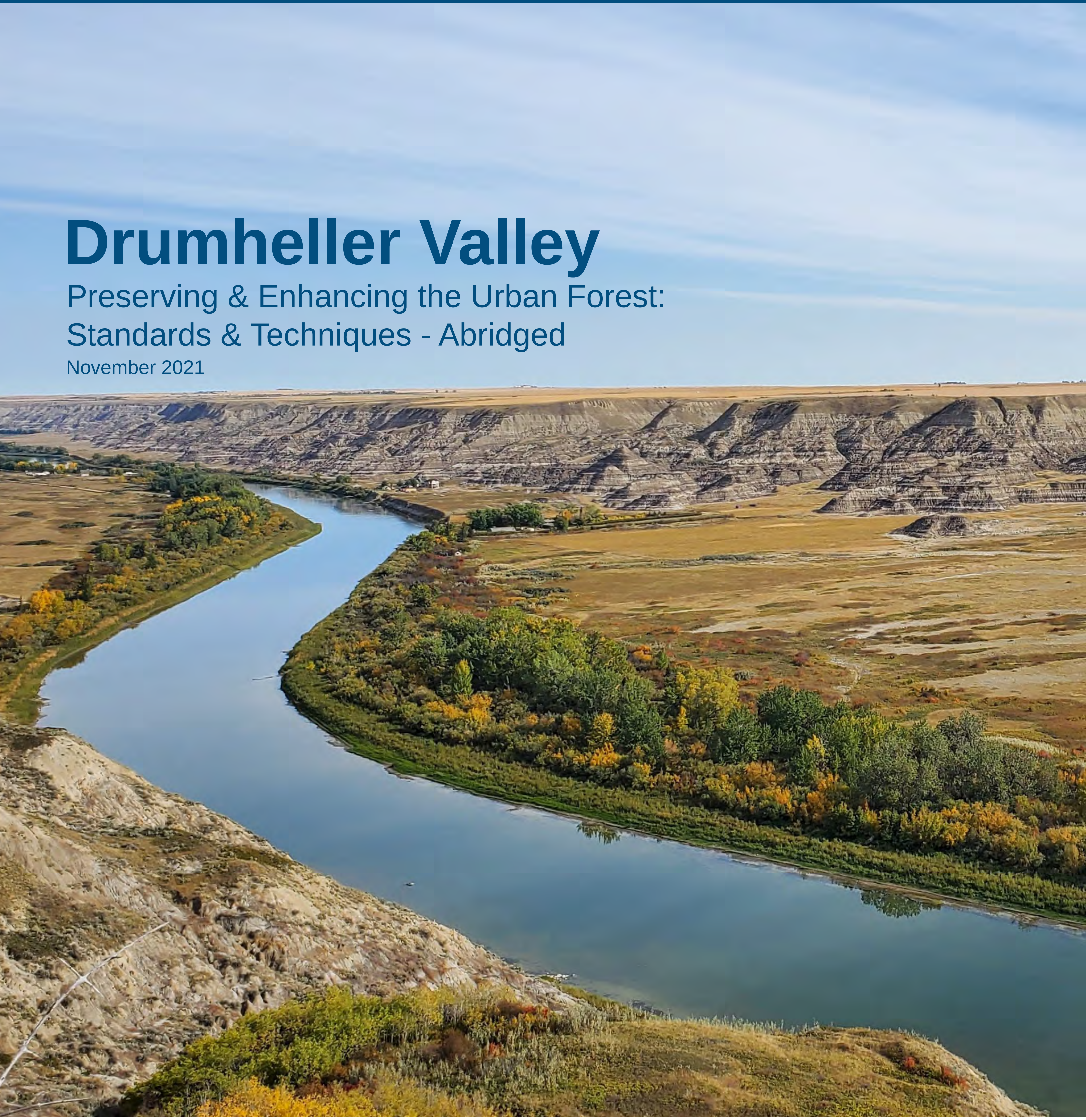
Drumheller Valley

Preserving & Enhancing the Urban Forest: Standards & Techniques - Abridged

November 2021



DRUMHELLER VALLEY

SECTION 1: INTRODUCTION

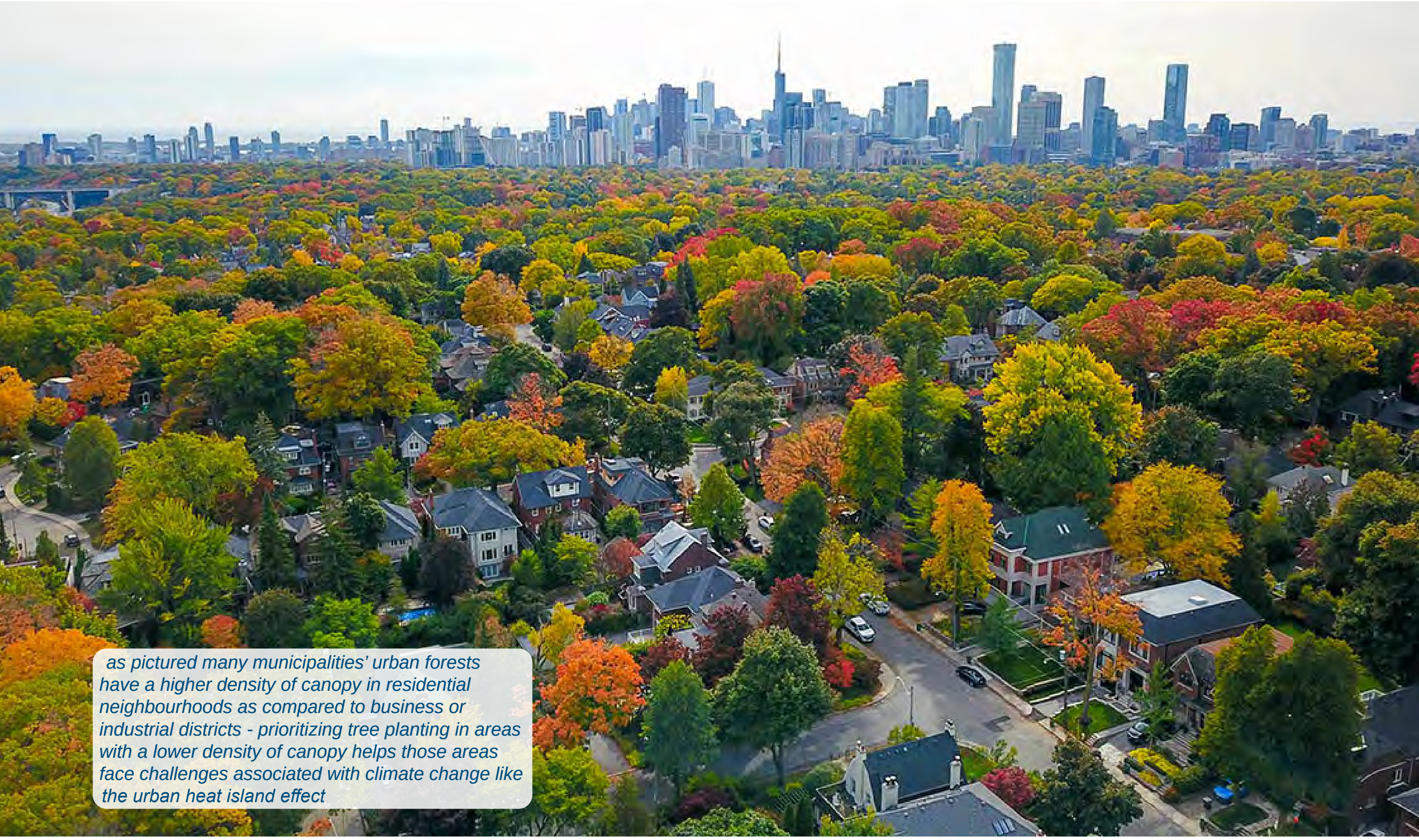
an urban forest along a river

urban forests connect urban areas with nature

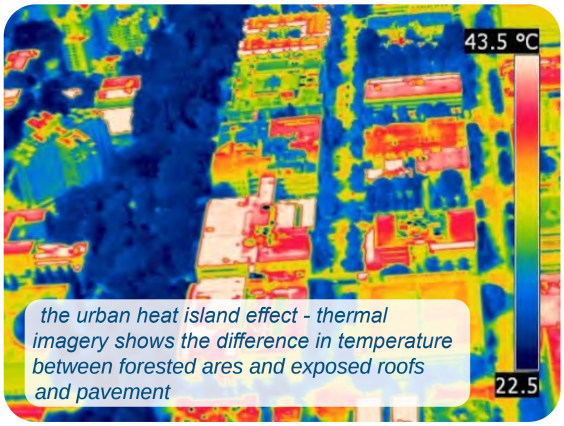
the spine of Drumheller's urban forest is the valley

