Drumheller Valley

Preserving & Enhancing the Urban Forest: Standards & Techniques

November 2021

DRUMHELLER VALLEY

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SECTION 1: INTRODUCTION

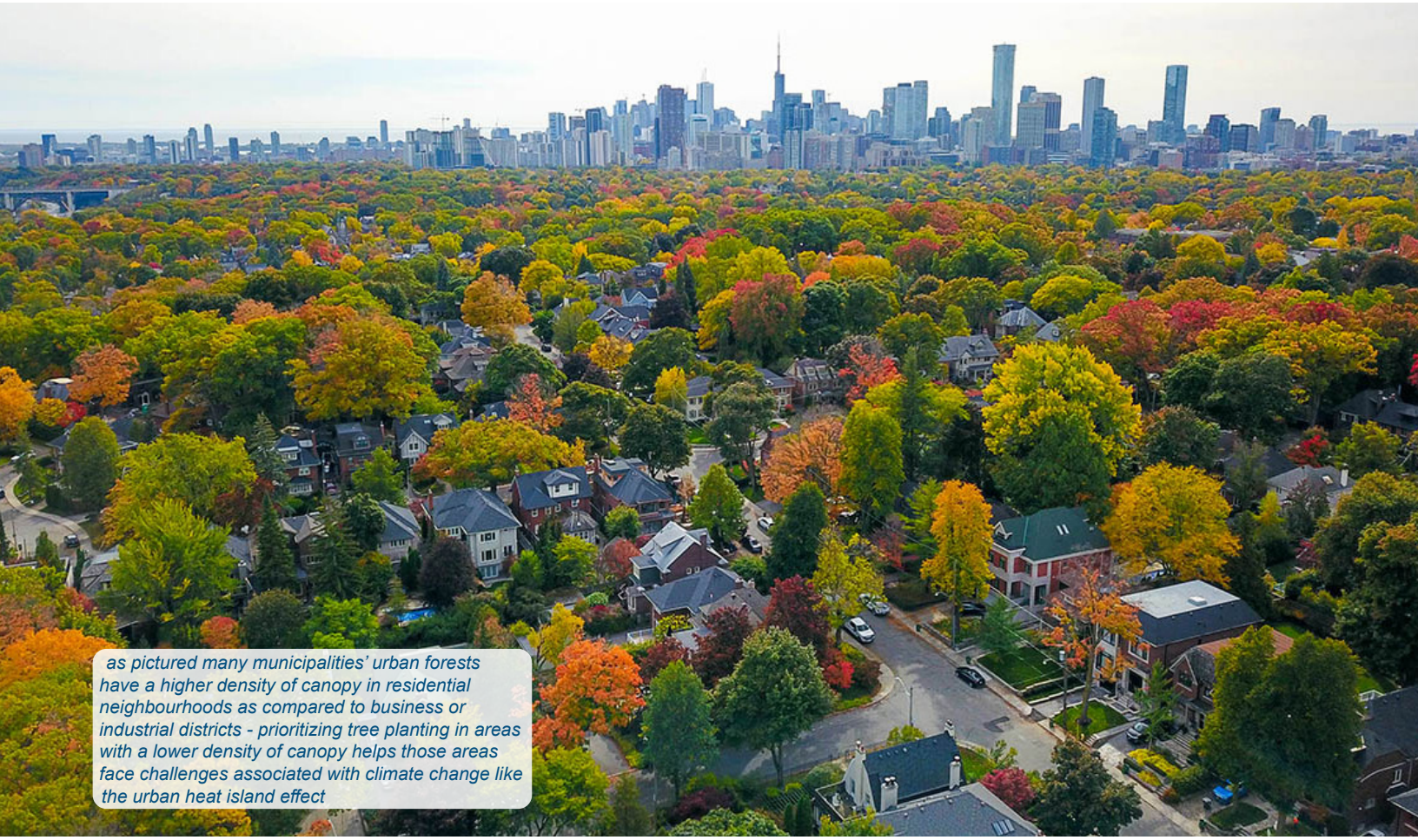
an urban forest along a river

urban forests connect urban areas with nature

the spine of Drumheller's urban forest is the valley

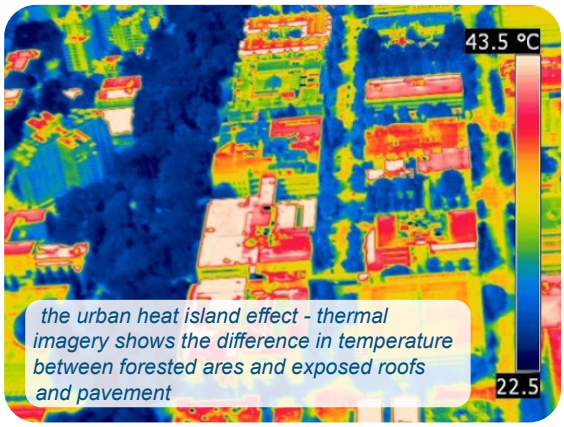
01. **What is the Urban Forest?** The urban forest is defined as ecosystems composed of trees and other vegetation that provide cities and municipalities with environmental, economic and social benefits. They include street and yard