Creating a Perth and Peel Urban Forest Spatial Mapping Layer

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1. Introduction

Urban tree canopy plays a vital role in enhancing the liveability of the urban environment by mitigating urban heat, improving air quality, enhancing biodiversity and promoting psychological and emotional well-being[i]. Overall canopy cover in Perth is 16%, the lowest of any major Australian city. As urbanisation accelerates, managing and conserving tree assets as part of urban planning is important.

This project aimed to establish a Local Government tree asset spatial mapping layer for the Perth and Peel regions. WALGA considers this to be a vital dataset that would provide numerous benefits, including information on the number and distribution of tree assets and species across the region, evaluation of the outcomes of State Government investment in planting programs, enabling an agile response to biosecurity incursions, and ensuring urban forest strategies and policies are underpinned by quantitative data.

This project included two components, 1) a short survey to collate baseline information on tree assets in Local Governments (e.g. the number of new trees planted per year and availability of tree asset data) and, 2) the development of an Excel template to collect information on the location of tree assets and key attributes (e.g. species canopy width, height, health rating and date planted). Tree asset data was then used to create a spatial mapping layer of tree assets within the Perth and Peel regions.

Additionally, the shapefiles for trees planted under the 2021/2022 Urban Canopy Grant Program and 2024/2025 Urban Greening Grant Program were added to the spatial mapping layer of tree assets, to enable the evaluation of long-term program outcomes.

The project stakeholders included WALGA, the Department of Planning, Lands and Heritage (DPLH), the Department of Primary Industries and Regional Development (DPIRD), Landgate, Western Australian Land Information System (WALIS), Water Corporation and Local Government.

2. Methods

Data collection

An initial meeting was held with the project stakeholders to assist develop the project scope and determine key tree attributes.

The baseline information on Local Government tree assets was gathered through Survey Monkey, with questions on the total number of tree assets across different categories, average number of new trees planted per annum, use of tree management software, availability of public data, willingness to provide data annually to WALGA and recommendations for future possible attributes to add to the data collection template.

The short survey and tree asset template were released to Local Governments on 21 November and closed on 2 December 2024. The metadata for tree assets included:

- Spatial Reference: GDA 20202 / MGA Zone 50
- Data Format: xlsx (Excel Workbooks)
- Data Custodian: WALGA
- Key Attributes:
- Location: Geographic coordinate (Longitude, Latitude)
- Tree ID: Unique identifier for each tree.

- Shapefile for Tree ID of each species
- Date planted: Date the tree was planted.
- Botanical name: Genus and species nomenclature
- Tree height (m): Height of the tree
- Trunk diameter (cm).: Diameter at Breast Height (DBH), diameter of the largest (main) trunk if the tree is multi-stemmed
- Canopy width (m): Canopy width at the widest point.
- Useful life expectancy (ULE) value: The anticipated number of years until the tree reaches the end of useful life/senescence and will require replacement.
- Health rating: Tree conditions (Excellent, Good, Poor and Dead)
- Availability of significant tree: The tree is on an LG significant tree register for environmental, cultural or social values.
- Date of data currency: Date when the tree data was collected or last audited.

The survey responses were exported into an Excel file from Survey Monkey and analysed.

Development of urban forest spatial mapping layer

Due to the inconsistency of received tree asset data, data sorting was conducted before importing it to the master Excel file. Some of the data was converted into categories for easier calculation in ArcGIS Pro (e.g. useful life expectancy of trees was categorised as 0, 1-5, 6-10, 11-15, 16-35 and >35 years). The data was standardised into the same format before importing into ArcGIS Pro. The finalised master sheet was saved as a CSV and imported into ArcGIS Pro to create a layer using the Analysis tool "Make XY Event Layer". The layer was developed under the geographic coordinate system (GCS) of GDA 2020. Given the large dataset, the data was visualised with different parameters using "Symbology" in ArcGIS Pro.

Although there is some publicly available data from Local Governments, uploading data into WALGA's spatial mapping layer was difficult. The City of Canning has publicly available data, but the public can only access the tree ID and location. While the Town of Victoria Park has publicly available data on street and park trees with attributes such as botanical name, location, significant tree status, tree height, and canopy width, there was an issue with exporting their data from Intramaps. Due to these problems, the creation of the spatial mapping layer was limited to the provision of datasets from Local Governments

Uploading of shapefiles for trees planted during Grant Programs

Shapefiles were imported into ArcGIS Pro to modify the data and ensure consistency. To finish the shapefiles uploading in a shorter time, the shapefile was created from the arranged data in Excel. Since the projected coordinate system (PCS) of this project was set to GDA 2020 Zone 50, the different PCSs of shapefiles were transformed into GDA 2020 Zone 50 using the Analysis tool "Project". With the same PCS for all shapefiles, the missing locations data was calculated using the Analysis tool "Calculate Geometry Attributes". A Master Excel file was then imported into ArcGIS to create the spatial mapping layer for both grant programs.

3. Results

Survey results

A total of 12 Local Governments responded to the survey: City of Albany, City of Canning, City of Melville, City of Perth, City of Subiaco, City of Swan, City of Vincent, City of Wanneroo, Shire of Serpentine Jarrahdale, City of Bassendean, Town of Cottesloe, and Town of Victoria Park.

The total number of tree assets and trees under different categories are shown in Figure 1 and Figure 2. The total tree asset for each Local Government varies between 12,800 – 84,300, however the City of Swan has a substantially larger asset of 634,760 trees (noting the City of Swan, City of Vincent and Town of Bassendean provided approximate tree asset numbers). The Town of Cottesloe and Shire of Serpentine Jarrahdale have unknown numbers. The Shire of Serpentine Jarrahdale mentioned the possibility of data provision next year as they are still working on their tree asset database. The City of Wanneroo noted their tree data only includes street trees from Girrawheen to Butler due to ongoing growth, with more tree assets to be documented for northern Wanneroo and parks.

Local Governments generally record tree assets in two categories 1) streetscapes and 2) parks, reserves and public open spaces. The Cities of Perth and Town of Bassendean also have a carparks category, while the City of Albany noted that carparks are included within the parks category. Local Governments generally have the highest proportion of tree assets within streetscapes, ranging between 49 – 84%. The exception is the town of Bassendean, with parks and open space (38%), streetscapes (26%), and private residential precincts (25%) comprising the majority of the total tree asset. The Local Governments of Cottesloe, Melville, Swan and Wanneroo were unable to provide information on the number of trees across different land categories.

