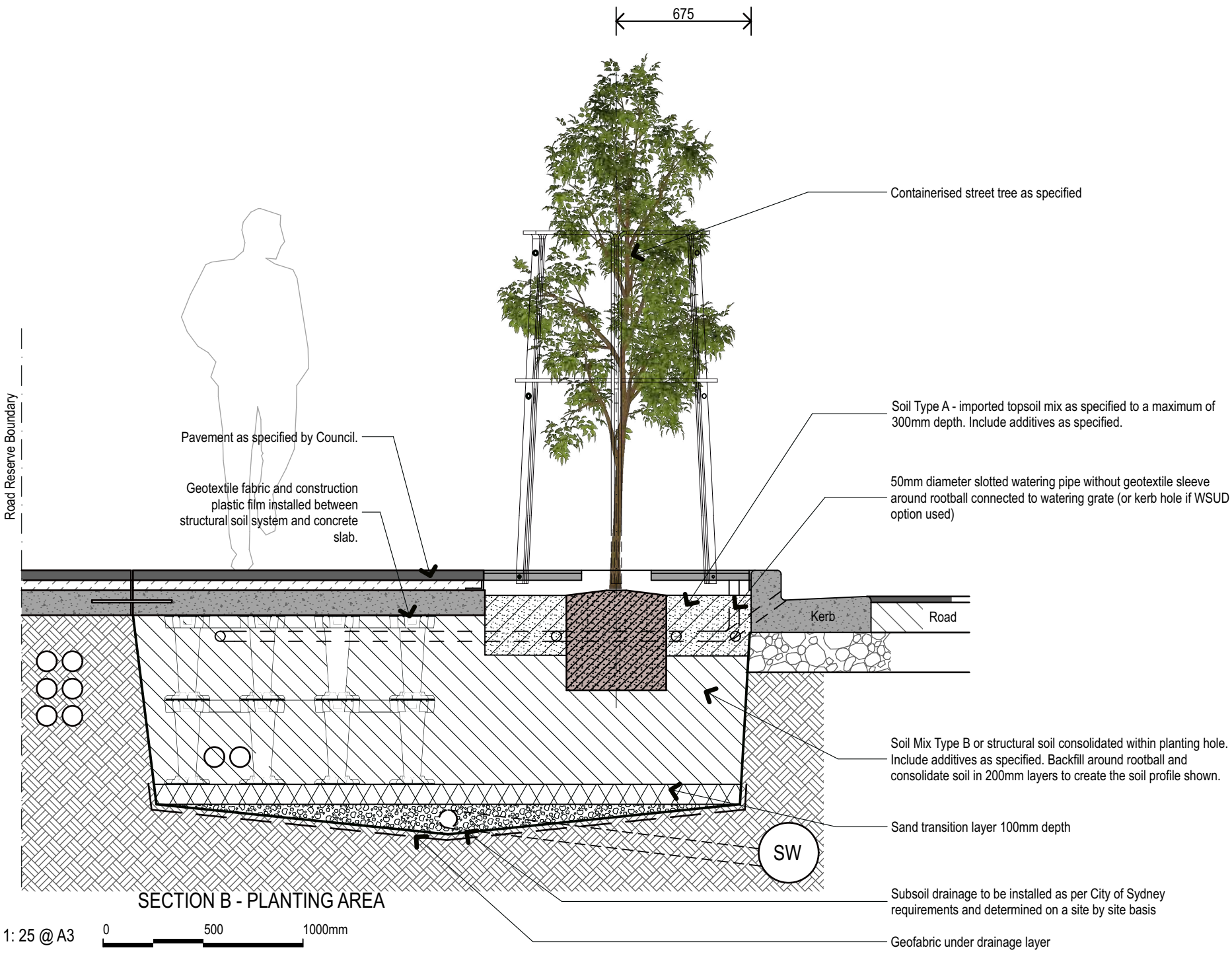
City of Sydney

TYPE 10A - INDICATIVE TREE PLANTING WITH STRUCTURAL SUPPORT & CONTINUOUS TRENCH [PLANS]

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.



