Strathbogie Shire Council

Urban Green Infrastructure Review

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URBAN
FOREST
CONSULTING

Urban Green Infrastructure Review

Client

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Contents

Project context

This desktop analysis aims to provide a baseline of urban green infrastructure for the 6 main towns of Strathbogie Shire Council:

- Euroa
- Nagambie
- Longwood
- Avenel
- Strathbogie
- Violet Town

The baseline analysis uses existing datasets coupled with satellite imagery to produce an overall vegetation layer for each town, called Fractional Vegetation Cover. The analysis has then prioritised locations for increasing green infrastructure, namely tree planting in each town and for possible water sensitive urban design sites in Euroa and Nagambie only.

Given Strathbogie Shire's status as a rural Shire Council, tree planting has been nominated as the most cost effective and efficient mechanism for increasing green infrastructure across its townships. Other mechanisms such as green roofs, walls, facades and establishment of new parcels of open space (all components of green infrastructure) are expensive and therefore not viable under Council's existing budgets and resources. They are also seen as unnecessary as vegetation cover across each town is already much higher than other urban areas across metro Melbourne and regional Victoria.

This report is supported by three other documents developed by E2Designlab:

1. Strathbogie Tree Pit Opportunities
2. Passively Irrigated Trees technical guide
3. Concept designs for wsud at Euroa train station carpark and Nagambie Rowing Club.

Benefits of urban green infrastructure

Urban green infrastructure (GI) refers to all of the urban vegetation that provides environmental, economic and social benefits such as clean air and water, climate regulation, food provision, erosion control and places for recreation. It includes urban parks and reserves, wetlands and stream corridors, street trees and roadside verges, gardens and vegetable patches, bikeways and pedestrian trails, wall and rooftop gardens, orchards and farms, cemeteries and derelict land. (CSIRO, 2019)

Urban green infrastructure, in the context of Strathbogie Shire, is the sum of all vegetation and its' associated landscape i.e. the soil and water that fits within the existing infrastructure of each town.

GI in Strathbogie's townships is a vital element for building urban resilience towards future challenges, particularly those associated with climate change. It enhances liveability, landscape character and biodiversity. Yet, despite these multi-functional benefits, GI is still not considered in many cases to be an asset of equal importance as hard infrastructure such as roads, buildings, footpaths, drainage networks and utilities e.g. powerlines.

Some key facts about green infrastructure, including trees:

- GI is one of the most cost effective and efficient mechanisms for reducing urban heat (Spronken-Smith et al, 1999)(Ali-Toudert, 2007)(Coutts et al, 2015)
- Shade trees reduce daytime temperatures between 5 – 20C (Rosenzweig et al, 2009)
- Canopy trees reduce heating and cooling needs by 5-10% (Nowak, 2008)
- Broad canopied trees and green open space are a critical component of a water sensitive town through their ability to intercept rainfall and reduce stormwater flows (Wong et al, 2009)
- Green infrastructure, particularly the presence of shade trees improves retail activity in commercial areas by up to 20% (Wolf, K, 2015)
- Tree lined streets can generate a 10-15% increase in residential property prices (Plant, 2016) (Pandit, 2013)
- Motorists will drive more slowly along treed streets (Mullaney, 2015)
- Shade along footpaths and shared user paths encourage pedestrian and cycling activity (Van Dillen et al, 2012)
- Large healthy trees provide much greater benefits than smaller trees: e.g. they can absorb 60-70 times more air pollution than smaller trees (Nowak, 2008)
- The distribution of GI throughout an urban area not only enhances connectivity of biodiverse areas but is now seen as a huge potential for biodiversity conservation (McDonnell et al, 2009)

Baseline Green cover

Atmospherically corrected satellite imagery from the Sentinel 2 satellite was used to develop a baseline measure of Fractional Vegetation Cover (FVC) across Strathbogie's urban centres for the year of 2018. Multiple images from the year were averaged out to produce one baseline map of vegetation at a resolution of 20m. Whilst the resolution is not as high as aerial imagery, it provides a cost-effective set of data which identifies both the presence and absence of green infrastructure within each town. FCV provides a percentage of vegetation cover for each pixel. Its works in a very similar way to NDVI by picking up the photosynthesising uniform vegetation. (Sentinel 2 product information, 2018).

Green cover maps for each township are shown below. These maps show the density of all vegetation in each pixel and includes all vegetation. Grass, shrubs and trees are given equal value. A green cover percentage has been calculated to compare the various towns.