trees, vegetation within parks and along public rights of way, water 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.

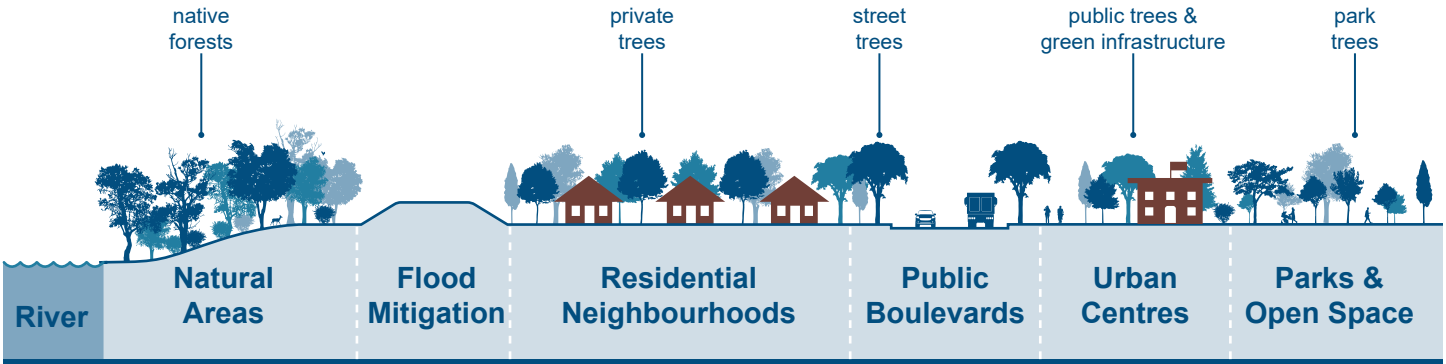


as pictured many municipalities' urban forests have a higher density of canopy in residential neighbourhoods as compared to business or industrial districts - prioritizing tree planting in areas with a lower density of canopy helps those areas face challenges associated with climate change like the urban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

preserving forested areas, and the benefits they provide, is integral to the long term sustainability of communities