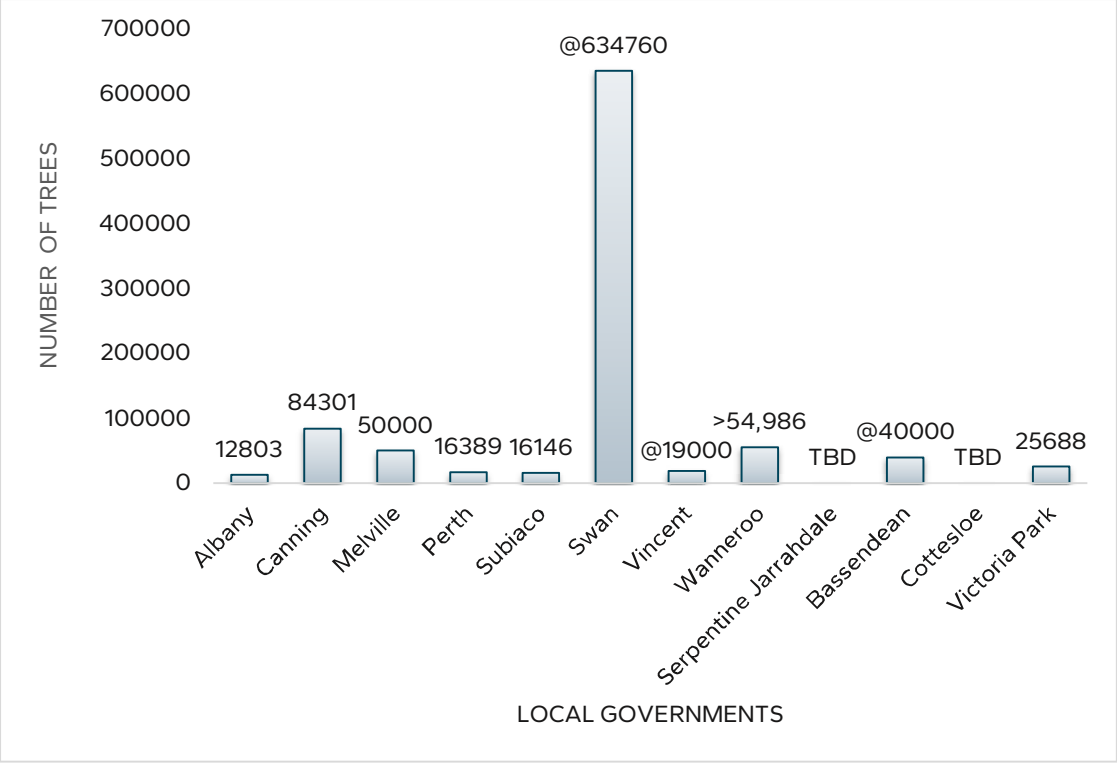


Figure 1 Total number of tree assets managed by Local Governments (LGs).
*Key: @ = Approximate number; > = More than; TBD = To be determined.

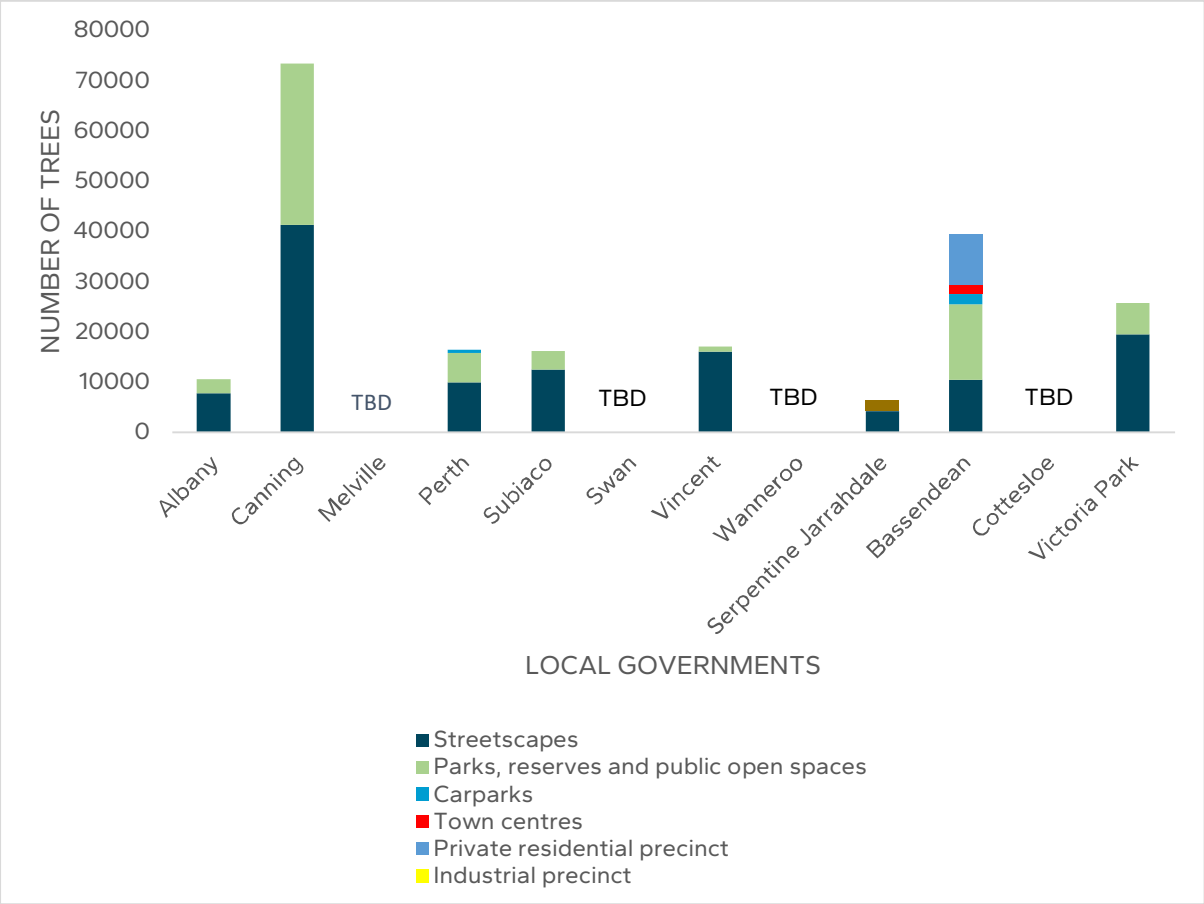


Figure 2 Number of tree assets in different categories managed by Local Governments (LGs).
*Key: TBD = To be determined.