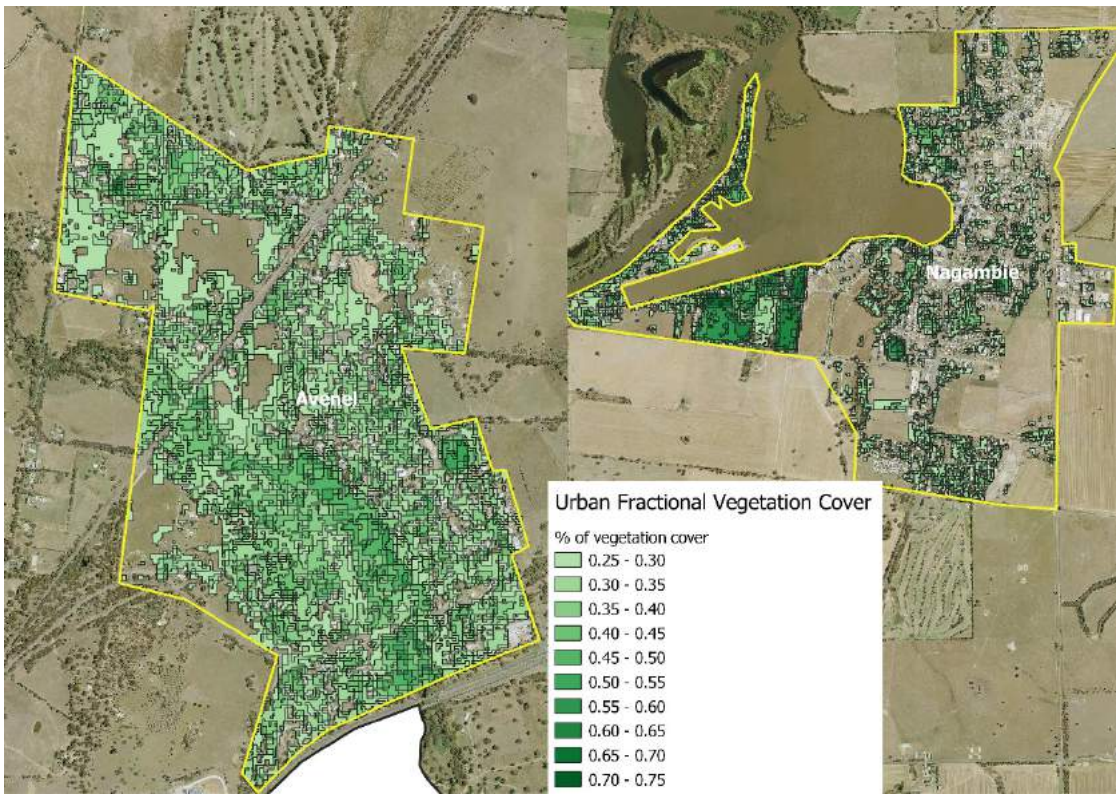


Image 1: FVC for Avenel and Nagambie

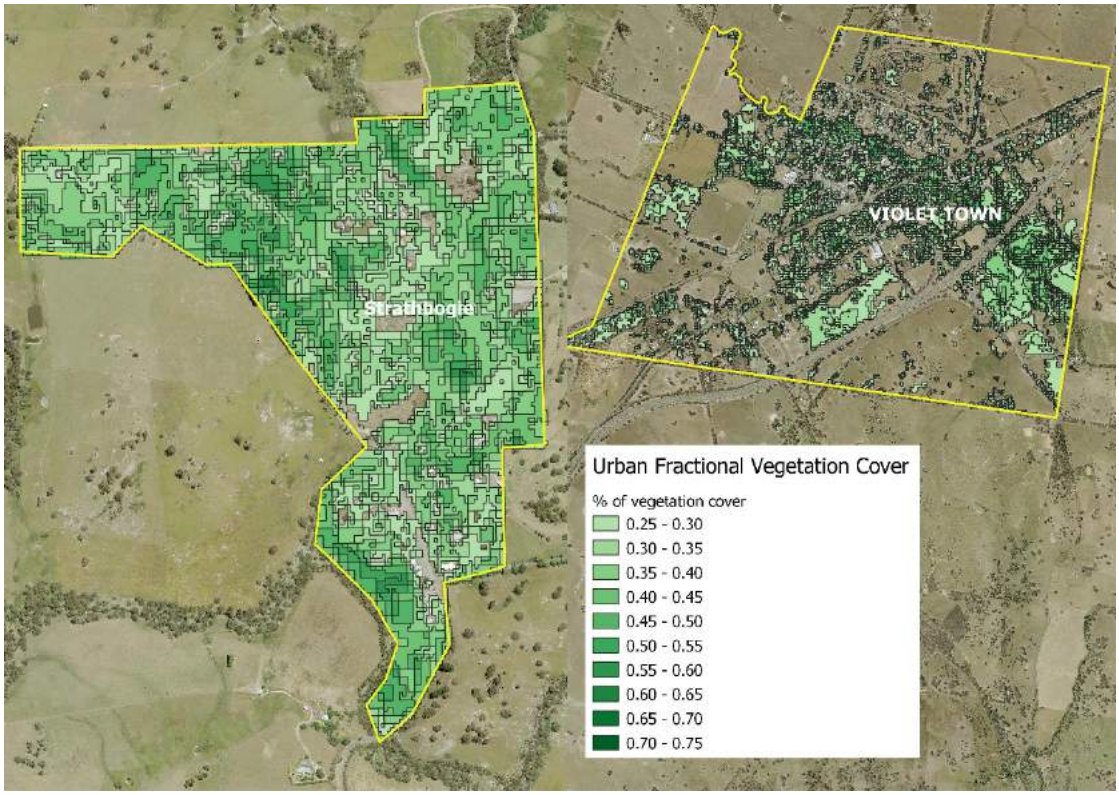


Image 2: FVC for Strathbogie and Violet Town

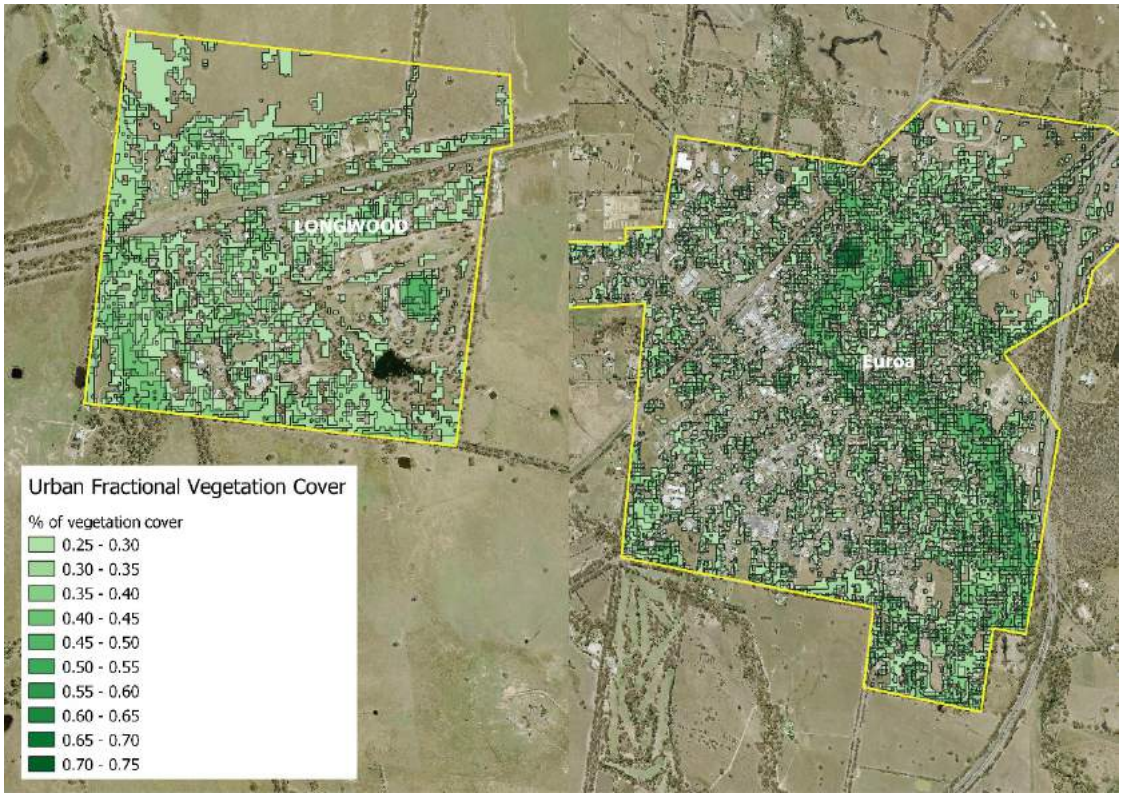


Image 3: FVC for Longwood and Euroa

Town	Green Cover %
Nagambie	35%
Violet Town	35%
Longwood	47%
Euroa	51%
Avenel	71%
Strathbogie	94%

Table 1: Percent green cover for each of Strathbogie's main six towns

The results show that Nagambie, Longwood, Euroa and Violet Town have the lowest amounts of photosynthesising vegetation. Given that Euroa and Nagambie are the most densely populated towns in the Shire, this is to be expected. The satellite has predominantly picked up mostly trees in both Violet Town and Longwood rather than the grass suggesting that the grass was dry. Strathbogie on the other hand recorded a 94% green cover. Upon analysis of the aerial this contribution is made from expanses of grass, vegetation along Spring Creek and vegetation along property boundaries. It is interesting to note that the grass in Strathbogie was picked up in the analysis but not for Longwood or Violet Town. There are a few factors that could influence this. Strathbogie is in the tablelands of the Strathbogie Ranges and could receive higher rainfalls than other areas of the Shire. Alternatively, the property owners in Strathbogie may also be irrigating large amounts of grass on their properties.