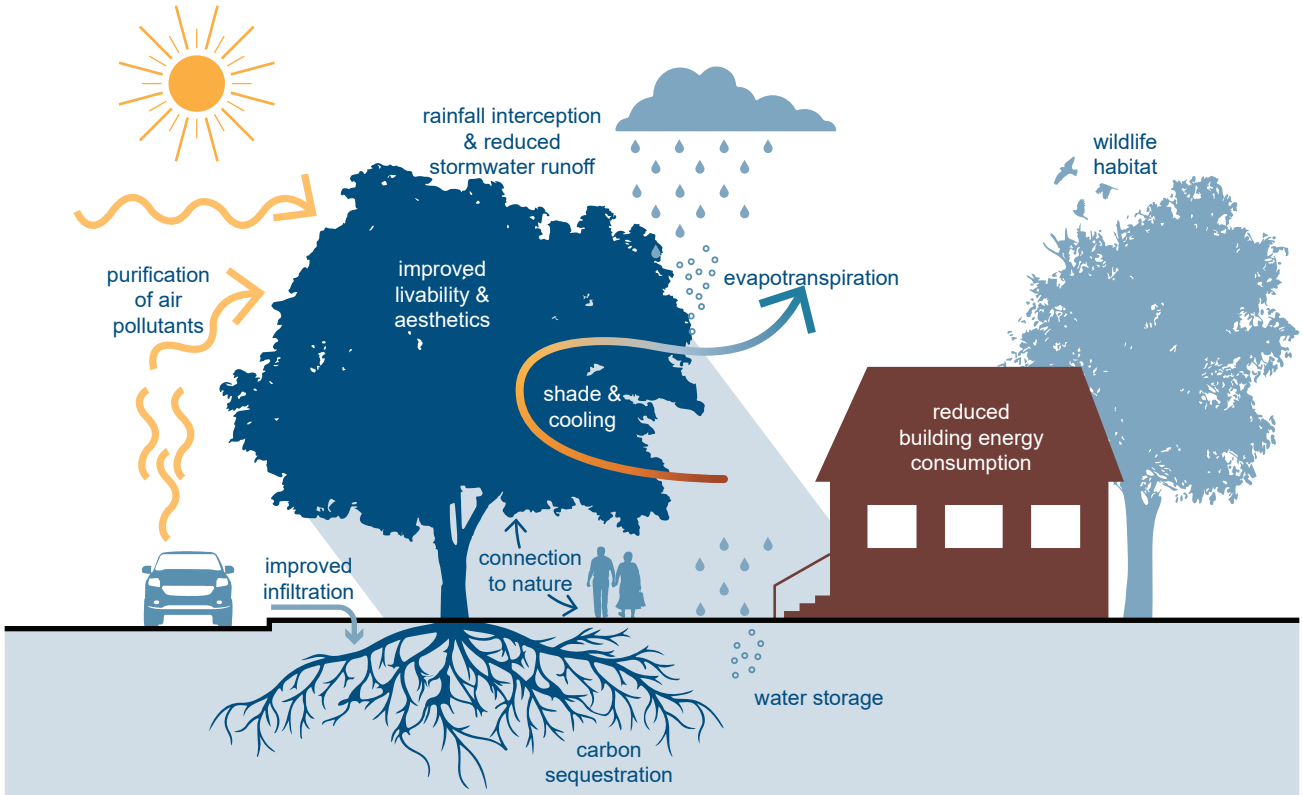


the urban heat island effect - thermal imagery shows the difference in temperature between forested ares and exposed roofs and pavement



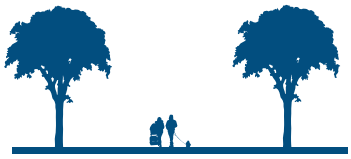
Components of the Drumheller Urban Forest

Benefits of a Healthy Urban Forest

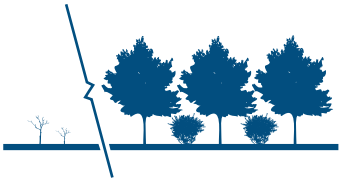


02. **Primary objectives of the Landscape Strategy are to ensure that the public lands and Urban Forest:**

- 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



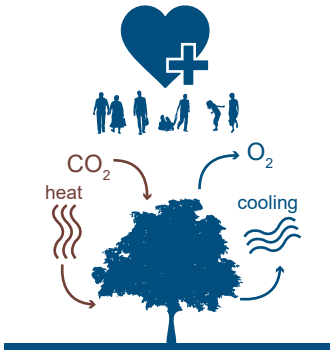
Open Space



Enhanced Aesthetics

Preserve Existing Trees

Leadership Through Sustainability

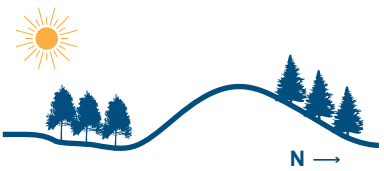


Healthy Community & Healthy Trees

Responsible Management of Public Funds

Improved Pedestrian Experience

Enhanced Habitat



Right Tree in The Right Place

Healthy Trees

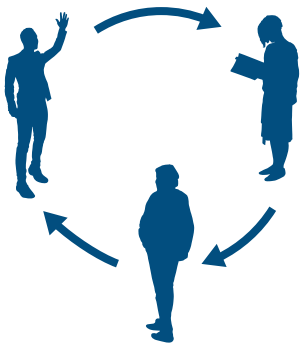
03. To achieve these objectives, **outcome based guidelines** regarding the design and construction of public lands, parks and roadway landscaping shall be considered. Support for targeted results will be a key measure of designs, materials and construction practices.