The average numbers of new trees planted annually in the 12 Local Governments are shown in Figure 3. The total number of new trees planted per Local Government ranges between 120 to 8,300 (with the Shire of Serpentine Jarrahdale noting that the reported tree planting numbers are only for free resident street trees, while more are planted in landscaping projects). The City of Wanneroo reported an increase in the total number of trees planted per year, with 2,500 trees in 2022, 3,000 in 2023, and over 5,000 trees in 2024. While not a respondent to the survey, the City of Stirling provided information on their tree planting numbers per annum, with an average of 8,300 per year.

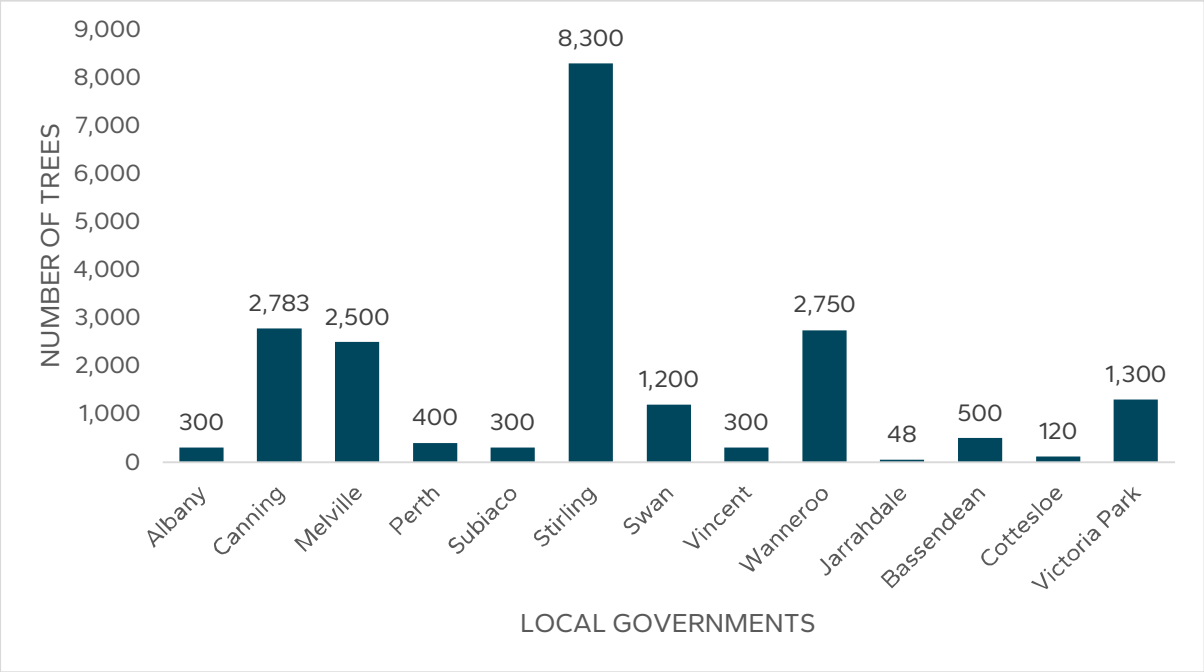


Figure 3 Average number of new trees planted per annum.

Regarding GPS location and basic attributes of each tree asset, the majority of the 12 Local Government respondents record this data, as shown in Figure 4. The City of Swan and the Town of Cottesloe do not currently record this information, while the Shire of Serpentine Jarrahdale commenced data collection in 2024.

Feedback from some Local Governments indicated capacity and resourcing constraints limit their ability to undertake tree audits and establish a tree asset database. The Town of Victoria Park noted that audits of street trees are undertaken annually. Most Local Governments are willing to provide their tree asset data to WALGA annually.

Three Local Governments utilise tree management software. The City of Melville and City of Subiaco use Forestree, while the City of Vincent uses Tree Plotter. The City of Wanneroo is currently reviewing tree management software for use.

Of the 12 Local Government respondents, only four do not have publicly available tree asset data: Town of Cottesloe, City of Subiaco, City of Swan, and City of Vincent. Different Local Governments use various portals for public data access, resulting in different formats and types of tree asset information.

There are only four Local Governments that previously accessed Urban Monitor parcels at the lot level through Data WA; Cottesloe, Melville, Perth and Victoria Park. Five Local Governments noted they were unsure why data had not been accessed, or that resource constraints were limiting the use of the data. Other reasons for not accessing the data include the data being over four years old, inconsistent data capture, low data accuracy and low level of detail.