It is very important to note however that FVC is not an equivalent measure for a commonly used metric of green infrastructure, namely tree canopy cover. Tree canopy cover for each town will be quite different to that of vegetation cover. For example, Strathbogie has a very high fractional vegetation cover, however the aerial image shows this is predominantly because of photosynthesising grass rather than dense tree cover. Tree cover would appear to be higher in Euroa.

There are several ways to measure tree canopy cover which range in cost and complexity. Point sampling aerial imagery as used in a tool called I-Tree Canopy could be used and whilst relatively cost effective, does not provide a spatial distribution of canopy as it produces only a set of statistics. It cannot therefore identify where the exact gaps in tree canopy are. Alternatively, processing of LiDAR or infrared imagery can produce spatial datasets of high-resolution height stratified vegetation cover. This is relatively expensive to undertake. Neither measurements are part of this analysis and not deemed necessary to provide a baseline GI analysis.

Instead, these green cover maps provide an excellent basis for considering where green infrastructure is needed. This is particularly relevant in Euroa and Nagambie that are more urbanised and have less green cover particularly along commercial/retail strips where pedestrians are more concentrated and where more shade is needed.

Strathbogie Shire's Urban Trees

To get a better understanding then of tree distribution within each township, Council's street and park tree inventory has been used. The inventory holds data on most of the street and park trees in urban areas. There is no data available for Strathbogie's township trees or Longwood's streets. This information is useful for understanding where the trees are located but also for considering the resilience and overall health of the asset. An attribute called Useful life expectancy has been collected for each tree which is a useful planning and management tool for Strathbogie's urban trees. This attribute helps Council to understand the length of time that a tree has left in situ before it will need additional input to manage for decline or inappropriateness for its location. Many factors contribute to a tree's ULE: age, health, species, proximity to infrastructure and past pruning techniques.

Avenel: 2,524 trees

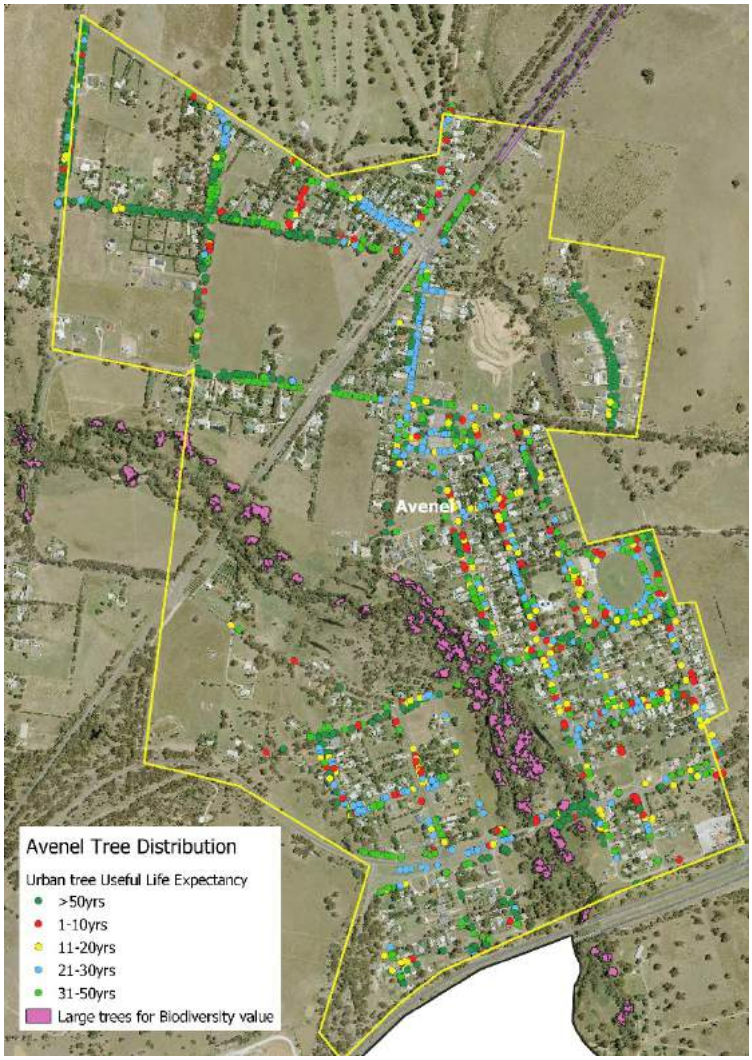


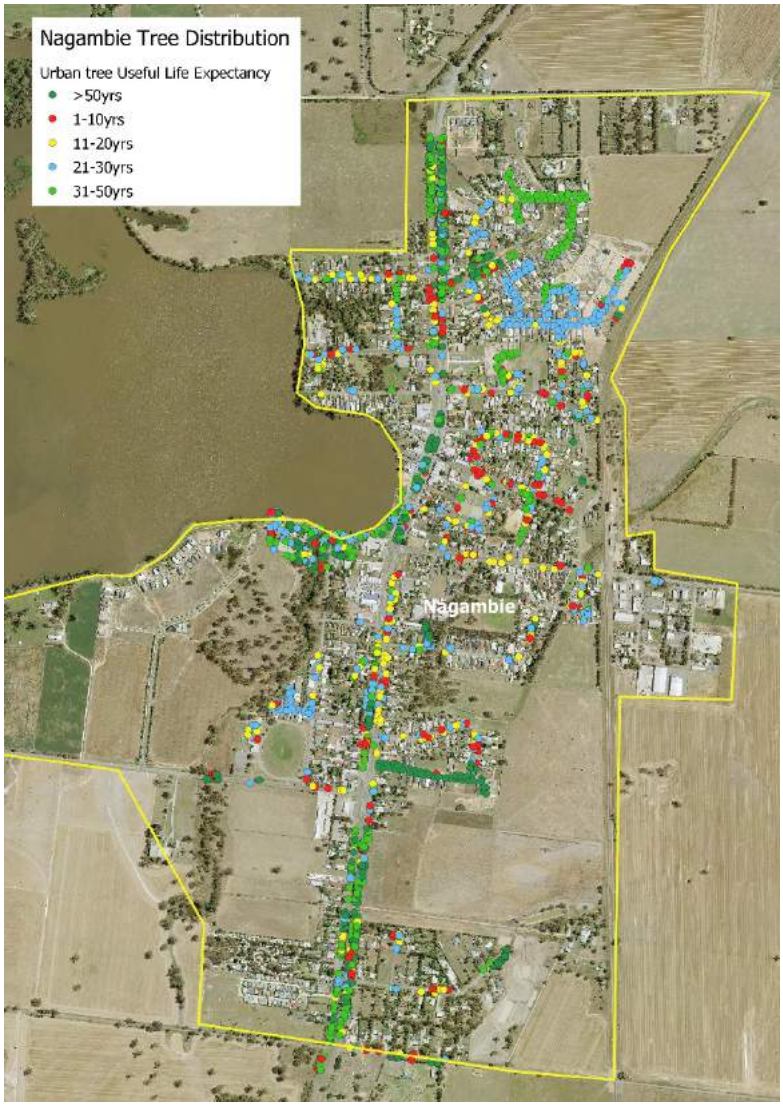
Image 4: Location of Avenel's street trees colour coded for useful life expectancy