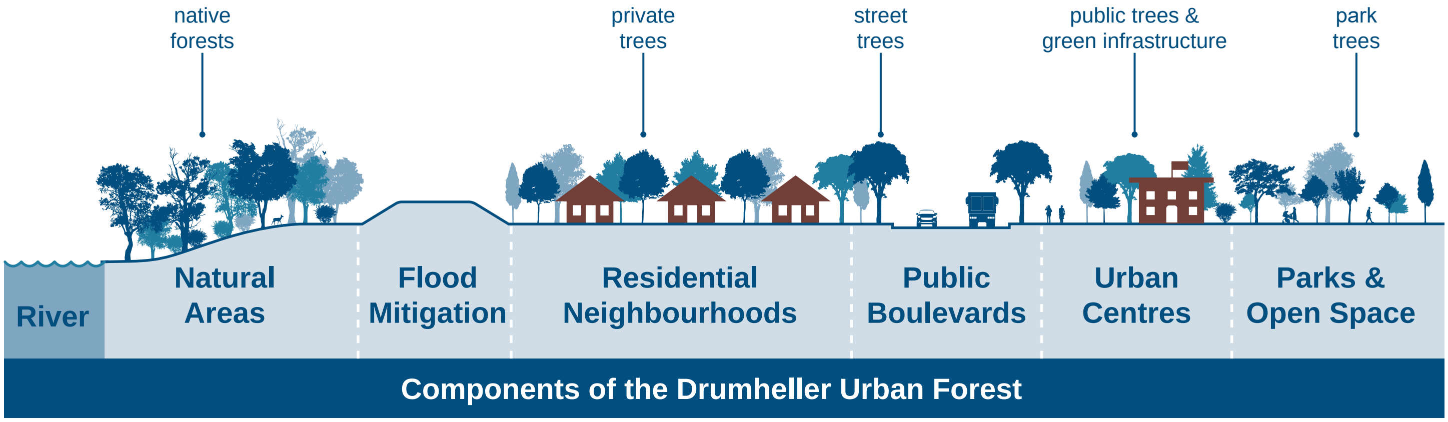
01. **What is the Urban Forest?** The urban forest is defined as ecosystems composed of trees and other vegetation that provide cities and municipalities with environmental, economic and social benefits. They include street and yard trees, vegetation within parks and along public rights of way, water systems, fish and wildlife. Urban forestry is the planned and programmatic approach to the development and maintenance of the urban forest, including all elements of green infrastructure within the community, in an effort to optimize the resulting benefits in social, environmental, public health, economic, and aesthetic terms, especially when resulting from a community visioning and goal-setting process.

Considering all of the benefits that trees and the urban forest provides, it is important that any landscaping associated with public land makes positive contributions ecologically and aesthetically to growth and economic prosperity.

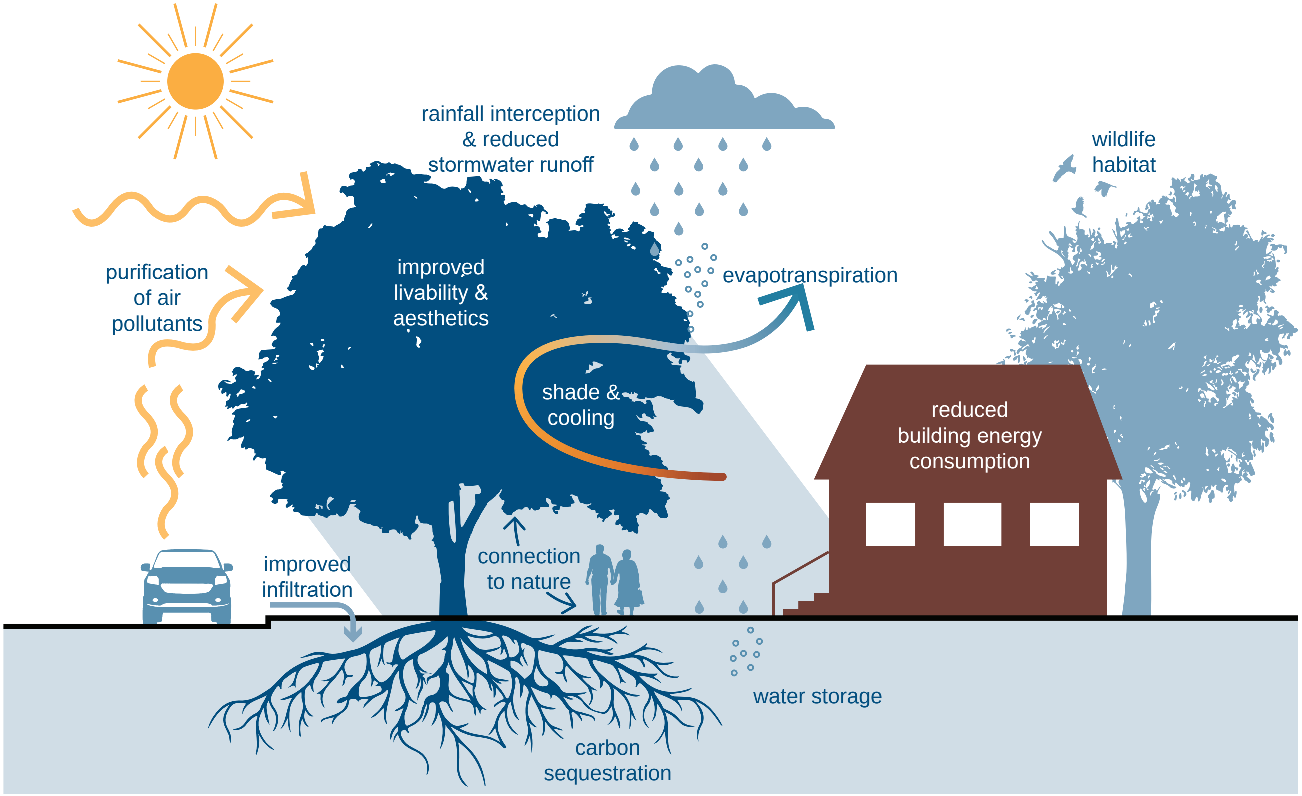


as pictured many municipalities' urban forests have a higher density of canopy in residential neighbourhoods as compared to business or industrial districts - prioritizing tree planting in areas with a lower density of canopy helps those areas face challenges associated with climate change like the urban heat island effect





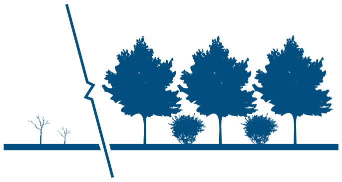
Benefits of a Healthy Urban Forest



02. **Primary objectives of the Landscape Strategy are to ensure that the public lands and Urban Forest:**

- Provide residents opportunity for a pleasant open space experience
- Enhance the aesthetics of public lands
- Encourage the preservation of existing trees and vegetation
- Enhance habitat and support biodiversity
- Provide environmental leadership by creating sustainable landscapes
- Providing a pleasant commuting and tourist experience by screening adjacent properties and roadways while supporting the safe movement of traffic
- Protecting the health, safety and welfare of the general public by contributing to the processes of air purification, oxygen regeneration, water absorption, abatement of noise, glare and heat, and by promoting energy conservation through the cooling and wind buffering effects of trees
- Support healthy and safe trees
- Utilize the right tree, in the right place with the right care
- Manage public funds prudently and equitably

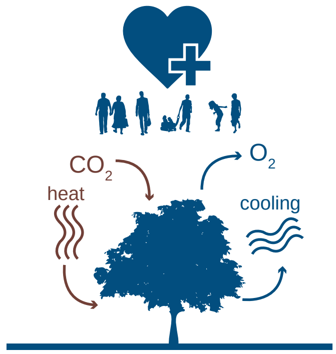
Open Space



Enhanced Aesthetics

Preserve Existing Trees

Leadership Through Sustainability

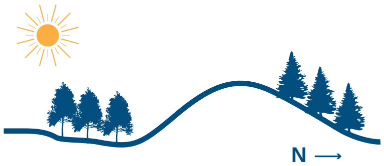


Healthy Community & Healthy Trees

Responsible Management of Public Funds

Improved Pedestrian Experience

Enhanced Habitat

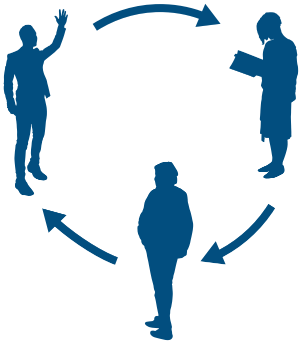


Right Tree in The Right Place

Healthy Trees

Sustainable Urban Forest

Valued by Community



Collaboration

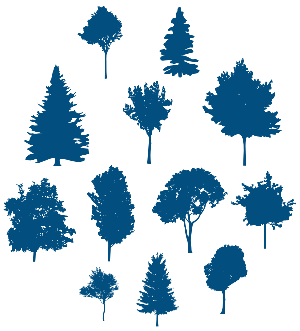
03. To achieve these objectives, **outcome based guidelines** regarding the design and construction of public lands, parks and roadway landscaping shall be considered. Support for targeted results will be a key measure of designs, materials and construction practices.

04. **The outcomes are:**

- Trees of the urban forest are in good health
- The urban forest is sustainable
- The urban forest provides benefits to the community, is valued and respected; and
- There is a collaborative approach to building the urban forest.