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.

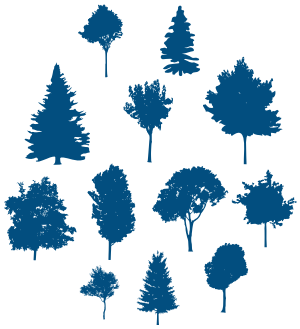
Sustainable Urban Forest

Valued by Community



Collaboration

25-50
Year Life Span



Diversity of Genus, Species & Cultivars

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.
- For dike construction, the tree replacement will be at a 5:1 ratio – the replacements can include trees or shrubs.
- Rapid carbon sequestration replacement for tree removals due to dike construction. Carbon sequestration information in Appendix A.
- The total vegetation biomass should be sufficient to offset 0.5% of the valley's carbon emissions.

1 x Removed

5:1

5 x Replaced

+ 1%
Per Decade

a residential neighbourhood nestled in the urban forest

Protect & Preserve

mature trees protected with tree fencing during construction

06. **The construction practices that support the plans outcomes and targets are:**

- Protect remnant forests and natural ecosystems within natural environment parks.
- Transitions from native forest to built form should be sensitive to the needs of the forest and human environment.
- Encourage the preservation of intact ecosystems.
- Plant trees and shrubs that comply whenever possible with the Canadian Nursery Certification Institute's Domestic Phytosanitary Certification Program standards for tree purchases and supply.
- Tree preservation is a priority in the designs for new development.

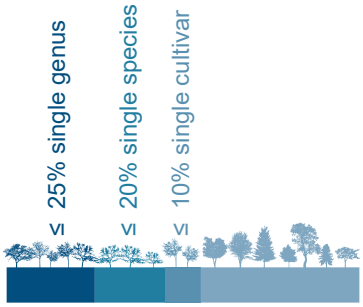
An Intact Ecosystem is an unbroken expanse of natural ecosystems within the zone of existing natural or naturalized area extent, showing no signs of significant human activity and large enough that all native biodiversity, including viable populations of wide-ranging species, could be maintained.

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:**

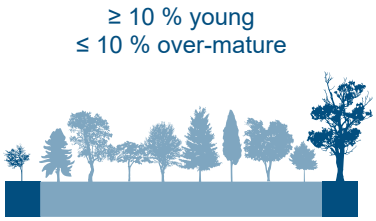
- Tree age class targets for established communities should be that no more than 10% of the trees are over-mature and no less than 10% of trees are young.
- The species diversity for trees planted in groomed parks, and near dikes and roadways should be that no more than 25% of trees represent any one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



Species Diversity Target

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.



Tree Age Class Target

04. **Guidelines and Specifications:**

- Designs should contribute to diversity targets.
- Total proportions of tree species and varieties selected to be planted on public land are to be reported on landscaping plans and approved by administration.
- Number of trees and shrubs are to be reported on plans. See Appendix D for example of planting plan.

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

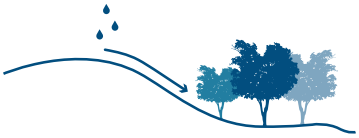
01. Drought is a normal part of Drumheller's climate. Natural moisture levels are not sufficient to sustain most species of trees without supplemental watering. The ability of trees to survive predictable and inevitable drought cycles and to better conserve soil moisture need to be addressed in any sustainable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