Common Species	No	% of popn
Yellow Box	450	18%
River Red Gum	411	16%
Peppercorn Tree	197	8%
Desert Ash	149	6%
Lombardy Poplar	99	4%
White Cedar	96	4%
Callery's Pear	88	3%
Late Black Wattle	55	2%
Silver Wattle	51	2%
Monterey Cypress	48	2%

Table 2: Most common species in Avenel

Avenel has a high proportion of both Yellow Box and River Red Gum across its streets. This is to be expected given both are indigenous to the area and whilst high, is not considered a management problem due to Avenel's rural biodiverse landscape and proximity around Hughs Creek. The River Red Gums in streets should be on a regular inspection program to mitigate risk of falling limbs. There is a strong mix of native and exotic species within the total tree population. 8% of Avenel's assessed trees have ULE 10 years or less (coded in red). They are distributed evenly across town and don't represent a large percentage of the population.

Nagambie: 2,521 trees



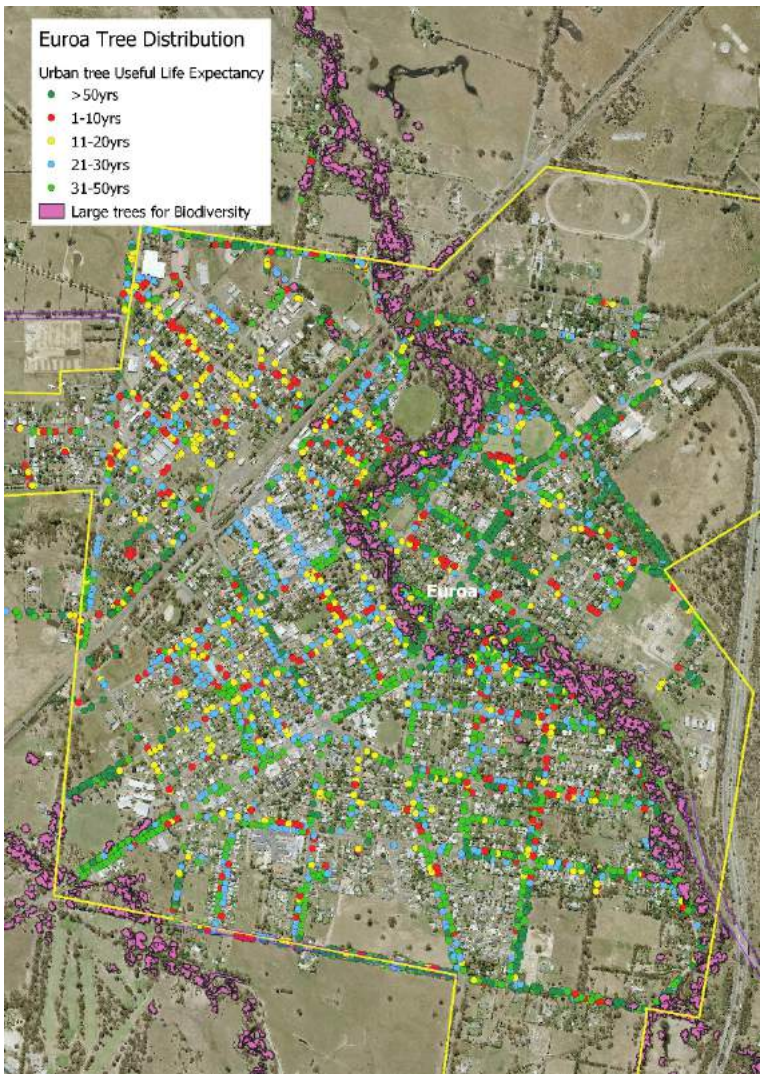
Common Species	No	% of popn
River Red Gum	417	17%
Grey Box	270	11%
Yellow Box	137	5%
Callery's Pear	132	5%
Desert Ash	96	4%
Pin Oak	96	4%
Weeping Bottlebrush	62	2%
Crimson Bottlebrush	58	2%
Yellow Gum	55	2%
Prickly leafed paperbark	48	2%

Table 3: Most common species in Nagambie

Image 5: Location of Nagambie's street trees colour coded for useful life expectancy

Nagambie also has a high percentage of river red gums, followed by a lesser dominance on grey box. Again, these red gums should have a regular inspection program to monitor risk in higher profile locations e.g. parks. Only three of Nagambie's most common species are exotic.
7.5% of assessed trees have ULE 10 years of less (coded in red) which is considered an average percentage and poses no significant management issues.

Euroa: 5,665 trees



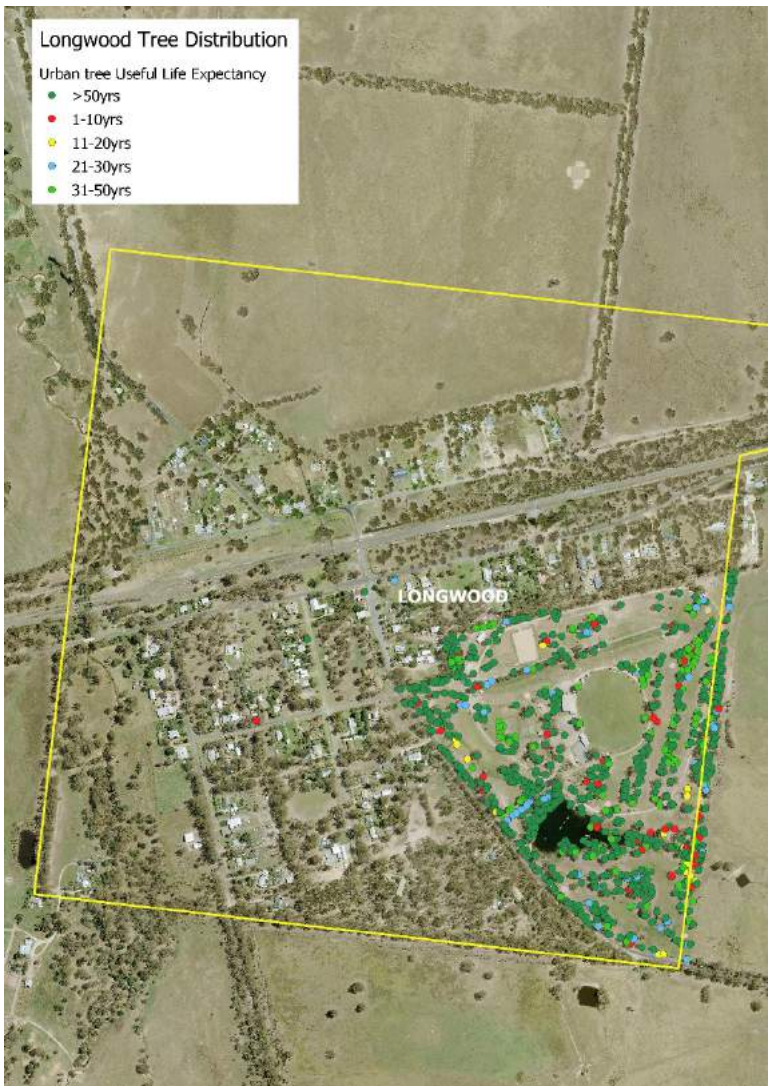
Common Species	No	% of popn
River Red Gum	1669	29%
Grey Box	458	8%
Desert Ash	336	6%
Yellow Box	214	4%
Callery's Pear	153	3%
Claret Ash	150	3%
London Plane	147	3%
Peppercorn Tree	130	2%
Red-flowering Gum	125	2%
Weeping Bottlebrush	104	2%