25-50

Year Life Span



Diversity of Genus, Species & Cultivars

+ 1%

Per Decade

Protect & Preserve

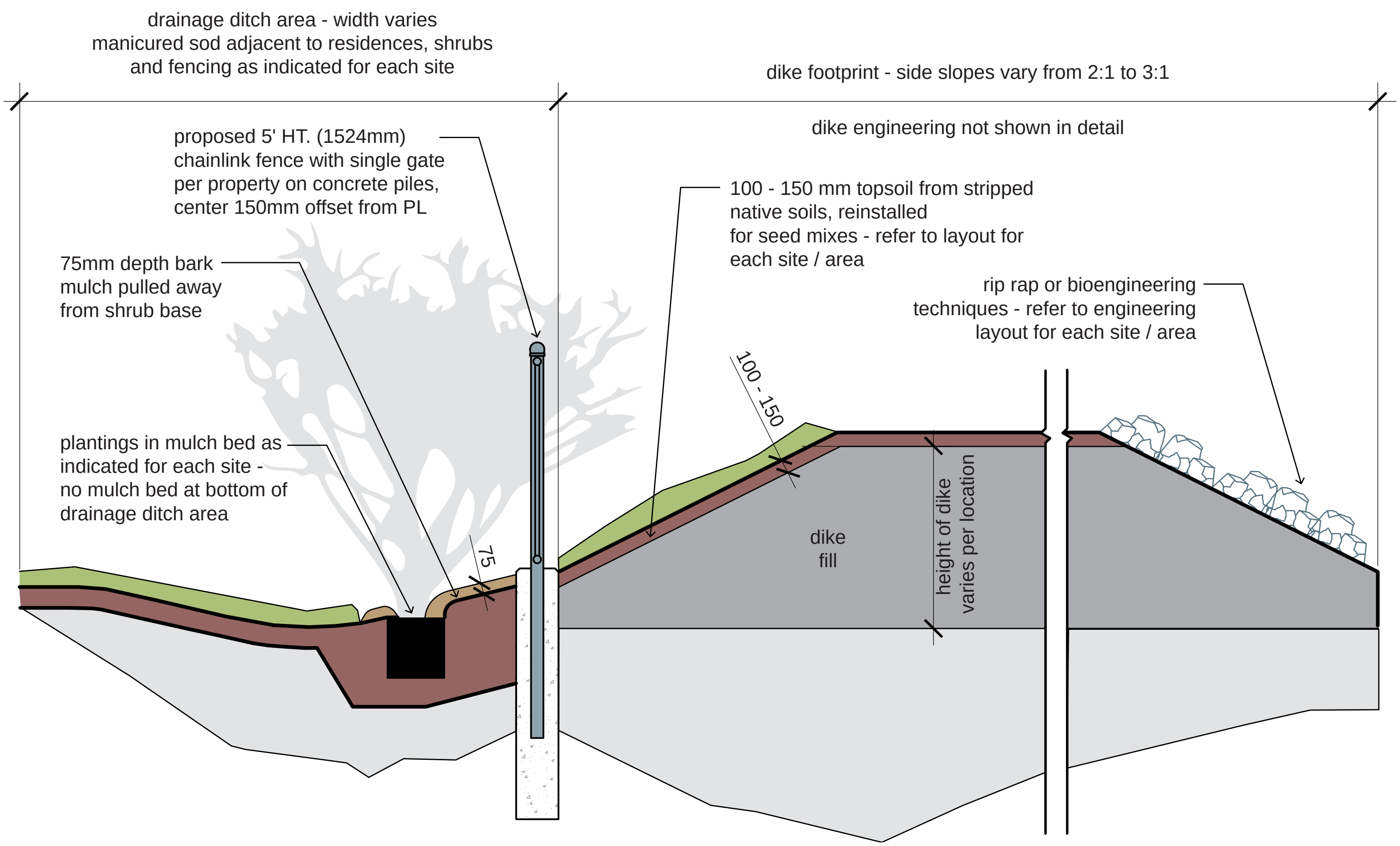
05. The targets are:

- Designs for tree planting on public land should accommodate and facilitate an average 50-year life span for trees in groomed parks and roadways and an average 25-year life span for sidewalks vaults.
- The species mix of the urban forest should contain both long and short-lived tree species.
- The species diversity for trees planted in groomed parks and roadways should be that no more than 25% of trees represent any one genus, no more than 20% of trees represent any one species, and no more than 10% of trees represent any one cultivar.
- The urban forest on public lands should increase by 1% per decade with an ultimate canopy cover target of 20%.
- Outline areas for potential planting opportunities and generate hierarchy matrix for overall urban forest to allow the urban forest to grow with intent.
- The total vegetation biomass should be sufficient to offset 0.5% of the valley's carbon emissions.
- Where possible existing vegetation should be protected and natural ecosystems preserved.

a residential neighbourhood nestled in the urban forest

06. **For dike construction, the tree replacement will be at a 5:1 ratio – the replacements can include trees or shrubs.** For ease of emergency access and maintenance trees and shrubs will not be planted on top of, or on the side slopes of, constructed dikes. The 5:1 replacement ratio will help to ensure:

- Rapid carbon sequestration replacement for tree removals due to dike construction. The amount of carbon sequestration lost by vegetation removal will be equaled or exceeded by new plantings within 20 years. Carbon sequestration information in Appendix A.
- A healthy, diverse and sustainable urban forest.



SECTION 2: DESIGNING FOR TREE POPULATION DIVERSITY

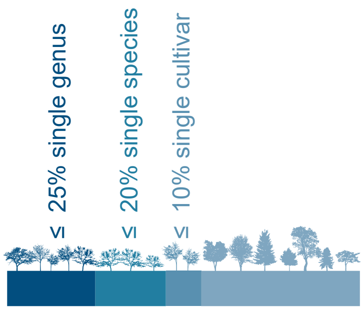
01. The greater the population diversity of the urban forest the more able it is to respond to variation and change in the environment, such as drought, fire and infestations. This results in a more sustainable urban forest and optimizes benefits provided.

02. **Targets:**

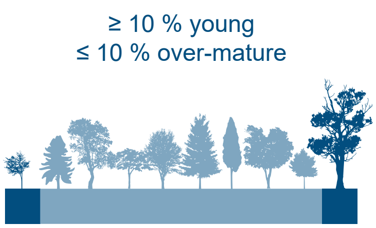
- Tree age class targets for established communities should be that no more than 10% of the trees are over-mature and no less than 10% of trees are young.
- The species diversity for trees planted in groomed parks, and near dikes and roadways should be that no more than 25% of trees represent any one genus, no more than 20% of trees represent any one species, and no more than 10% of trees represent any one cultivar.

03. **Design Practices:**

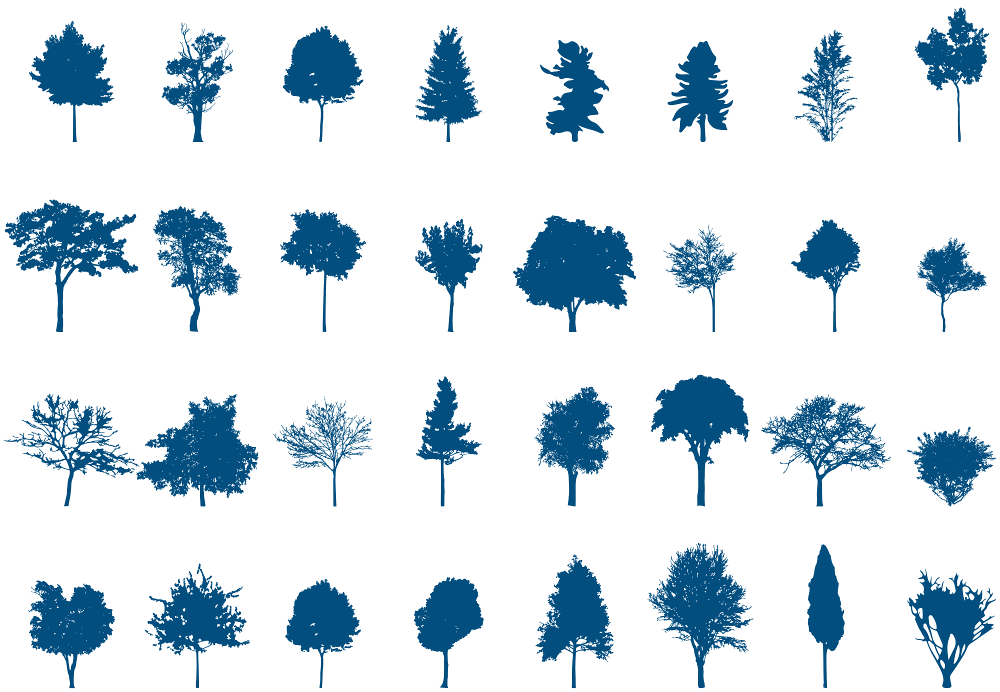
- The species mix of the urban forest should contain both long and short-lived tree species.
- Choose trees that are grown from seed rather than clones. e.g. Choose seed grown American Elm rather than cloned Brandon Elm as 10% of elm trees grown from seed have been shown to be resistant to Dutch Elm Disease. Most conifers & Oak species are seed grown.
- Choose less common species that perform same function as more common species. e.g. Choose Norway or White Spruce or Siberian Elm, rather than Colorado Spruce or Brandon Elm.
- Choose multiple cultivars within planting plans. e.g. use Patmore, Prairie Spire and Foothills green ash within the same design. Use multiple apple/crabapple varieties in one planting design.



Species Diversity Target



Tree Age Class Target



SECTION 3: DESIGNING TREE PLANTING SITES TO ENSURE SUFFICIENT MOISTURE

"Gator Bags" being used to ensure sufficient moisture for newly planted trees

This LID feature, located next to a roadway, helps to conserve soil moisture while storing and cleaning stormwater

01. Drought is a normal part of Drumheller's climate. Natural moisture levels are not sufficient to sustain most species of trees without supplemental watering. The ability of trees to survive predictable and inevitable drought cycles and to better conserve soil moisture need to be addressed in any sustainable design. When trees are getting sufficient moisture, they are healthier, and less prone to insect infestations.