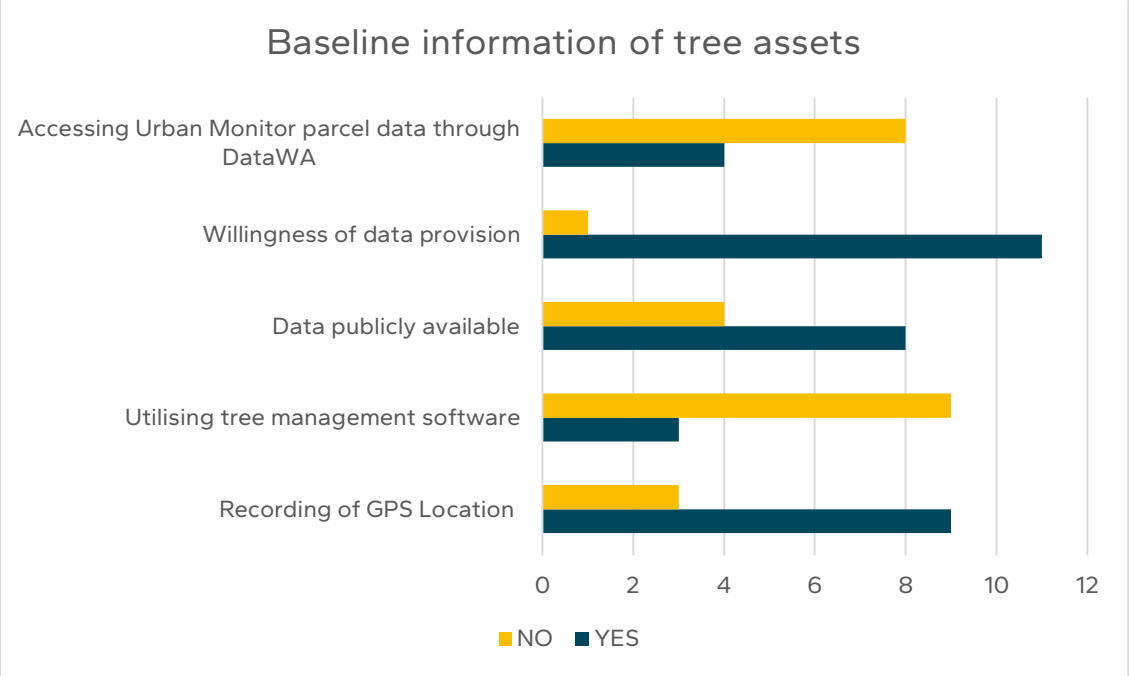


Figure 4 Number of LGs with available baseline information on tree assets.

Tree assets results

Throughout the project, three local governments provided their tree assets data to WALGA; the City of Melville, City of Perth and City of Vincent.

Figure 5 shows the distribution of canopy width in the City of Melville, City of Perth and City of Vincent. The 6-metre threshold was based on WALGA's definition of a "Regulated Tree" in the Model Local Planning Policy (LPP) Tree Retention[ii]. The City of Vincent has 8,051 trees (46%) with canopy widths smaller than 6 metres, and 9,198 trees (53%) with canopy widths larger than 6 metres. In contrast, the City of Melville has 22,782 trees (46%) with canopy widths smaller than 6 metres, and 16,183 trees (32%) with canopy widths larger than 6 metres, and remaining trees unknown. The City of Perth does not have canopy width data for its tree assets.

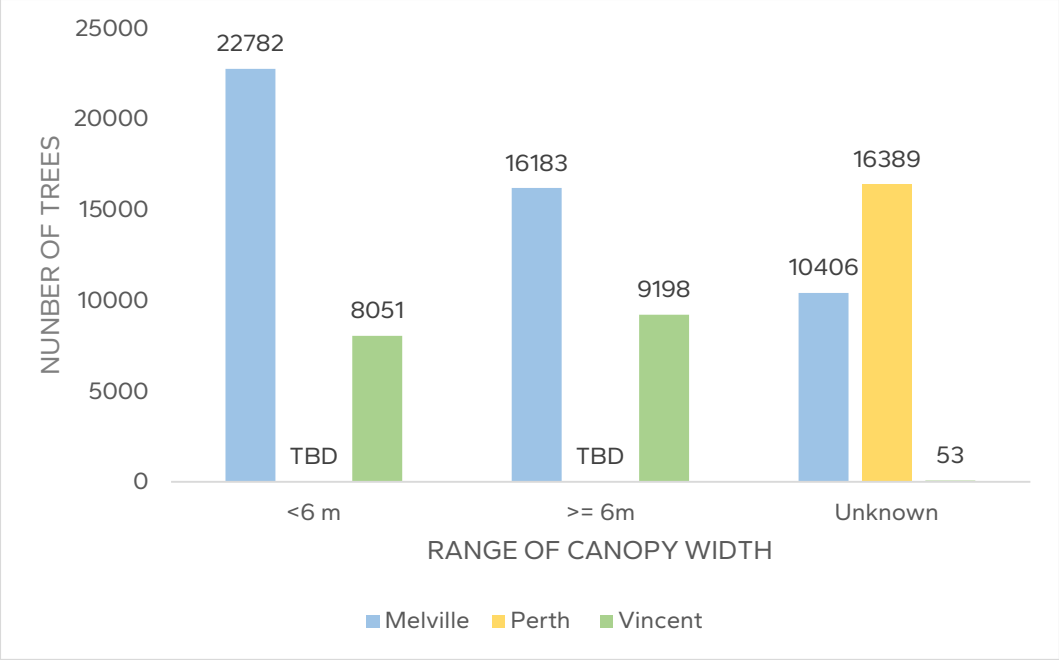


Figure 5 Distribution of tree canopy widths across LGs in Perth and Peel regions.

Figure 6 provides an example of a spatial mapping layer of tree canopy widths in North Perth, City of Vincent. Canopy width ranges from 0 – 200 m, with one tree having a canopy width larger than 200 metres.

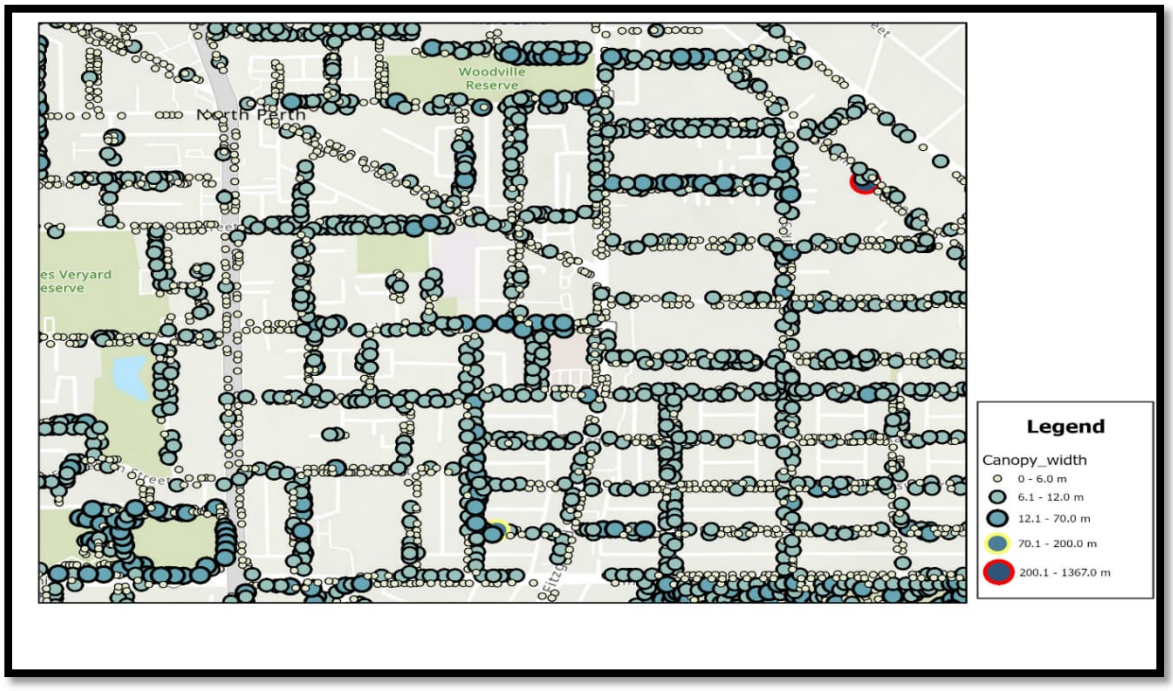


Figure 6 Enlarged view of tree canopy width ranges in North Perth, City of Vincent.