SECTION A - STRUCTURAL SOIL



SECTION B - PLANTING AREA

Scale 1: 25 @ A3

0 500 1000mm

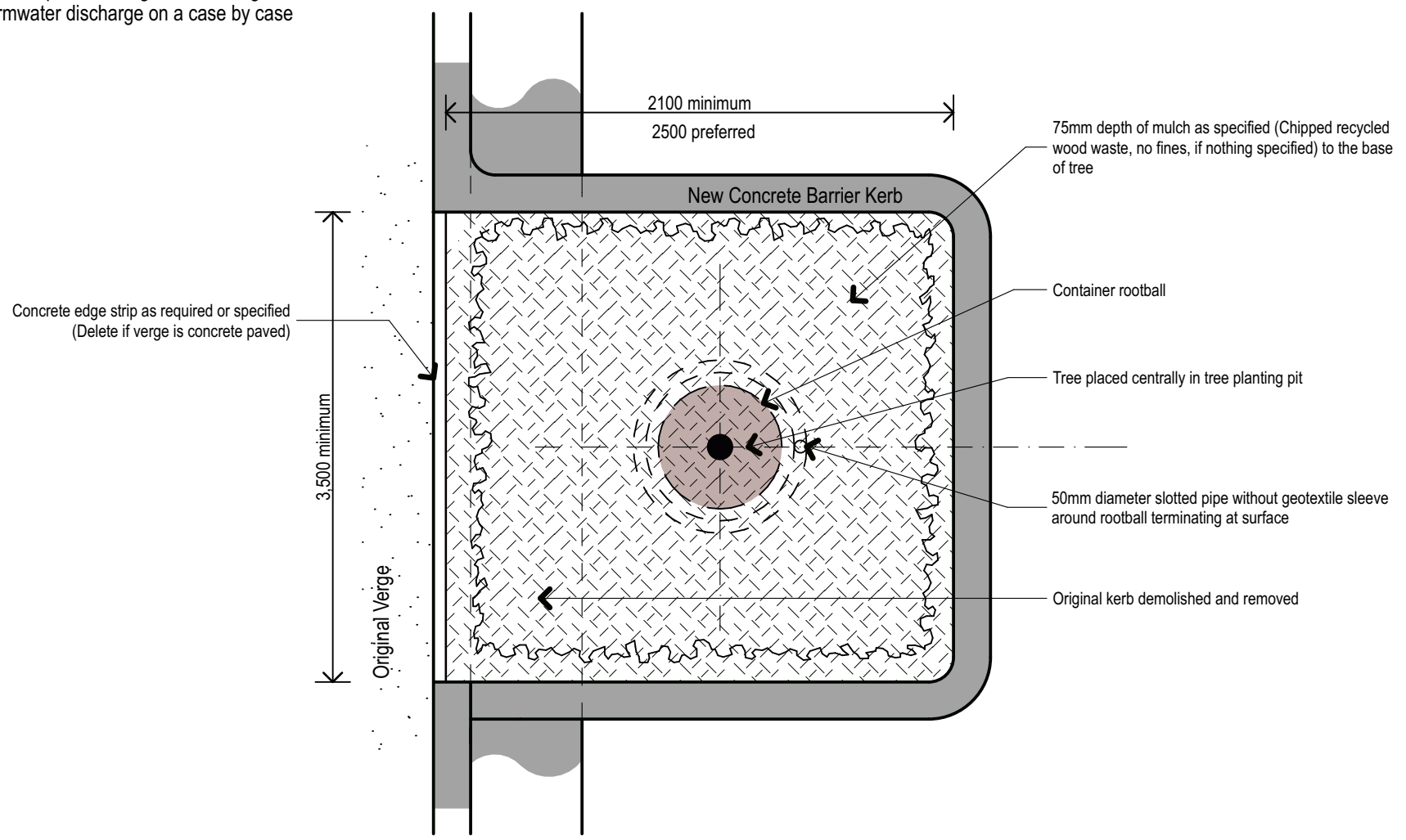
City of Sydney

TYPE 10B - INDICATIVE TREE PLANTING WITH STRUCTURAL SUPPORT & CONTINUOUS TRENCH [SECTIONS]