02. **Design Practices:**

Use the following priority to select appropriate locations for tree planting:

1. Parks and roadways with central control irrigation systems.
2. Natural Environment parks where trees might naturally occur.
3. Flood mitigation areas, with appropriate set back from the dike structures.
4. Parks, residential streets, and other classes of roadways where community partners undertake watering responsibilities.
5. Parks and roadways designed to conserve soil moisture, with LID (Low Impact Development) drainage features.
6. Parks and roadways with irrigation systems manually operated by administration forces.

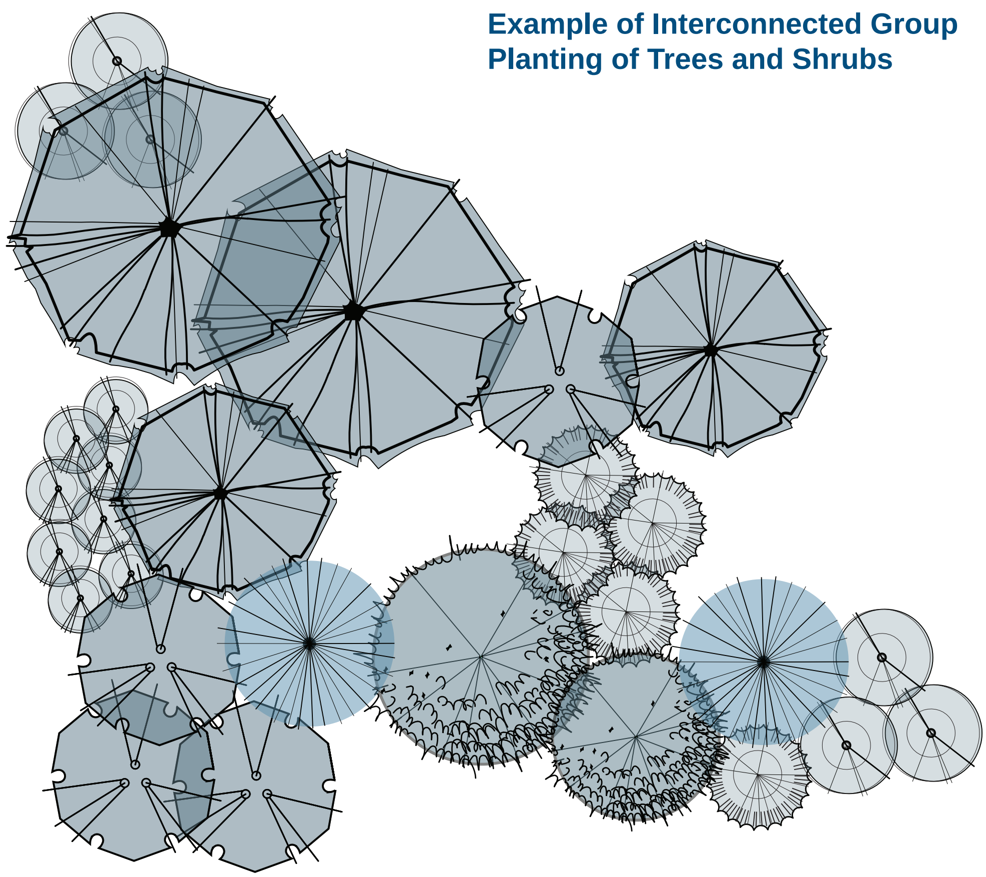
Water Harvesting & Recycling

Plant Vegetation Where Water May Flow

03. **Design Practices for non-irrigated parks, flood mitigation areas and roadways:**

- Use water harvesting/recycling whenever possible.
- Ensure that water is free of salts and contaminants toxic to trees.
- Plant trees and shrubs in drained low areas where water might naturally flow.
- Plant trees as much as possible in cultivated beds and in interconnected groups.
- Use mulches to conserve water - Organic mulches are preferred.
- Use of 20-gallon watering bags such as “Gator Bags” is encouraged as they appear to improve tree survival, quality and root penetration.

Example of Interconnected Group Planting of Trees and Shrubs

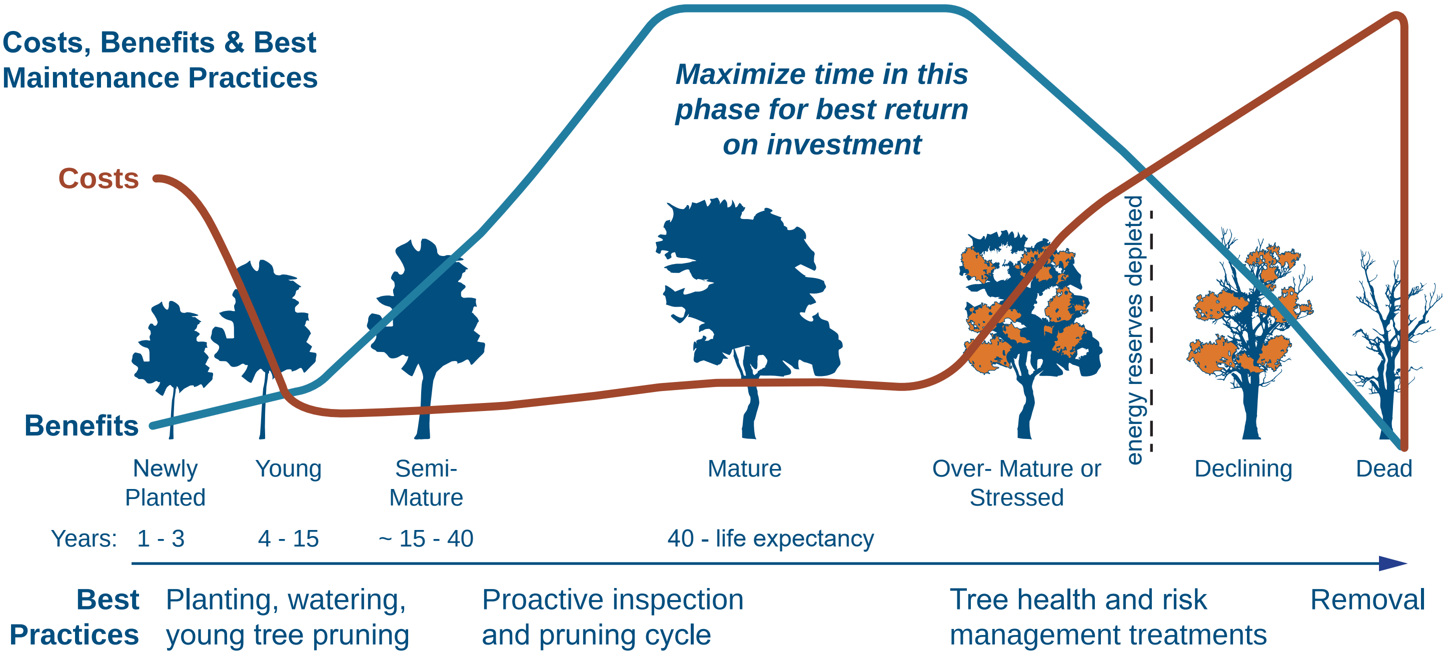


SECTION 4: DESIGNING FOR MAINTENANCE

01. Trees cost the most at the start and end of their lives and produce the greatest benefits in the middle when they are healthy and mature. Good tree planning, selection and maintenance maximizes each tree's healthy lifespan and minimizes how often the trees must be removed and replaced. Trees and shrubs have different requirements and are slower to grow and more permanent than most living landscape. Designs that provide optimal conditions for tree and shrub growth will have the longest lifecycle and lowest maintenance costs. However, it is likely that some trees and shrubs will die prematurely during their lifetimes, therefore, trees and shrubs must be designed to be easily replaced.

02. **Design Practices:**

- Consideration should be given to allow for equipment access and ancillary design elements should be readily obtainable.
- Designs should accommodate the easy removal and replacement of trees and shrubs or the design should be robust enough to accommodate losses without aesthetic or functional impact.
- Planting beds are preferred over single specimen tree wells.
- Use high canopy trees on roadways and medians where soft landscaping is deemed appropriate.
- Avoid discontinuous planting medium and small pockets of organic soils.
- Plant trees and shrubs where they would naturally grow.
- Understand individual species reproductive and growth patterns and choose the right plant for the right condition and desired outcome.