Figure 7 provides a comparison of ULE values for the City of Melville, City of Perth and City of Vincent. Approximately 93% of trees in the City of Vincent have ULE values larger than 15 years while the City of Melville has 54% of trees with ULE values over 15 years. The City of Perth does not have ULE data for most of its tree assets.

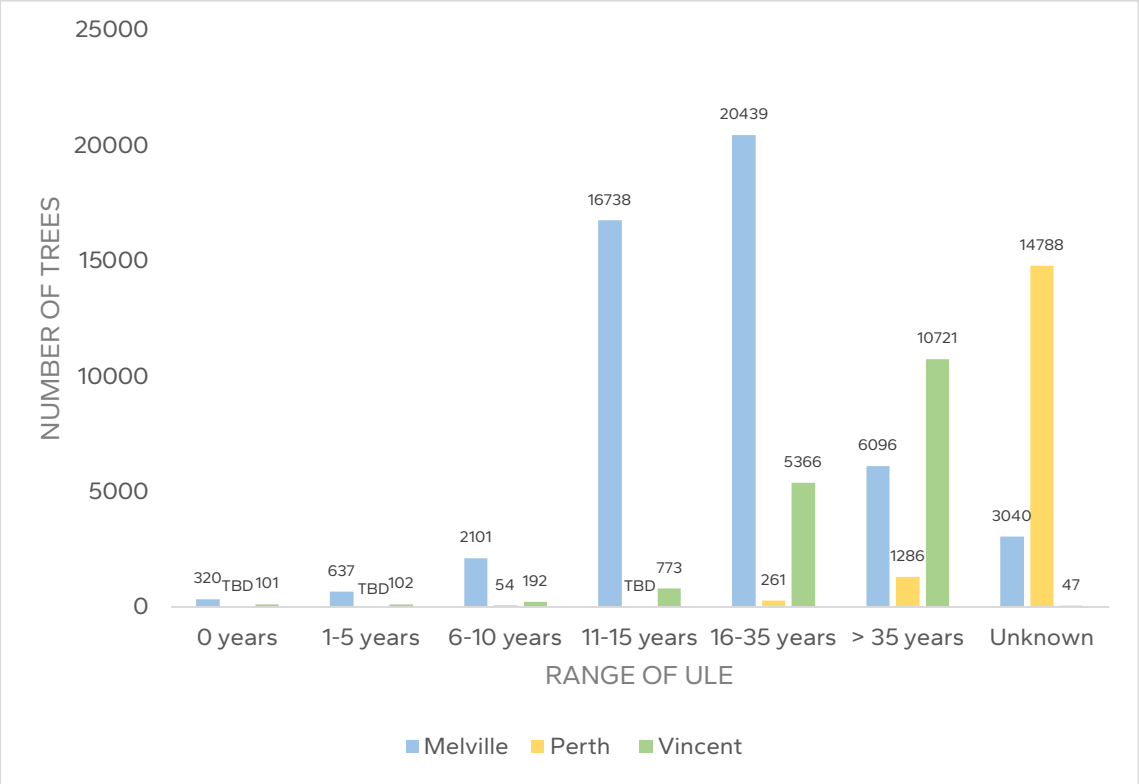


Figure 7 Distribution of useful life expectancy (ULE) across LGs in Perth and Peel regions.

Figure 8 provides an example of a spatial mapping layer of useful life expectancy (ULE) value generated for the tree assets data in North Perth. Some trees near North Perth have a ULE value of 0 years, representing they are senescent and may soon require replacement.

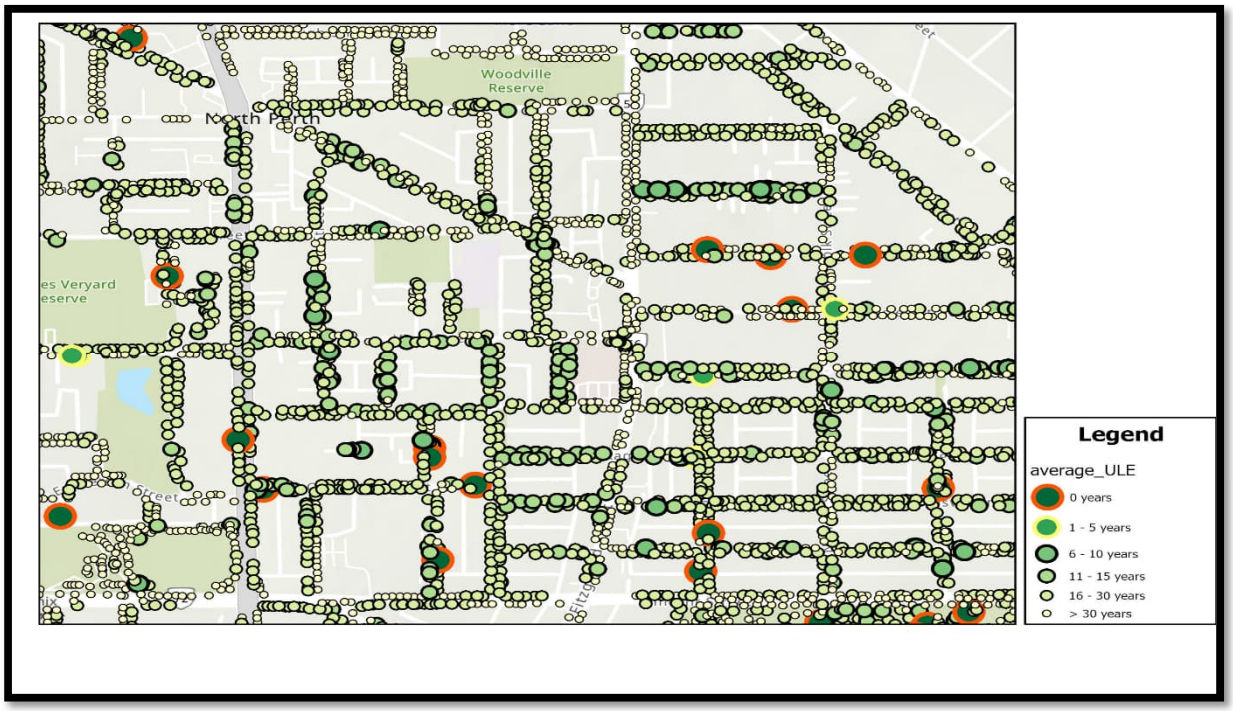


Figure 8 Enlarged view of useful life expectancy (ULE) ranges in North Perth, City of Vincent.