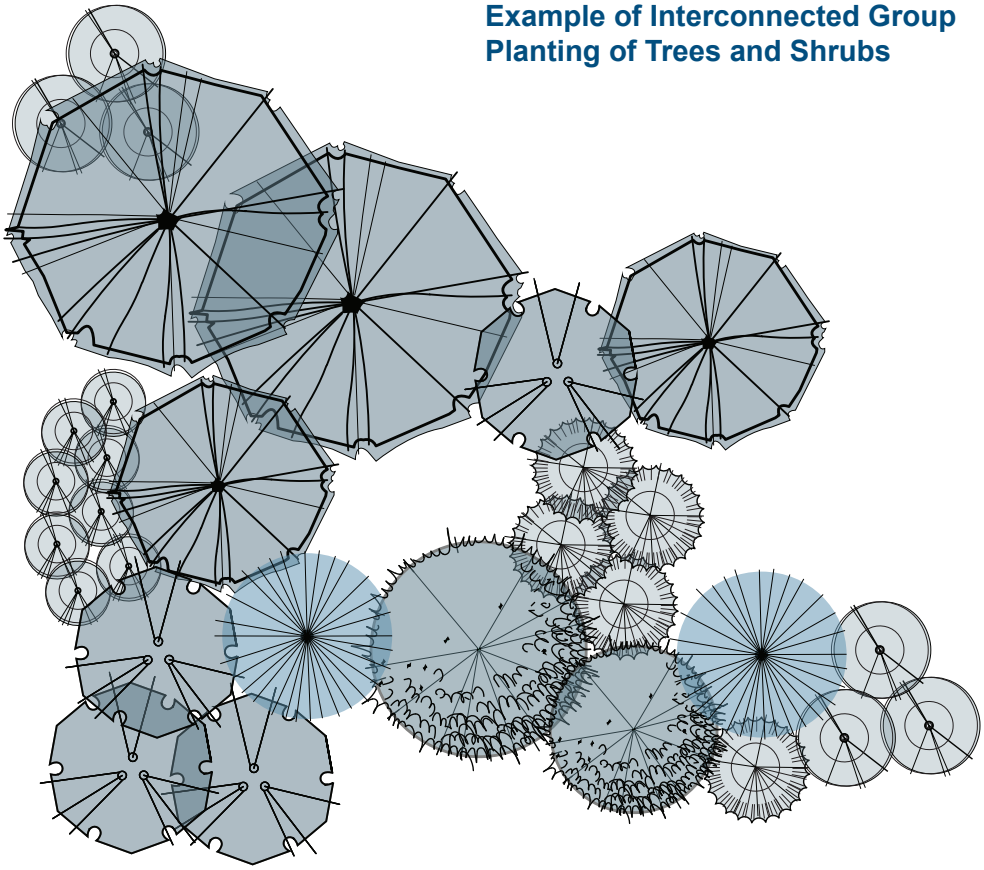
03. **Design Practices for non-irrigated parks, flood mitigation areas and roadways:**

- 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.

04. **Guidelines and Specifications**

- Within irrigated sites, trees shall be separately zoned from turf areas.