SECTION 5: DESIGNING FOR WINTER, SNOW AND DE-ICERS

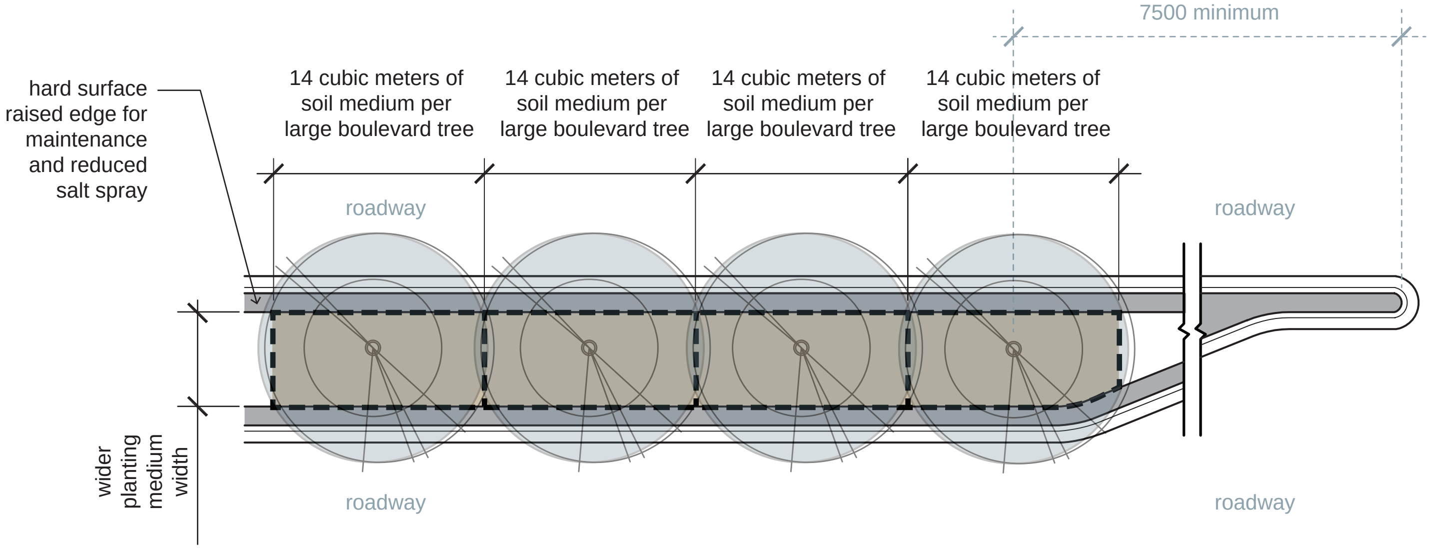
01. Winter is an inevitable part of Drumheller's climate. Winter brings with it the need to clear snow and de-ice streets and sidewalks. The prevailing cold winds are from the west and north, and these winds can be drying to plants. The winter sun can passively warm exposed trunks causing sunscald of young and thin-barked trees. Snow clearing activities can damage trees and vegetation, and road salts are toxic and destroy soil structure.

02. **Design Practices:**

- Consideration should be given to the placement of trees and shrubs in relation to winter weather phenomena and winter sun.
- Ensure that both trunk and root stocks are winter hardy for Drumheller's winter conditions.
- Avoid thin-barked trees in locations exposed to winter sun or winds. Possible mitigation to this situation would include sheltering trunks with medium height shrub beds or light reflective barriers applied to trunk.
- Plant conifers where shelter from northwest and southeast winds is desirable for users. For example, at outdoor seating areas, parking lots, sports fields, northwest and southeast corners of buildings.
- Avoid sighting coniferous trees in locations where they may shade paved surfaces and encourage icing. For example, do not place conifers along south side of pathways and sidewalks.
- Plant high canopy deciduous trees in locations where cooling summer shade and warming winter solar heating is desired. For example, at outdoor seating areas, around benches and playgrounds or tot lots, adjacent to southern exposure of residences and buildings.
- Hard landscaping is preferred within areas adjacent to roadways subject to intensive ice and snow management activities. These include intersections, hills, school zones, bus routes, expressways, arterials and medians.

- If soft landscaping is to be used on medians, designs are to mitigate damaging from de-icers and snow removal on the vegetation by employing the following techniques:
  - A vertical barrier to deflect the salt splash and gravel thrown away from the tree planting strip and back on to the road.   A typical solution is a barrier is placed behind a concrete strip that acts as snow storage or a splash pad. In the past the barrier has been a low concrete wall. Consideration must be given to road speed and vehicle safety in design of barrier.
  - A horizontal barrier to keep salt from contacting the soil. Typically, this is a layer of bark mulch.
  - Sufficient water must be available to flush out salts on an annual basis. Typically, this is some form of irrigation such as a grid of dripline. Also, refer to designing for maintenance for sustainable boulevard planting, page 16.
  - Use salt tolerant species near the roadway.

Sustainable Median Planting for Snow



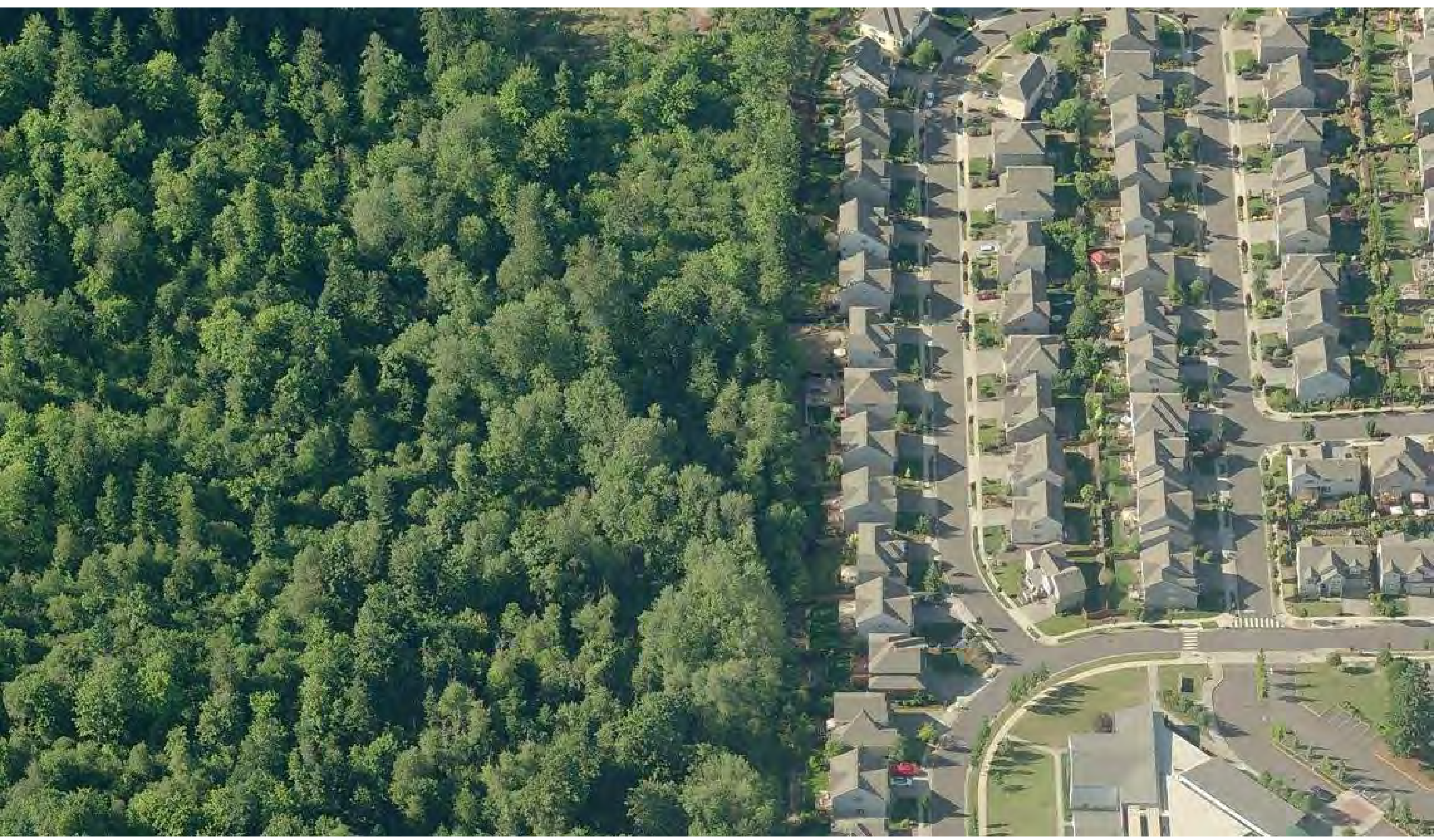
SECTION 7: STEWARDSHIP OF THE URBAN FOREST

01. **How the Public can Assist with the Health of the Urban Forest**

Stewardship of our urban forest is important for the long-term health and vitality of our communities and the people living within them. Stewardship can take on many forms such as participating in an educational program about our natural environment, reporting trees that appear diseased or unsafe, citizen science management and monitoring or volunteering in community forestation initiatives.

There are some simple things that the public can do to assist with the health and quality of the urban forest:

- During hot, dry weather, assist by watering boulevard trees. Twice a week water the roots of trees near private property with up to 20 litres of water – this would be about 5 to 10 minutes of slow running water from a hose, or a couple of large watering cans full of water.
- Comply with open fire bans and fire danger ratings, and practice forest fire safety to protect our forests.
- Be aware of young, stressed trees adjacent to private property – usually indicated by leaves turning brown prematurely or falling prematurely. Report concerns to Town of Drumheller.



02. **The Urban Forest's End of Life Cycle**

Trees as with all living things, live for a roughly pre-determined length of time. Cottonwoods and their kin the poplars and aspens are fast growing and quick to establish, living upwards of 80 years - some live a little longer. When trees begin to senesce they outgrow their ability to obtain enough resources to stay alive. As the tree's ability to self-maintain falls further behind, it becomes more susceptible to disease, pests, storms and other natural predators. The fallen tree is important to ecosystems however, as micro-organisms and insects break it down into useable nutrients and organic matter that increase soil fertility and provide food for numerous species of fungi, lichen, plants, insects, animals etc.