Table 4: Most common species in Euroa

Image 6: Location of Euroa's street trees colour coded for useful life expectancy

Euroa's streetscapes and parks are highly dominated by River Red Gums, which represent almost a third of all street and park trees in Euroa. In any urban setting, this over-representation would be cause for concern as a lack of species diversity reduces resilience in the population. That said, River Red Gums, as per all other Strathbogie townships, are indigenous to the area and provide unique landscape character to each town, especially in connecting to the conservation area of Seven Creeks. It is not proposed for Council to reduce the number of existing river red gums, rather increase the use of other species in new streetscape and park plantings to broaden species diversity.
9.5% of assessed trees have ULE 10 years or less (coded in red) and are spread across town posing no potentially significant amenity loss or management challenge.

Longwood Recreation Reserve: 1,241 trees



Common Species	No	% of popn
River Red Gum	656	53%
Grey Box	117	9%
Red Ironbark	89	7%
Red Box	69	6%
Yellow Box	60	5%
Lemon-scented Gum	44	4%
Spotted Gum	30	2%
White Peppermint	23	2%
Lightwood	19	2%
Sugar Gum	16	1%

Table 5: Most common species in Longwood Rec Reserve

Image 7: Location of trees in Longwood Recreation Reserve colour coded for useful life expectancy

Only trees in Longwood's recreation reserve have been inventoried. The park, again, is dominated by River Red Gums representing over half of all trees. This supports the landscape character in Longwood and enhances localised biodiversity. The River red gums have been assessed with high useful life expectancies (over 50 years). Only 4% of assessed trees have ULE 10 years or less.

Council could consider assessing trees in Longwood's Streets to add to the inventory.

Violet Town: 2,616 trees

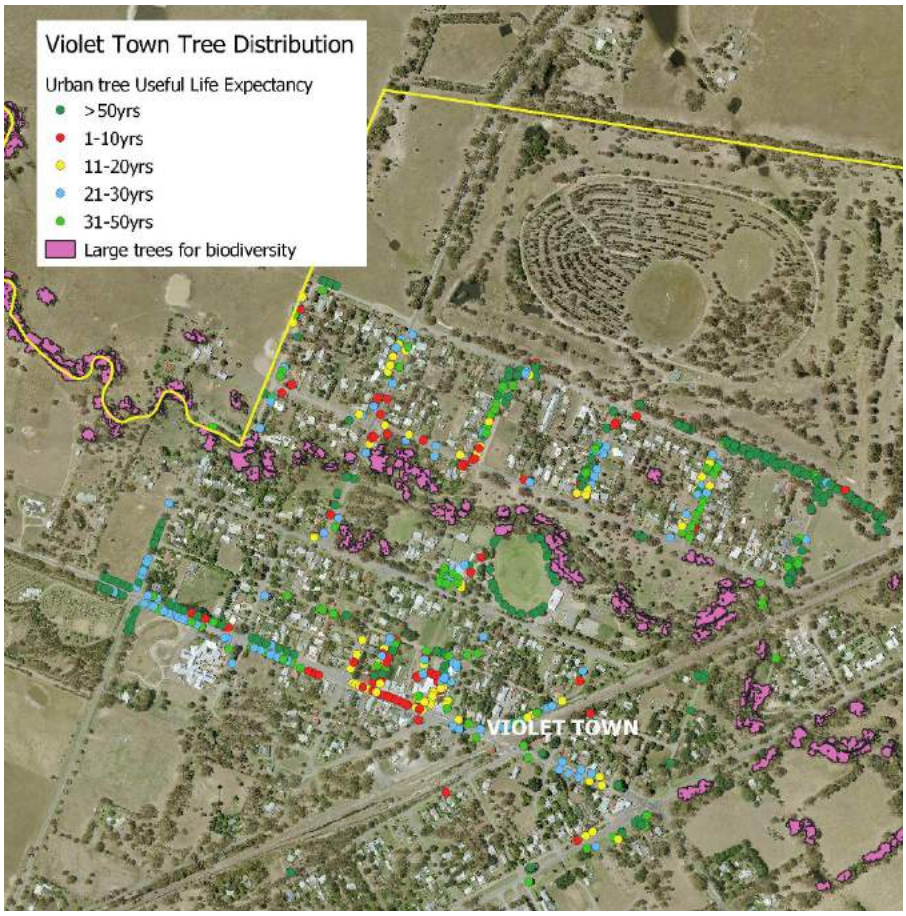


Image 8: Location of Violet Town's street trees colour coded for useful life expectancy

Local indigenous species are the most common species in Violet Town's streets. It is noted that not all streets appear to have been inspected and data recorded. Honeysuckle Creek and the riparian vegetation along it are the centrepieces of Violet Town's landscape. The street and park tree species match this to enhance biodiversity and landscape character.

Very few trees in Violet Town have a low ULE, however it is worth noting that those that do are grouped together along Cowslip Street between Hyacinth Street and Lily Street. Almost all of them are Liquidambars. These trees need further on-site analysis to determine an appropriate course of action.

Common Species	No	% of popn
River Red Gum	919	35%
Grey Box	166	6%
Yellow Box	143	5%
Desert Ash	109	4%
Snow in Summer	64	2%
Weeping Bottlebrush	59	2%
Silver Wattle	56	2%
Prickly-leaved Paperbark	53	2%
Claret Ash	51	2%
Liquidambar	47	2%

Table 6: Most common species in Violet Town

Strathbogie Shire's Open Space

The Fractional Vegetation Covers for each town suggests that there is no shortage of vegetation or even permeability within each town as compared to metro areas where imperviousness can be as high as 70-80%. This in turn bodes well for urban heat impacts as there is adequate green cover to mitigate significant build-up of heat in the impervious landscape. A scan of aerial imagery also shows that tree canopy cover is relatively adequate across what appears from aerial imagery as open space. There were some parcels that were not recognised by GIS data as open space and yet were likely to benefit from increased canopy. The Nagambie Recreation Reserve (see Image 10) was one such parcel.

A more detailed analysis of the quality and quantity of open space in Strathbogie in meeting the needs of the community would provide the necessary information to determine whether more green open space is in fact needed for Strathbogie Shire townships. Individual on-ground open space assessments would also identify any further opportunities for increased tree canopy in specific locations e.g. over shared user paths, seating, picnic tables and playgrounds, determine accessibility for residents and required function (active vs recreation).