Local Governments use various health rating systems. The City of Melville has six health rating levels for its tree assets, and the City of Vincent has five. Figures 9 and 10 show the health conditions of trees in the City of Melville according to their rating system. Most trees in the City of Melville have a 'good' health rating.

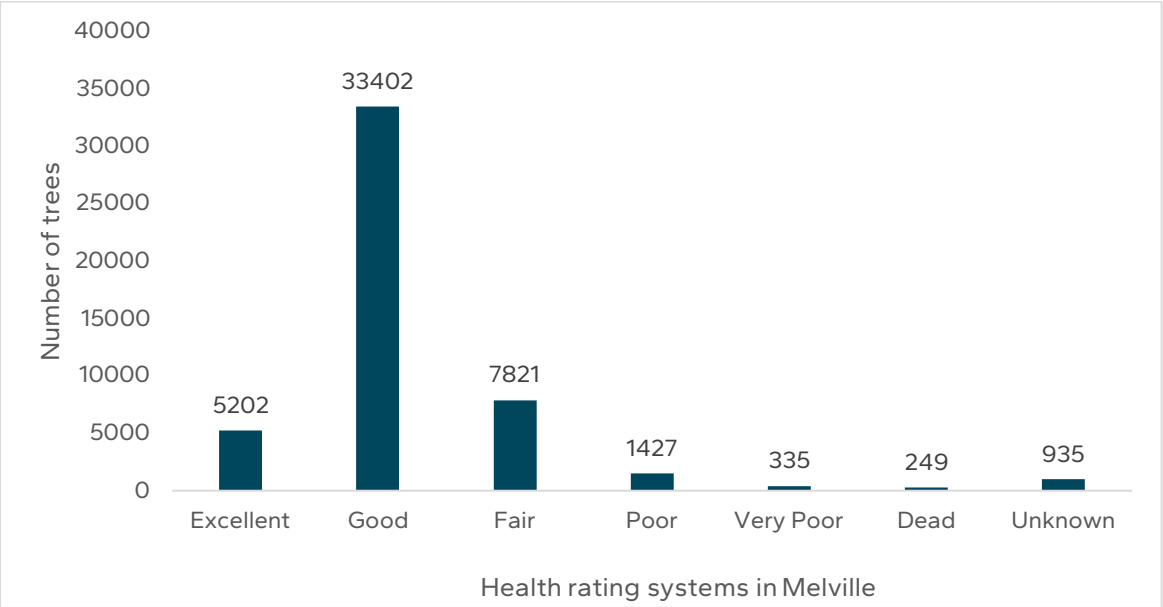


Figure 9 Health conditions of trees in the City of Melville.

1.10 Health

Tree health to be assigned one of six categories: Excellent, Good, Fair, Poor, Very Poor, Dead.

- **Excellent** - The tree is demonstrating exceptional growth for the species. The tree should exhibit a full canopy of foliage and demonstrate no pest or diseases problems. Foliage colour, size and density should be typical of a healthy specimen of that species.
- **Good** - The tree is in good condition and growing well for the species. The tree should exhibit a full canopy of foliage and have only minor pest or diseases problems. Dead wood, if it exists, will be internal and a normal feature of that species. Foliage colour, size and density should be typical of a healthy specimen of that species.
- **Fair** - The tree is in reasonable condition and growing well for the species. The tree should exhibit an adequate canopy of foliage. There may be some dead wood present in the crown, some grazing by insects or animals may be evident and/or foliage colour, size or density may be atypical for a healthy specimen of that species.
- **Poor** - The tree is not growing to its full capacity; extension growth of the laterals is minimal. The canopy is thinning or sparse or significant sections of it may be dead. Large amounts of dead wood may be evident throughout the crown. Significant pest and disease problems are evident or symptoms of stress indicating decline.
- **Very Poor** - The tree is in a state of decline and the canopy will be very thin and sparse. A significant volume of deadwood will be present in the canopy or pest and disease problems may be causing a severe decline in tree health. Most of the tree canopy is dead or dying although the entire tree is not dead.
- **Dead** – The tree is dead

Figure 10 Health rating system in the City of Melville.

Figures 11 and 12 show the health conditions of trees in the City of Vincent and their health rating system descriptions. Around 96% of trees in the City of Vincent are in 'good' or 'fair' condition. Due to missing data, there is no result for the health rating system of the City of Perth.