Tree trunks have other uses once they have fallen, and can continue to contribute to the landscape in new ways. Natural furniture carved out of stumps and longer sections of trunk can provide interesting elements in the landscape. Smaller logs can be used for elements in natural playgrounds such as jump steppers and climbing apparatus. Mulch can be created to help with water retention in soft landscape areas.

Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide (CO_2).

CO_2 is the most common greenhouse gas produced by human activities. [1]

Trees naturally sequester CO_2.

The amount of CO_2 sequestered by a tree will vary depending on its species, growth rate, the density of its wood, its location and the life stage of the tree.

Nevertheless, there are various ways to estimate the amount of CO_2 sequestered by a tree.

The following method has been used to estimate the amount of CO_2 sequestered by a tree. [2]

Example of CO_2 calculation

Tree details:

10 years old
15 feet tall ("H")
8 inch trunk ("D")

1 inch = 25.4 mm

1 foot = 0.3048 m

1 lbs = 0.453592 kg

step 1

Wabove-ground= 0.25 D^2 H

= 0.25(82)(15) = 240 lbs

Wtotal green weight = 1.2* Wabove-ground

= 1.2 * 240 = 288 lbs

step 2

Wdry weight = 0.725 * Wtotal green weight

= 0.725 * 288 = 208.8 lbs

step 3

Wcarbon = 0.5 * Wdry weight

= 0.5 * 208.8 = 104.4 lbs

step 4

Wcarbon-dioxide = 3.67 * Wcarbon

= 3.67 * 104.4

= 383.5 lbs CO_2 sequestered in 10 years

step 1

calculate total green weight of the tree

The green weight is the weight of the tree when it is alive. First you have to calculate the green weight of the above-ground weight as follows[3]:

Wabove-ground= 0.25 D^2 H (for trees with D<11)

Wabove-ground= 0.15 D^2 H (for trees with D>11)

Wabove-ground= Above-ground weight in pounds

D = Diameter of the trunk in inches
H = Height of the tree in feet

The root system weight is about 20% of the above-ground weight. Therefore, to determine the total green weight of the tree, multiply the above-ground weight by 1.2:

Wtotal green weight = 1.2* Wabove-ground

step 2

Determine the dry weight of the tree

The average tree is 72.5% dry matter and 27.5% moisture[4]. Therefore, to determine the dry weight of the tree, multiply the total green weight of the tree by 72.5%.

Wdry weight = 0.725 * Wtotal green weight

step 3

Determine the weight of carbon in the tree

The average carbon content is generally 50% of the tree's dry weight total volume [5] . Therefore, in determining the weight of carbon in the tree, multiply the dry weight of the tree by 50%.

Wcarbon = 0.5 * Wdry weight

step 4

Determine the weight of carbon dioxide in the tree

CO_2 has one molecule of Carbon and 2 molecules of Oxygen. The atomic weight of Carbon is 12 (u) and the atomic weight of Oxygen is 16 (u). The weight of CO_2 in trees is determined by the ratio of CO_2 to C is 44/12 = 3.67.

weight of carbon dioxide = 3.67 * (weight of carbon)

[1]U.S. Geological Survey,www.usgs.gov

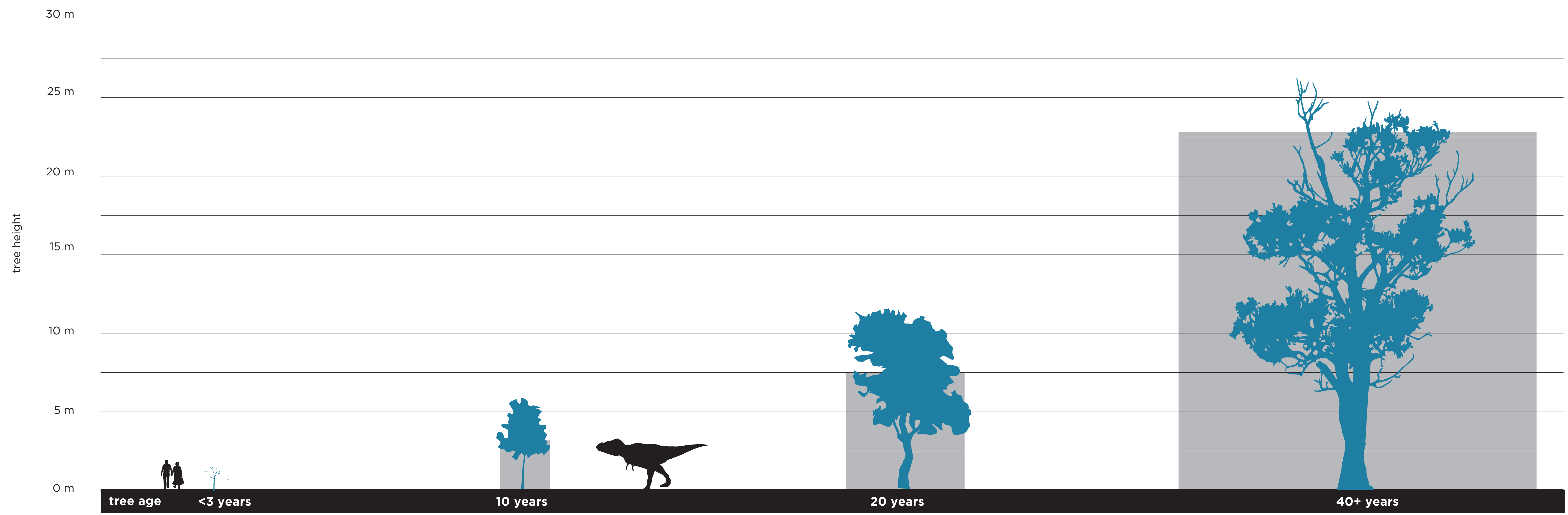
[2] Method adapted from EcoMatcher.com

[3] Total-Tree Weight, Stem Weight, and Volume Tables for Hardwood Species in the Southeast," Alexander Clark III, Joseph R. Saucier, and W. Henry McNab, Research Division, Georgia Forestry Commission, January 1986.

[4]"Heating With Wood: Producing, Harvesting and Processing Firewood," Scott DeWald, Scott Josiah, and Becky Erdkamp, University of Nebraska – Lincoln Extension, Institute of Agriculture and Natural Resources, March 2005.

[5]Carbon sequestration: how much can forestry sequester CO2?, Egbuche, Christian. Forestry Research and Engineering: International Journal. 2018.

assumed amount of CO_2 sequestered by a tree at various life stages



sapling

height: 1.2 m
trunk diameter: 10 mm
CO_2 sequestered: 0.1 kg (lifespan)
CO_2 sequestered: 0.05 kg (annual avg.)

**assumed age of 2 years*

young tree

height: 6.0 m
trunk diameter: 170 mm
CO_2 sequestered: 159.6 kg (lifespan)
CO_2 sequestered: 16.0 kg (annual avg.)

**assumed age of 10 years*

early mature tree

height: 12.0 m
trunk diameter: 370 mm
CO_2 sequestered: 907.3 kg (lifespan)
CO_2 sequestered: 45.4 kg (annual avg.)

**assumed age of 20 years*

mature tree

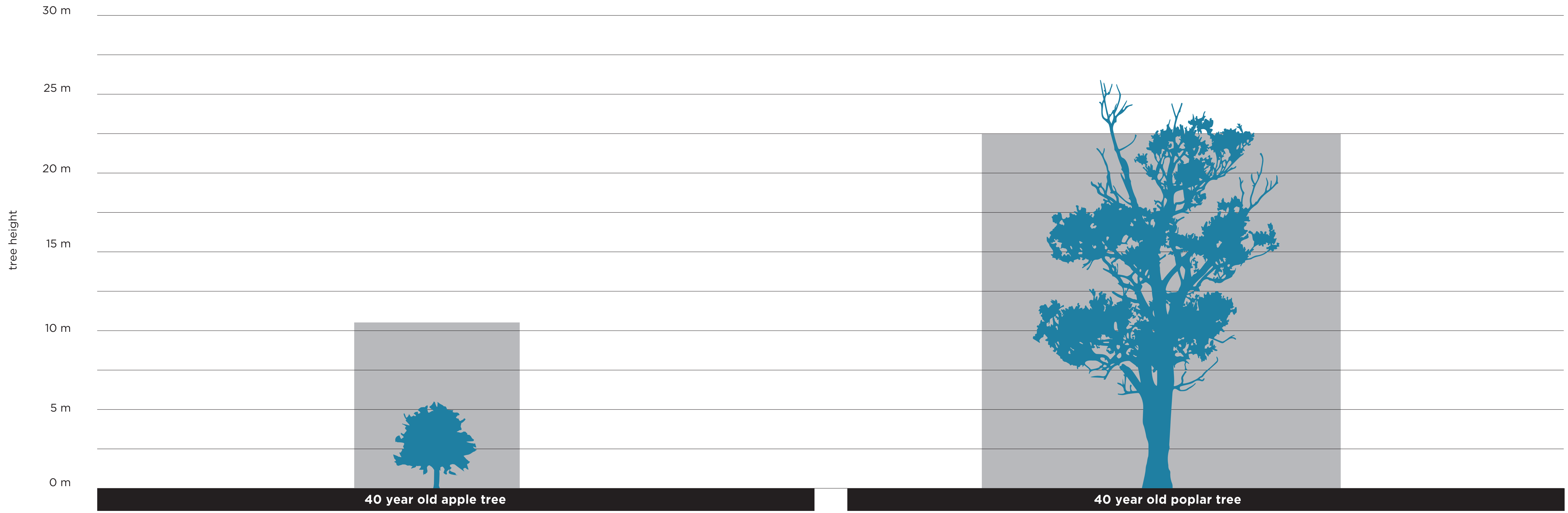
height: 25.0 m
trunk diameter: 775 mm
CO_2 sequestered: 8291.7 kg (lifespan)
CO_2 sequestered: 207.3 kg (annual avg.)