Image 9: Euroa's data showing distribution of open space (based on Planning Zones and Council owned land feature classes)

In Nagambie, the Recreation Reserve is low on tree canopy cover but is considered neither a park nor owned by Council as shown in the aerial image below.

Image 10: Nagambie's data showing distribution of open space. (based on Planning Zones and Council owned land feature classes)

Priority tree planting, as detailed in the next section includes these parcels not picked up in the above data just in case Council does have capacity to plant trees on them.

Prioritisation

Vegetation Cover and Social Vulnerability to Heat

Based on research undertaken by the Victorian Centre for Climate Change Adaptation and Research (Norton et al, 2013), areas of prioritisation for green infrastructure are where social vulnerability intersects with heat and areas of high pedestrian activity.

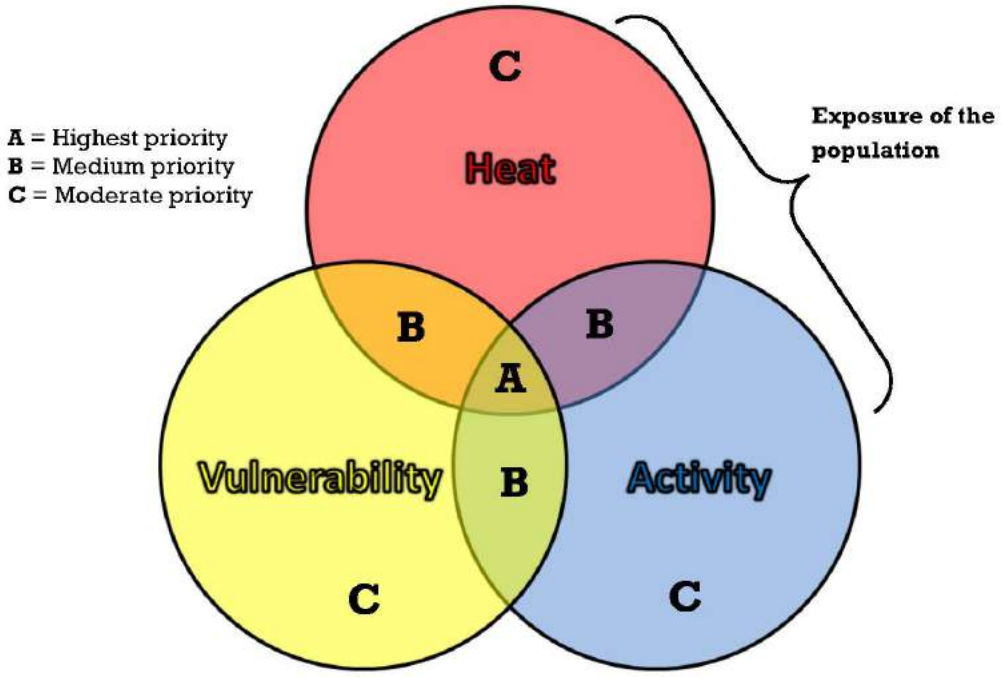


Image 11: Venn diagram representing factors required to identify areas of high (A), medium (B) and moderate (C) priority for GI implementation for surface temperature reduction (Norton et al, 2013)

Given heat has not been directly measured, for this prioritisation it is assumed that areas with lower vegetation cover have higher capacity for heat impacts (Coseo et al, 2013).

Social vulnerability has been defined by Loughnan et al, 2013 as those members of the community who are more vulnerable to heat impacts such as those socio-economically disadvantaged, young children, older people living alone, those in social housing and those in need of assistance. However, most of these datasets has not been made publicly available for Strathbogie Shire through the Social Atlas.id website. Instead, socio-economic disadvantage (measured as SEIFA in the 2016 census) which has been reported on for Strathbogie at township level has been used as the predominant indicator of vulnerability.

SEIFA Disadvantage in Strathbogie Shire:

Strathbogie Shire's small areas and benchmark areas		
Area	2016 index	Percentile
Avenel and District	1,016.7	55
Victoria	1,010.0	51
Australia	1,001.9	46
Rural North West	993.8	41
Regional VIC	977.0	32
Strathbogie Shire	974.0	31
Violet Town and District	974.0	31
Nagambie - Kirwans Bridge	966.6	28
Euroa and District	955.4	23

Table 7: SEIFA across Strathbogie (Source: Australian Bureau of Statistics, Census of Population and Housing 2016. Compiled and presented in profile.id by .id)

Euroa, Nagambie and Violet Town all have disadvantage scores lower than the Regional Victorian average. Generally, any score below 1,000 identifies as disadvantaged and the lower the score, the more disadvantaged the area.

Therefore, areas more vulnerable to heat as measured by socio-economic disadvantage and green cover are:

Town	Green Cover %	GC Rank	SEIFA Disadvantage	SEIFA Rank	Total Ranking Score
Nagambie	35%	1	966	2	3
Violet Town	35%	1	974	3	4
Euroa	51%	3	955	1	4
Longwood	47%	2	N/M	5	7
Avenel	71%	4	1016	4	8
Strathbogie	94%	5	N/M	5	10

Table 8: Matrix of vulnerability and green cover to determine prioritisation of GI

These results suggest that tree canopy shade for heat mitigation and protection of people is needed more in Nagambie, Violet Town and Euroa.

From a tourism point of view, economic data is only available at a whole of Municipal level meaning prioritisation of tree planting for amenity and therefore tourism benefits are difficult. Based on research that suggests well-treed and landscaped retail areas mean that visitors stay longer and spend up to 20% more money (Wolf, 2015), tree planting in these locations are likely to have a direct economic benefit.

Water Sensitive Urban Design

E2Designlab have detailed water sensitive urban design opportunity sites, predominantly as tree pit sites, in both Euroa and Nagambie. The full report entitled “Strathbogie Urban and Rural Green Infrastructure Review – Tree Pit opportunities Feb 2019 should be read in conjunction with this report. 25 opportunity sites have been developed over these two towns and of these, 2 sites have been prioritised for concept design phase. The Euroa Train Station carpark and the Nagambie Bowls Club – Glass Street are the two sites. The concept designs are included in the above-named report.

Area of Priority

Using both the fractured vegetation cover and the geolocation of existing street trees, aerial imagery has then been analysed further to identify potential street and park tree planting sites.

Tree planting and wsud opportunity sites have been mapped for each town below. They include tree planting in areas of open space and along streets. As demonstrated, it is the streets that show the most need and opportunity rather than the open spaces.

Tree planting opportunities have been based on FVC cover, aerial imagery (vacant sites) and land use zone. High impact tree planting (colour coded red) is tree planting along entry roads into town or within retail/commercial areas. Residential tree planting is colour coded yellow. Tree planting in open space would need further clarification on who owns each parcel of land.

Vacant tree planting sites have been estimated using point data from aerial imagery. They are an early indictor only and ground validation is required to confirm viability of each site for tree planting to consider powerlines, underground services, other infrastructure and potential future development of sites.