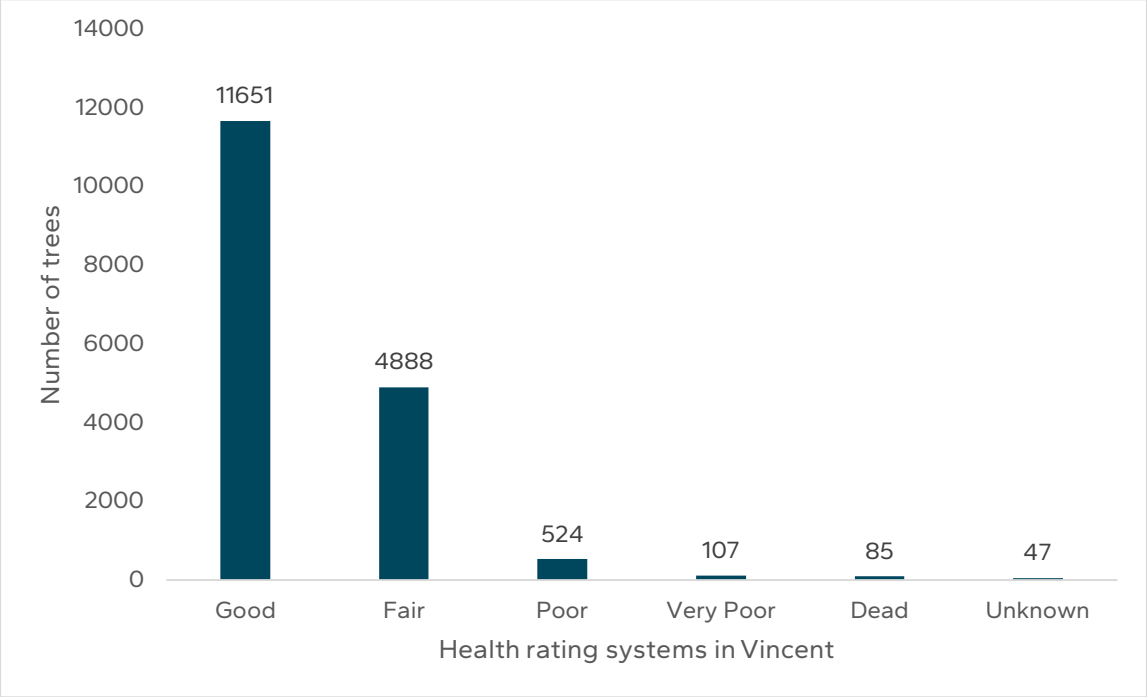


Figure 11 Health conditions of trees in the City of Vincent.

Vitality: Summarises the health and vigour and a measure of physiological condition of the tree.

Category	Description
Good	Canopy full with even foliage density throughout, leaves are entire and are of an excellent size and colour for the species with no visible pathogen damage. Good growth indicators, e.g. seasonal extension growth. Good specimen.
Moderate	Canopy full with minor variations in foliage density throughout, leaves are entire and are of good size and colour for the species with minimal or no visible pathogen damage. Good growth indicators, none or minimal deadwood.
Poor	Canopy with moderate variations in foliage density throughout, leaves are not entire, are significantly reduced in size and/or are discoloured, significant pathogen damage. Significant amounts of deadwood and/or epicormic growth, noticeable dieback of branch tips, possibly extensive.
Moribund	Canopy density significantly reduced throughout, leaves are not entire, are significantly reduced in size and/or are discoloured, significant pathogen damage. Significant amounts of deadwood and/or epicormic growth, noticeable dieback of branch tips, possibly extensive.
Dead	No live plant material observed throughout the canopy, bark may be visibly delaminating from the trunk and/or branches.

Figure 12 Health rating system in the City of Vincent.

Future possible tree attributes recommended by Local Governments to include in the spatial mapping layer include species' common name, a standardised name for cultivars, tree age (young, semi-mature, mature, over-mature), amenity value, tree risk assessment, structure, and presence of infrastructure (e.g. powerlines, footpaths etc).

Figures 13 and 14 provide an example of the spatial mapping of trees planted under the 2021/22 Urban Canopy Grant Program and 2024/25 Urban Greening Grant Program.

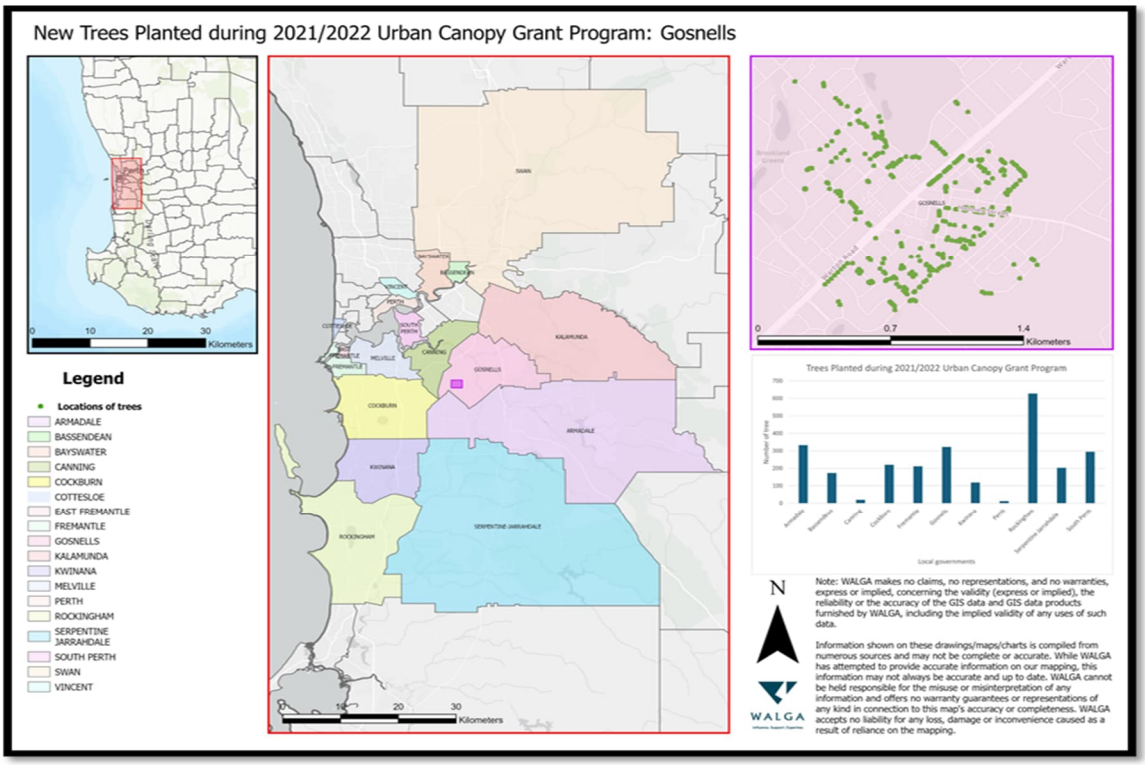


Figure 13 Spatial mapping layer of new trees planted during 2021/2022 Urban Canopy Grant Program in Gosnells.