**assumed age of 40 years*

amount of CO_2 sequestered by tree over lifespan ($1\ mm^2 = 1$ kg)

** represented species Populus balsamifera* (balsam poplar)
** assumed growth rate of 600 +/- mm height per year*
** assumed growth rate of 20 mm diameter per year*
** albertasaurus for scale*

example of amount of CO_2 sequestered by different tree species



mature ornamental tree

height: 5.0 m
trunk diameter: 800 mm
CO_2 sequestered: 1767.3 kg (lifespan)
CO_2 sequestered: 44.2 kg (annual avg.)

** assumed Malus species*
assumed age of 40 years

mature native tree

height: 25.0 m
trunk diameter: 775 mm
CO_2 sequestered: 8291.7 kg (lifespan)
CO_2 sequestered: 207.3 kg (annual avg.)

**assumed Populus species*
assumed age of 40 years

amount of CO_2 sequestered by tree over lifespan (1 mm^2 = 1 kg)

assumed replacement CO_2 sequestration equivalents for a 20 year old tree *

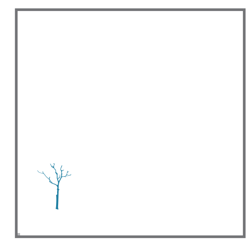
907 kg of CO2 sequestered

1 x early mature tree removed

height: 12.0 m
trunk diameter: 370 mm
CO_2 sequestered: 907.3 kg (lifespan)
CO_2 sequestered: 45.4 kg (annual avg.)

assumed age of 20 years

0.1 kg of CO_2 sequestered



1 x replacement sapling

height: 1.2 m
trunk diameter: 10 mm
CO_2 sequestered: 0.1 kg (lifespan)
CO_2 sequestered: 0.05 kg (annual avg.)

assumed age of 2 years

1226 kg of CO_2 sequestered

1 x early mature tree

height: 13.2 m
trunk diameter: 410 mm
CO_2 sequestered: 1226 kg (lifespan)
CO_2 sequestered: 55.7 kg (annual avg.)

assumed age of 22 years

time of planting — 20 years later

907 kg of CO_2 sequestered

1 x early mature tree removed

height: 12.0 m
trunk diameter: 370 mm
CO_2 sequestered: 907.3 kg (lifespan)
CO_2 sequestered: 45.4 kg (annual avg.)

assumed age of 20 years

13.5 kg of CO_2 sequestered

1 x replacement 70 mm caliper trees

height: 3.0 m
trunk diameter: 70 mm
CO_2 sequestered: 13.5 kg (lifespan)
CO_2 sequestered: 2.7 kg (annual avg.)

assumed age of 5 years

1829 kg of CO_2 sequestered

1 x mature trees

height: 15.0 m
trunk diameter: 470 mm
CO_2 sequestered: 1829 kg (lifespan)
CO_2 sequestered: 73.2 kg (annual avg.)

assumed age of 25 years

☐ amount of CO_2 sequestered by removed tree for reference

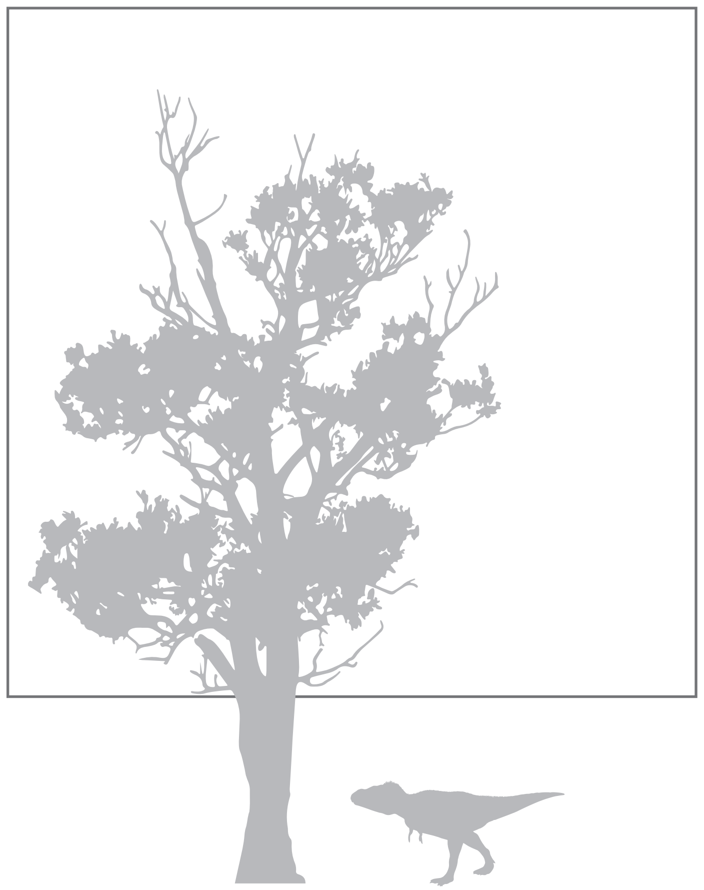
■ amount of CO_2 sequestered by tree over lifespan

* *represented species Populus balsamifera* (balsam poplar)
assumed growth rate of 600 +/- mm height per year
assumed growth rate of 20 mm diameter per year
albertasaurus for scale

assumed replacement CO_2 sequestration equivalents for a 40 year old tree * - sapling replacement

time of planting | 20 years later

8290 kg of CO_2 sequestered

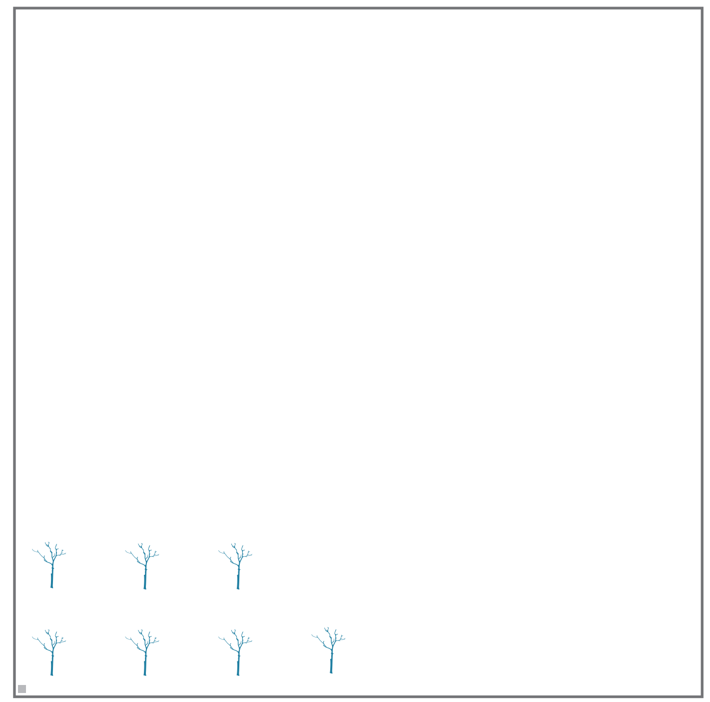


1 x mature tree removed

height: 25.0 m
trunk diameter: 775 mm
CO_2 sequestered: 8291.7 kg (lifespan)
CO_2 sequestered: 207.3 kg (annual avg.)

**assumed age of 40 years*

0.7 kg of CO_2 sequestered

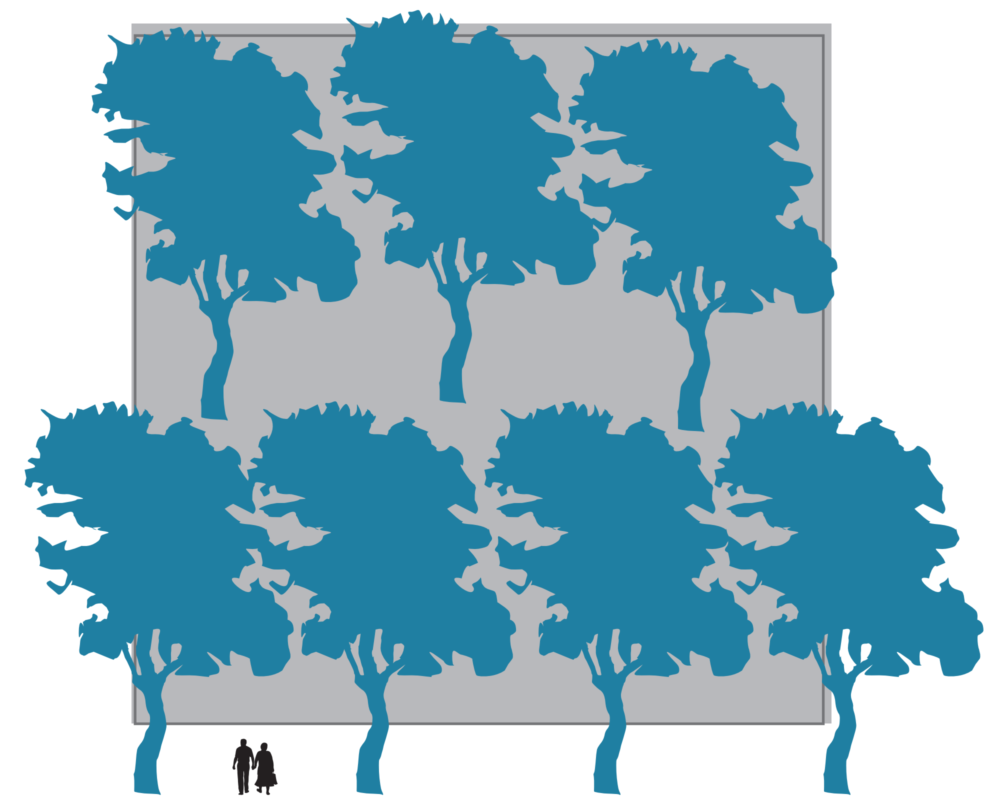


7 x saplings planted as replacement

height: 1.2 m
trunk diameter: 10 mm
CO_2 sequestered: 0.1 kg (lifespan)
CO_2 sequestered: 0.05 kg (annual avg.)