Example of Interconnected Group Planting of Trees and Shrubs

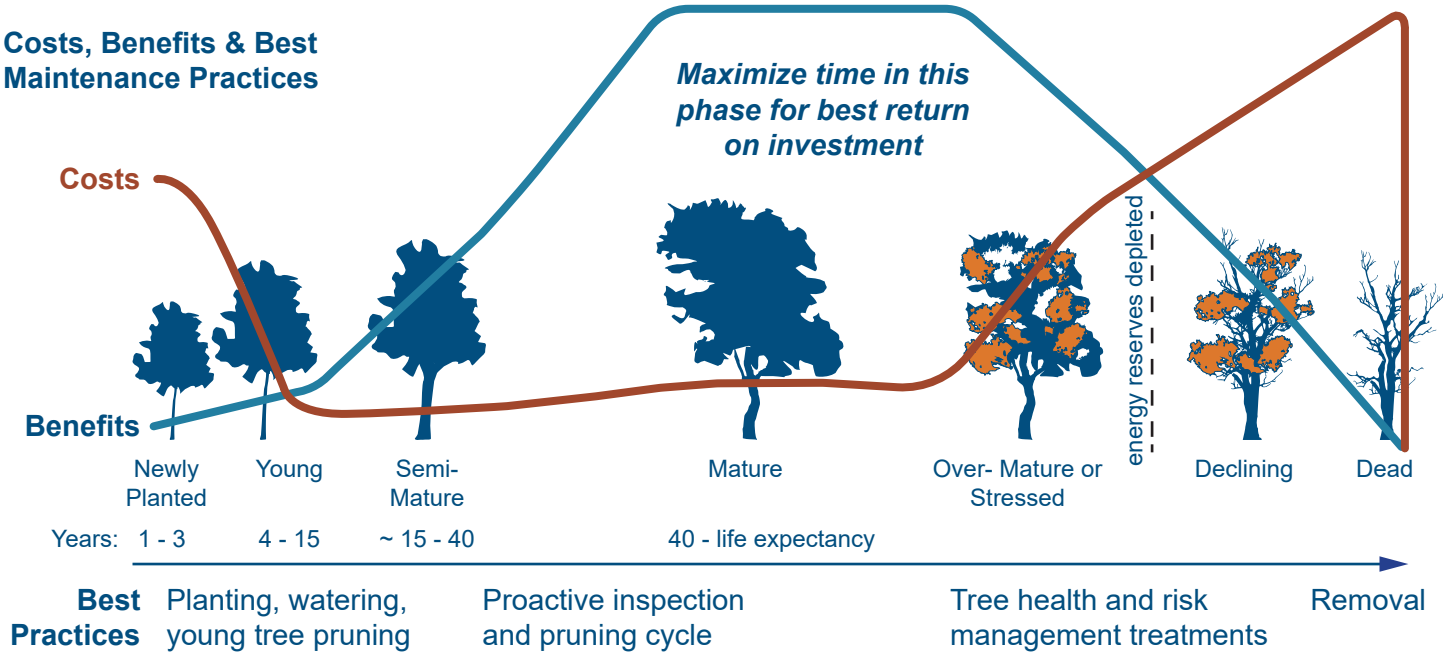


SECTION 4: DESIGNING FOR MAINTENANCE

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. Refer to planting lists – **significant characteristics and environments best suited** (Appendix B+C) columns for information on specific plants.