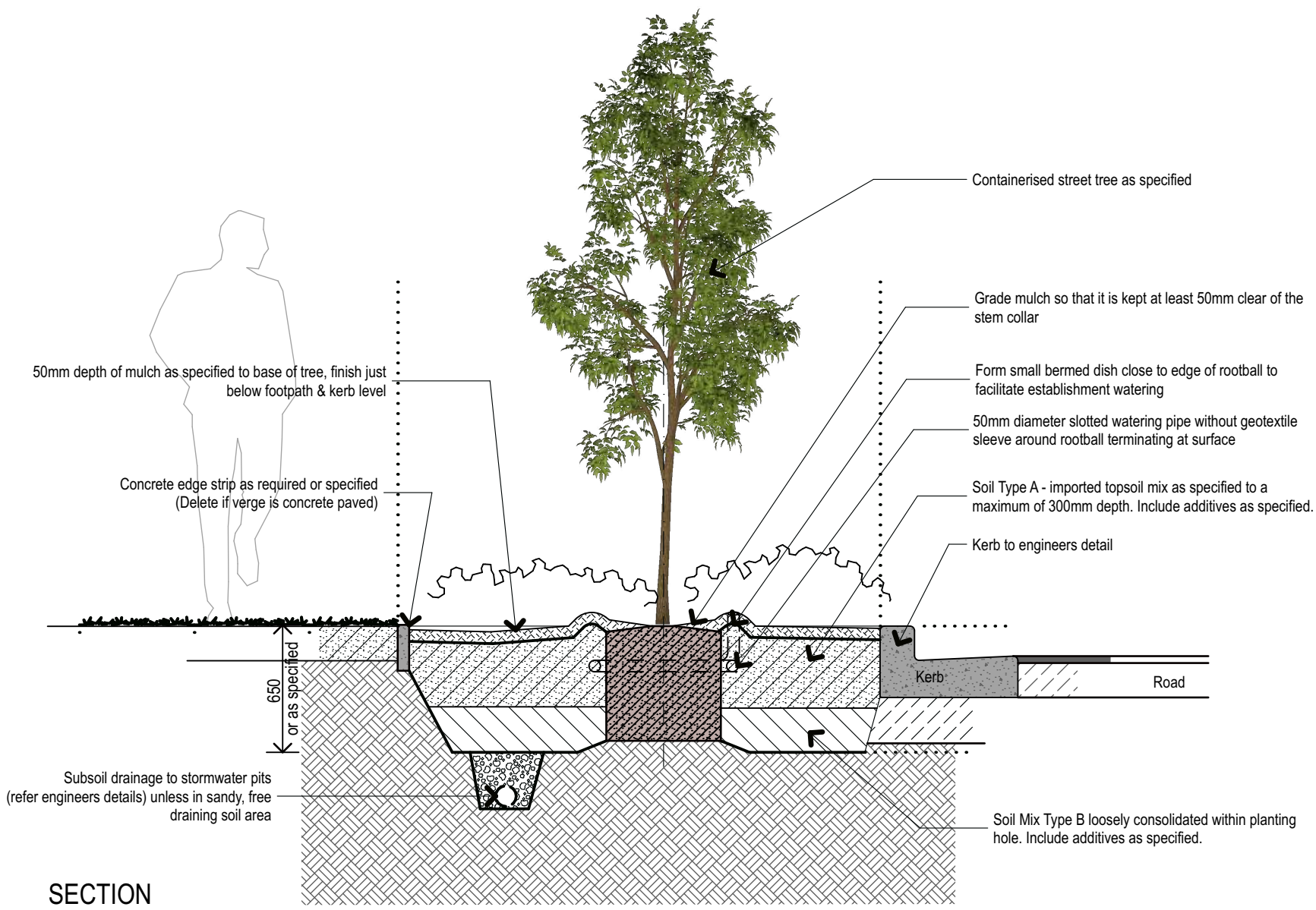
NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.

NOTE 2:
All blister and kerb extension details are to be verified for adequate drainage and existing gutter stormwater discharge on a case by case basis.