**assumed age of 2 years*

8582 kg of CO_2 sequestered



7 x early mature trees

height: 13.2 m
trunk diameter: 410 mm
CO_2 sequestered: 1226 kg (lifespan)
CO_2 sequestered: 55.7 kg (annual avg.)

**assumed age of 22 years*

☐ amount of CO_2 sequestered by removed tree for reference

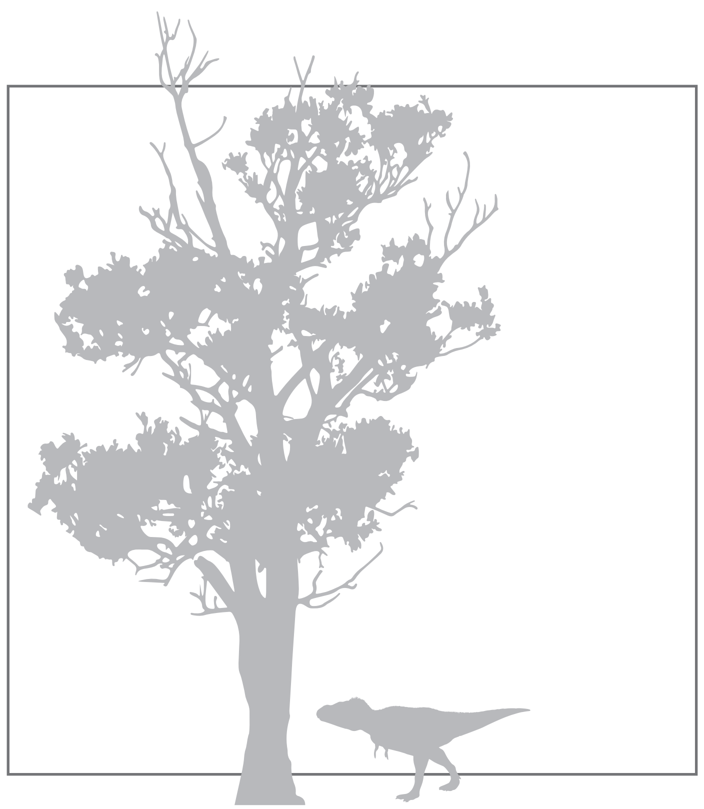
■ amount of CO_2 sequestered by tree over lifespan

** represented species Populus balsamifera* (balsam poplar)
assumed growth rate of 600 +/- mm height per year
assumed growth rate of 20 mm diameter per year
albertasaurus for scale

assumed replacement CO_2 sequestration equivalents for a 40 year old tree * - 70 mm caliper replacement

time of planting | 20 years later

8290 kg of CO_2 sequestered

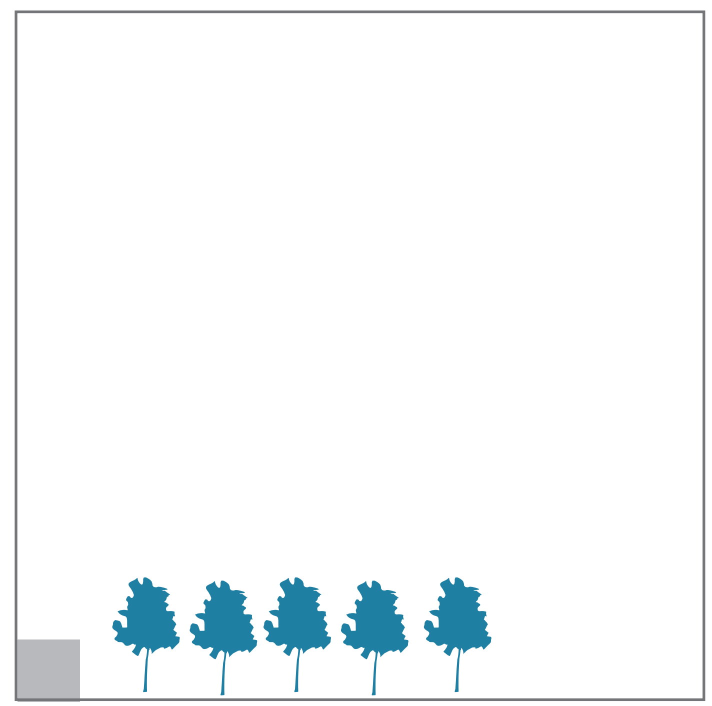


1 x mature tree removed

height: 25.0 m
trunk diameter: 775 mm
CO_2 sequestered: 8291.7 kg (lifespan)
CO_2 sequestered: 207.3 kg (annual avg.)

**assumed age of 40 years*

67.5 kg of CO_2 sequestered

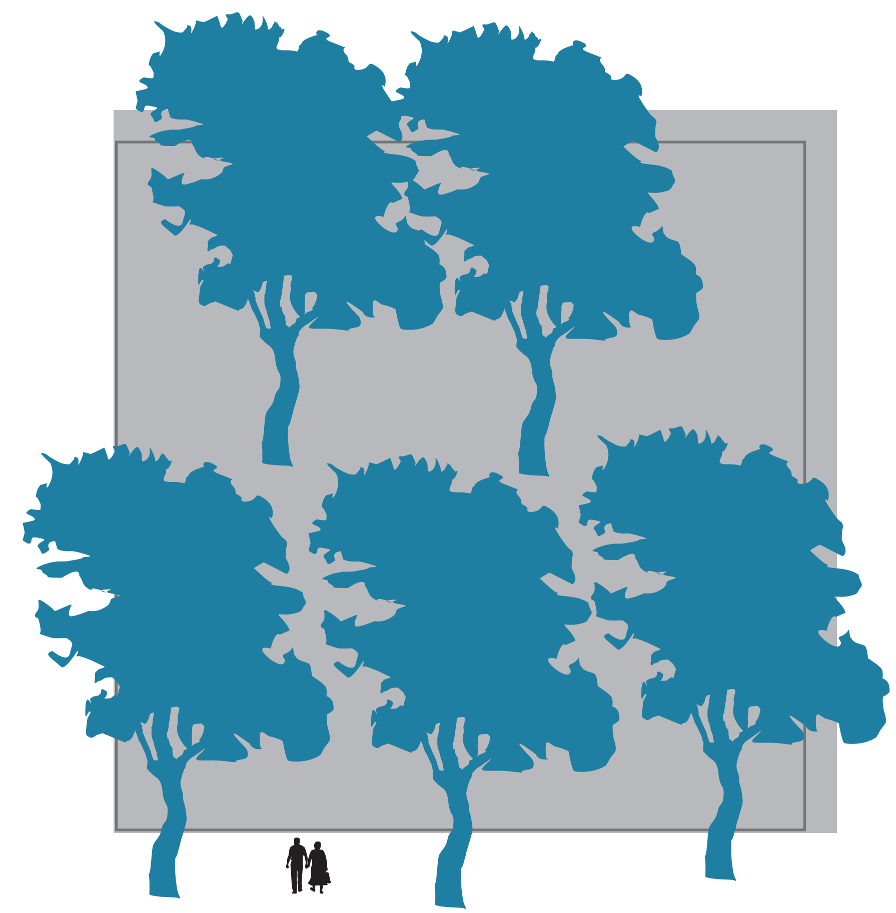


5 x 70 mm caliper trees

height: 3.0 m
trunk diameter: 70 mm
CO_2 sequestered: 13.5 kg (lifespan)
CO_2 sequestered: 2.7 kg (annual avg.)

**assumed age of 5 years*

9145 kg of CO_2 sequestered



5 x mature trees

height: 15.0 m
trunk diameter: 470 mm
CO_2 sequestered: 1829 kg (lifespan)
CO_2 sequestered: 73.2 kg (annual avg.)

**assumed age of 25 years*

☐ amount of CO_2 sequestered by removed tree for reference

■ amount of CO_2 sequestered by tree over lifespan

** represented species Populus balsamifera* (balsam poplar)
assumed growth rate of 600 +/- mm height per year
assumed growth rate of 20 mm diameter per year
albertasaurus for scale

DRUMHELLER VALLEY