Pruning of Plants & Removal of Invasive Species

Ease of Access

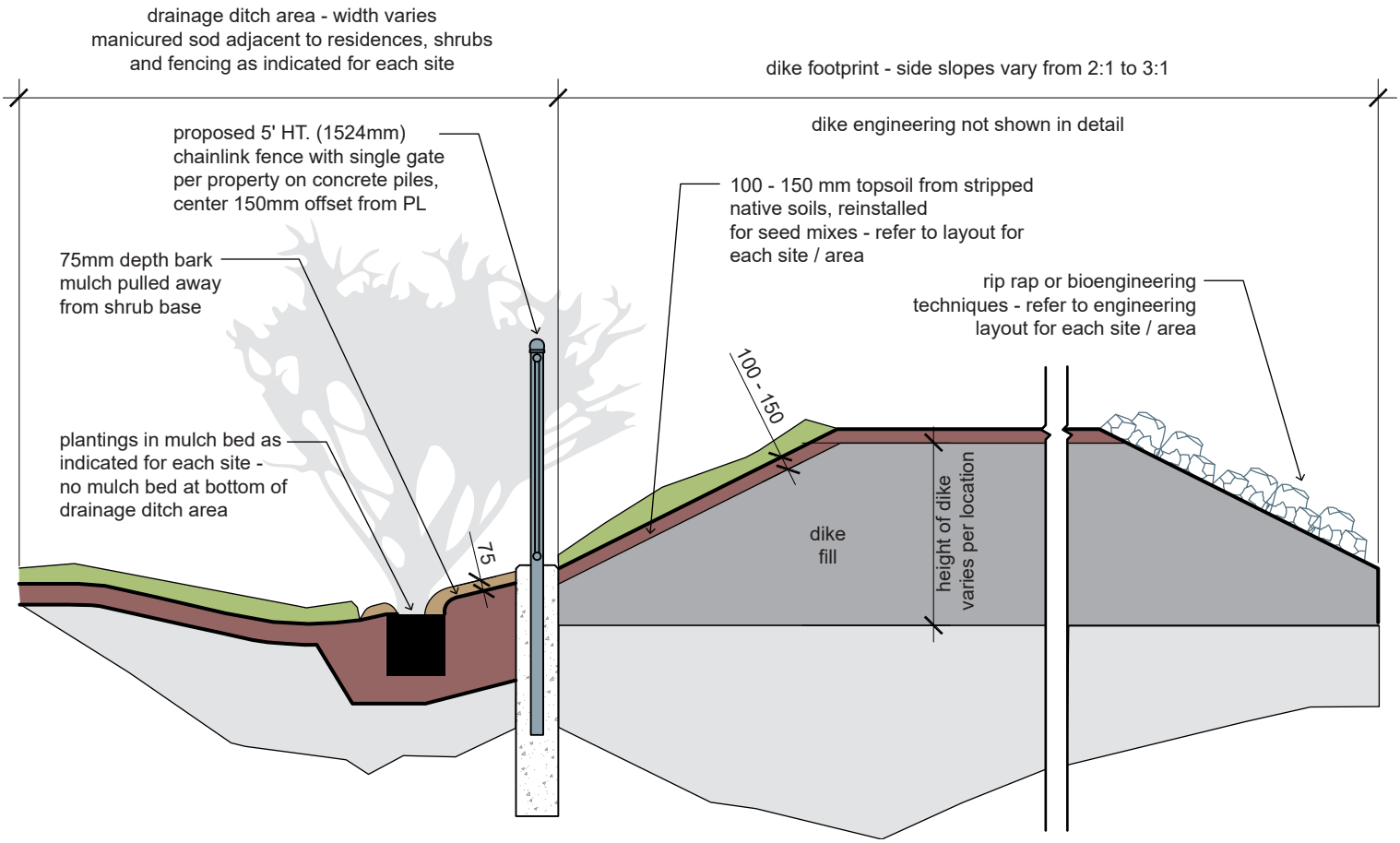
Ease of Replacement

03. Guidelines and Specifications

For sustainable dike landscaping provide the following:

- Minimum of 10 cubic meters of sandy loam soil per tree with tree planting, with 50% allowable shared soil volume.
- Provide a means of supplementary water capable of sustaining trees in optimum health.
- Provide plantings on lower side slopes of dike to take advantage of passive irrigation.
- Provide mulch at base of trees and shrub areas were appropriate. Where mulch is not appropriate, provide native seed mixes or native sod transplants.
- Provide maintenance with special attention to trees when they are young so that structural defects can be addressed early. Prune for structure to reduce long term maintenance and improve wind resistance.
- Control invasive species that degrade ecosystems.
- Utilize and continually update integrated pest management policies to address current and future threats to the urban forest.
- No tree planting within dike fill.