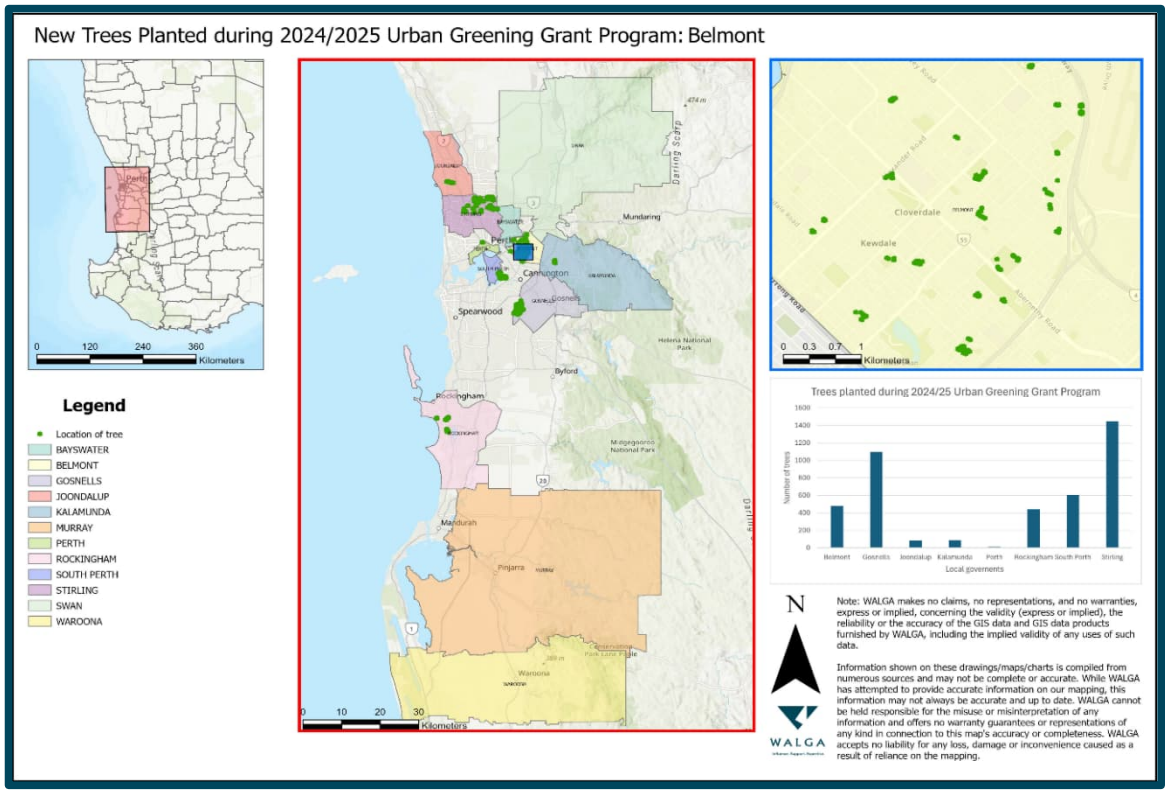


Figure 14 Spatial mapping layer of new trees planted during 2024/2025 Urban Greening Grant Program in Belmont.

4. Discussion

The provision of tree assets datasets from only three Local Governments limited the creation of a comprehensive spatial mapping layer for the Perth and Peel regions. However, more Local Governments are preparing their data beyond the project's timeframe.

The lack of time for data collection was a significant limitation of this project. The GIS analysts of Local Governments were required to format the data according to the required attributes, and some of the Local Governments had insufficient internal resources. Furthermore, some Local Governments required data-sharing agreements with WALGA, which slowed the provision of datasets.

Incomplete data, such as planting dates, was another limitation. Several fields or data were missing from Local Governments. Different methods of auditing tree assets, data accuracy and variability in tree health rating systems between Local Governments also affected the ability to create a consistent dataset.

Despite these limitations, the project developed a successful proof of concept and provided examples of the possible data analysis that can build information on the diversity, age and health of urban forests in the Perth and Peel regions.

By changing different symbology fields in ArcGIS Pro, tree assets can be analysed in various ways according to their attributes to assist with urban forest management and planning. For example, spatial representation of tree assets that have reached the end of their useful life expectancy can identify areas of future low canopy to mitigate with new tree plantings. Attributes such as height, canopy width and trunk diameter can be visualised with a determined value such as for as a "Regulated Tree" in WALGA's Local Planning Policy for Tree Retention, to identify the number and distribution of tree assets that meets this definition.

The City of Vincent and City of Melville had clear datasets that aligned with WALGA's template of key attributes of tree assets under the tree management software Tree Plotter and Forestree, respectively, indicating the value of utilising tree management software to ensure comprehensive data collection on tree assets.

5. Recommendations

It is recommended that WALGA continues to develop the Local Government tree asset spatial mapping layer, by including more Local Governments and undertaking annual data updates to ensure currency of information. WALGA and the State Government should also consider a long-term host for the final dataset, with DataWA (and in the future SpatialWA) existing hosts of WA public sector data.

WALGA and the State Government may consider options to increase the number of Local Governments that record their tree asset data, given the demonstrated benefits of establishing a spatial mapping layer for urban forest planning across the Perth and Peel regions. To overcome barriers such as resource constraints, options could include facilitating the bulk purchasing of tree management software or securing funding for a baseline data capture that Local Governments can continue to update.

It is also recommended that WALGA collaborate with DPLH to determine the ability to link tree asset data with Urban Monitor canopy cover data, thereby enabling the monitoring of canopy change of individual trees over time.

To address the inconsistency of tree health rating systems, a standardised system using the "Field Calculator" in ArcGIS Pro could be created. Due to significant inconsistencies in tree health data collection, it would be beneficial for all Local Governments to use the same evaluation methods for tree audits.

13. Conclusion

In conclusion, this project provided proof of concept and a foundational dataset for WALGA to establish a spatial mapping layer of tree assets within the Perth and Peel regions. The development of this urban forest spatial mapping layer is invaluable for urban forest planning and management across the Perth and Peel regions.

Given the limitations and recommendations mentioned, stakeholders must collaborate closely to achieve the annual creation of the urban forest spatial mapping layer. This, in turn, will support the successful implementation of Local Government Urban Greening Strategies and inform strategic documents such as the State Government's Perth and Peel Urban Greening Strategy (in draft).

14. References

[i] Melaas, E. K., Wang, J. A., Miller, D. L., & Friedl, M. A. (2016). Interactions between urban vegetation and surface urban heat islands: a case study in the Boston metropolitan region. Environmental Research Letters, 11(5), 054020.
[ii] WALGA (2024) Model Local Planning Policy for Tree Retention. Urban Forest | WALGA