Nagambie

Estimated number of vacant tree sites: 329

Image 12: Priority tree planting and water sensitive design locations in Nagambie.

Avenel

Estimated number of vacant tree sites: 88

Image 13: Priority tree planting locations in Avenel.

Longwood

Estimated number of vacant tree sites: 47

Image 14: Priority tree planting locations in Longwood

Euroa

Estimated number of vacant tree sites: 366

Image 15: Priority tree planting and water sensitive design locations in Euroa.

Estimated number of vacant tree sites: 366

Violet Town

Estimated number of vacant sites: 52

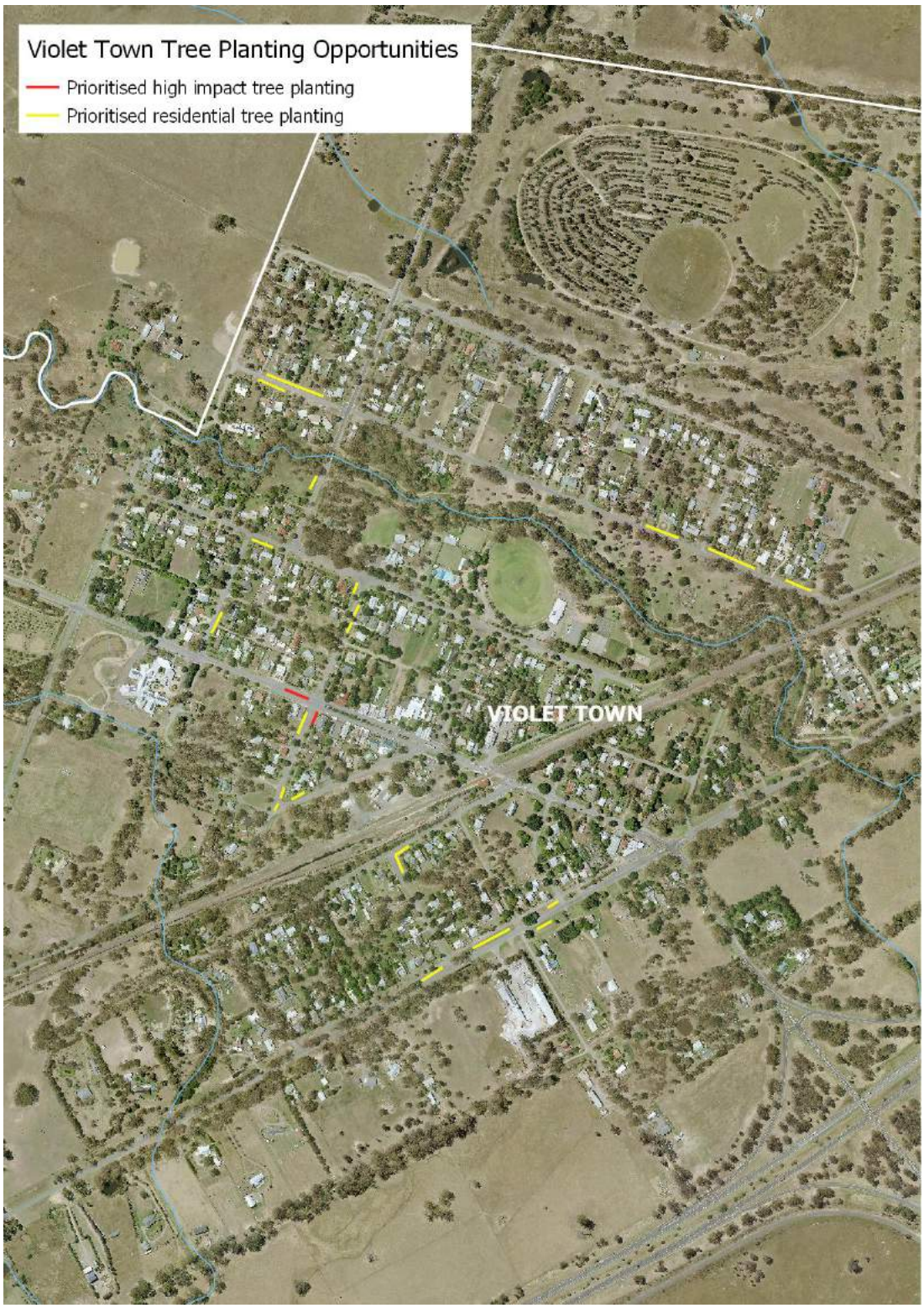


Image 16: Priority tree planting locations in Violet Town

Strathbogie

Estimated number of vacant sites: 51

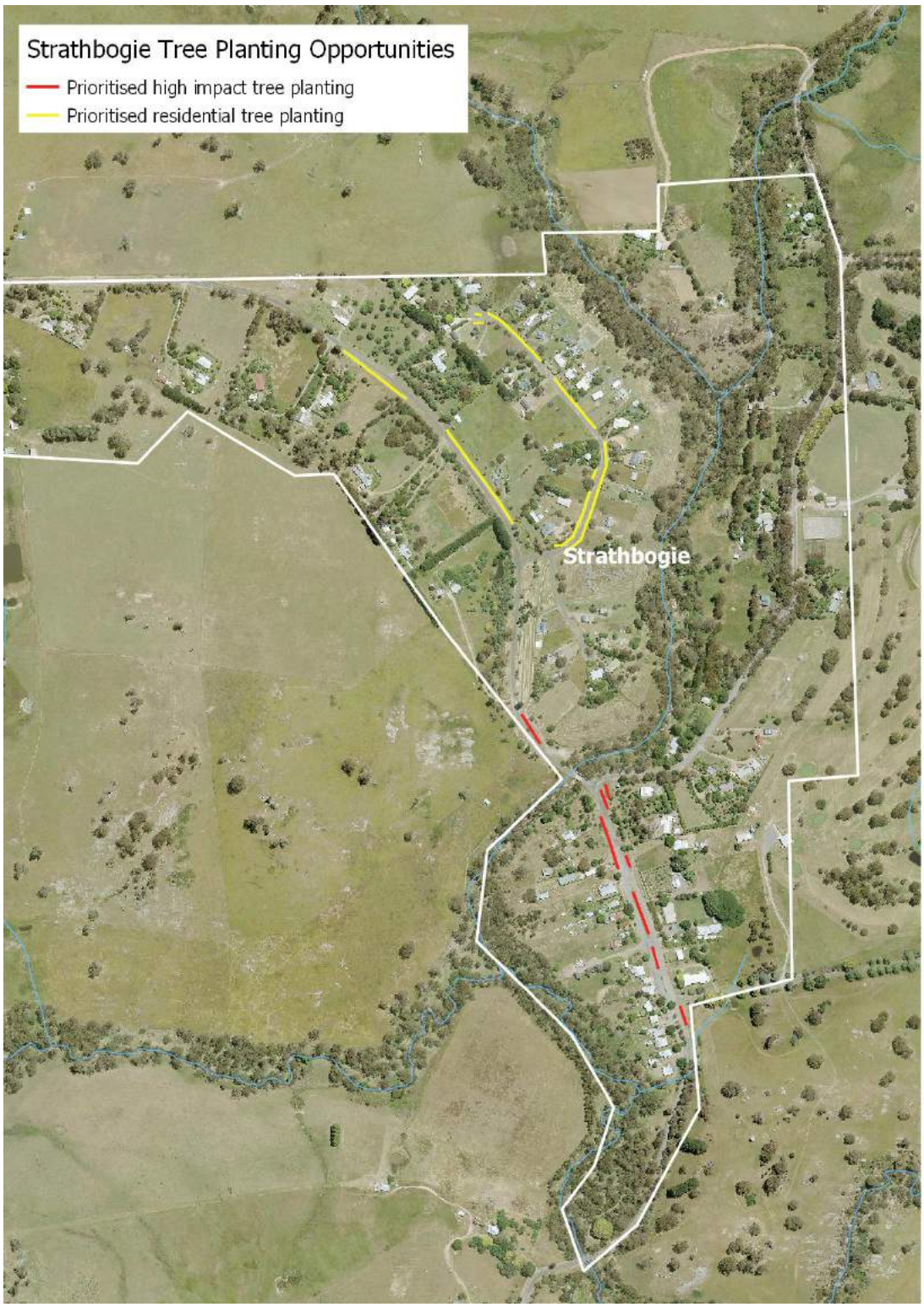


Image 17: Priority tree planting locations in Strathbogie

Discussion

Despite not being complete, the tree inventory suggests there are approximately 14,775 trees across Strathbogie's main four towns: Euroa, Nagambie, Avenel and Violet Town. Data has not been collected for Strathbogie or Longwood's streets.

Based on the mapping and prioritisation, an estimated 933 vacant street tree sites exist across Strathbogie Shire's six main towns.

Further to this, Council estimate that there are 1,187 trees with a useful life expectancy of less than 10 years. So, by 2029, it is feasible that there will be a total of 2,120 vacant street tree sites if no trees are replanted after removal.

With current budgets and resources, Council remove an average of 29 street trees per year (based on a total of 87 trees removed between 2016 and early 2019) and yet only plant on average 15 advanced trees per year. This means that current Council budgets and resources are seeing an annual decrease in street tree numbers which is likely to also mean a decrease in overall tree canopy cover, however this would need to be verified with tree canopy spatial mapping.

Council's Current tree planting budget is $10,000 and cost per tree planted is around $660 which is a relatively standard cost for rural and regional towns. The Cities of Melbourne, Yarra and Port Phillip for example can spend up to $10,000 per tree planted which includes highly engineered growing solutions to allow a tree to thrive in highly constrained environments.

By considering forthcoming tree loss as trees reach the end of their useful lives and the number of vacant sites requiring a tree, it is estimated that Strathbogie Council should be planting an estimated 200 trees each year for the next ten years to 2030. This would ensure both renewal of the tree population but also provision of adequate tree canopy in each town. 200 trees a year is a significant increase on Council's current capacity.

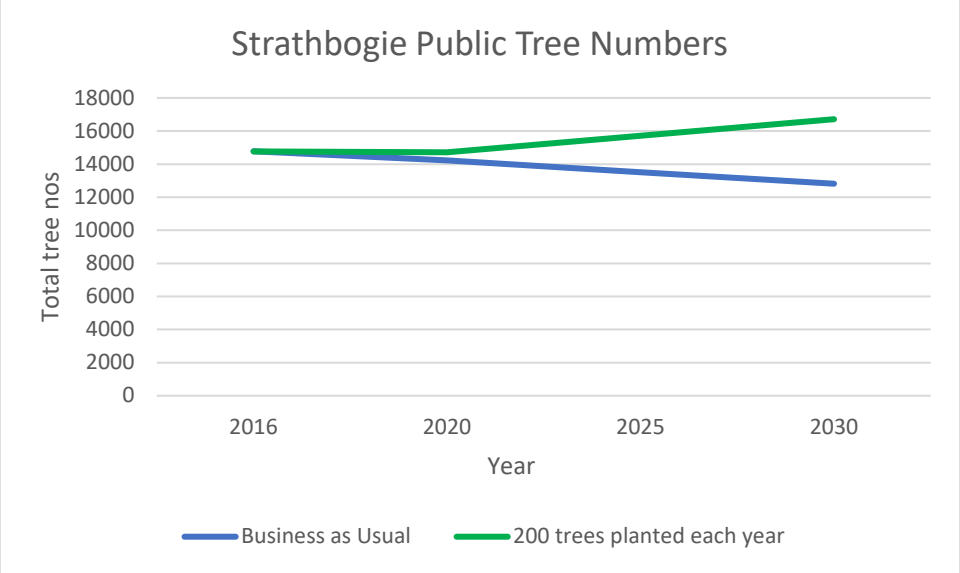


Image 18: graph showing gradual tree number decline under business as usual and tree increase by planting 200 trees a year for next 10 years.