PLAN



SECTION

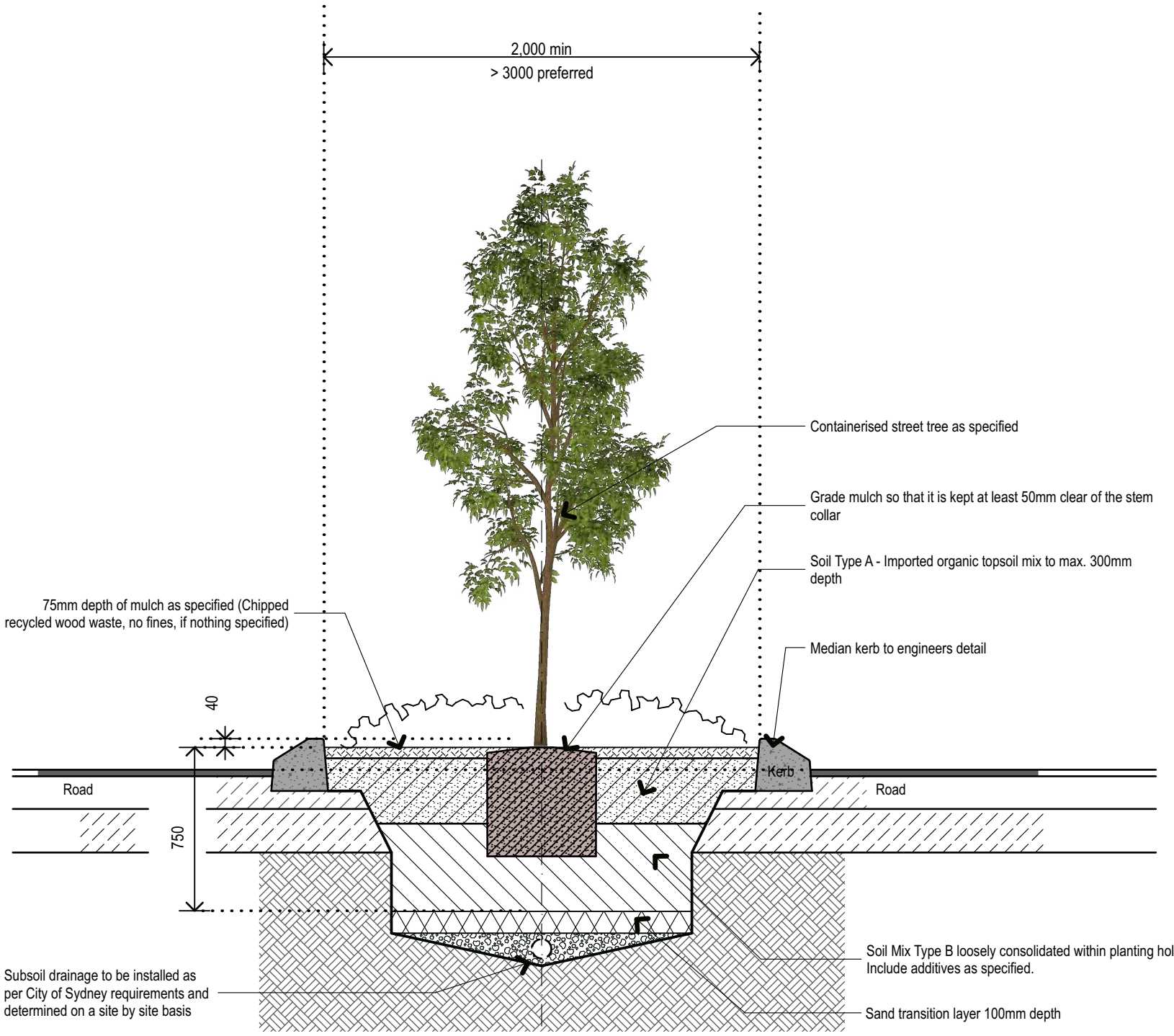


Scale 1: 25 @ A3 0 500 1000mm

TYPE 11 - INDICATIVE TREE PLANTING IN-ROAD BLISTER

NOTE 1:
All details are to be read in conjunction with any site specific DA conditions or Council issued Contract Documentation.

NOTE 2:
All median details are to be verified for adequate drainage and soil depths on a case by case basis.



Scale 1: 25 @ A3 0 500 1000mm

TYPE 12 - INDICATIVE TREE PLANTING IN-ROAD MEDIAN