From a prioritisation perspective, more trees are required in Euroa, Nagambie and Violet Town due to lower green cover and higher presence of communities who are more vulnerable to heat and therefore in need of shade.

From the high-level analysis, tree canopy cover is required more over streets than in open space. A detailed open space review however would determine exact locations for increased tree planting that align with active and recreational needs for each parcel. There is currently insufficient data to determine if the extent of open space is adequate in meeting the needs of the Strathbogie Shire community.

25 priority water sensitive urban design sites have been identified across Euroa and Nagambie. Of these 25 sites, 2 have been selected for feasibility and concept design.

Recommendations

1. A 10-year street tree planting plan should be developed based on the results from this report. This plan should articulate in spreadsheet format trees to be planted per year, specific locations, species type and costs for tree planting every year for ten years. Areas where tree planting opportunity and wsud opportunities intersect should be further ground-truthed and costed for future implementation. It is noted that the results from this analysis are desktop only and further ground validation will be required to determine viability of vacant site locations. Some locations are in highly constrained streetscapes e.g. Nagambie's main street. Getting trees into these locations may require water sensitive solutions such as a tree pit and therefore cost more per unit.

2. Second to this, Council will need to raise the issue of inadequate tree planting budgets. Planting 200 trees per year is likely to need a budget in excess of $130,000 per annum. It is recognised that while this figure appears high to existing budgets, it is an investment in Strathbogie Shire's future. It is an investment in attracting tourism, in shade provision, in stormwater management and in community health. From this perspective, there is a significant return on investment that will continue to pay dividends well into the future.

3. Council should consider an open space review to determine the active and recreational open space needs for their future community and whether the existing spread and quality is adequate.

4. The two concept designs for water sensitive urban design should be funded, installed and monitored to provide the evidence base for further roll out of water sensitive design in line with the other 23 identified sites.

The following shapefiles/imagery have been developed for Council which inform this prioritisation:

1. High impact prioritised tree planting.shp
2. Residential prioritised tree planting.shp
3. Vacant sites desktop only.shp
4. PassiveIrrigationOpportunities.shp
5. Townships raster (Fractional Vegetation Cover)
6. Townships.shp (Vectorised Fractional Vegetation Cover in 5% bands)

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