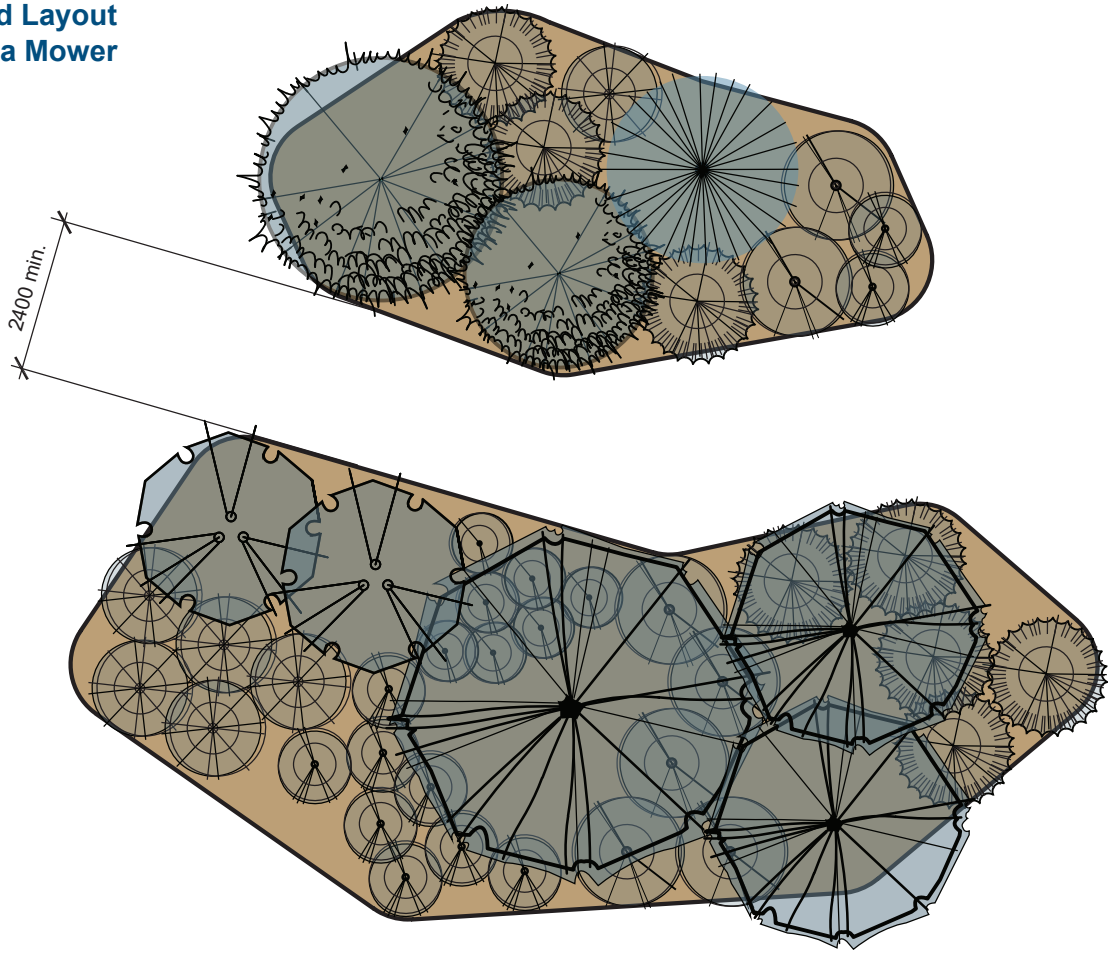
Dike Planting with Fencing Adjacent to Private Residences



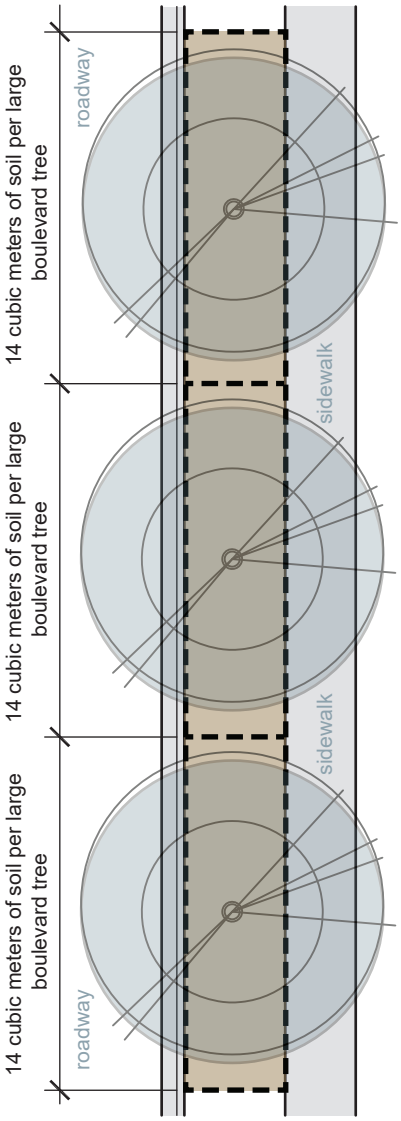
For sustainable park and open space landscaping provide the following:

- Minimum of 10 cubic meters of sandy loam soil per tree with tree planting. If the tree is in a constrained area without adjacent existing soils, increase this volume to 20 cubic meters.
- Provide a means of supplementary water capable of sustaining trees in optimum health.
- Rain gardens or low-lying planting are encouraged to take advantage of passive irrigation.
- Beds and clusters are to be located a sufficient distance away from each other and other obstacles and intrusions to allow passage of a wide area mower between them – approximately 2.4 meters is sufficient (92”).
- Provide maintenance with special attention to trees when they are young so that structural defects can be addressed early. Prune for structure to reduce long term maintenance and improve wind resistance.
- Control invasive species that degrade ecosystems.
- Utilize and continually update integrated pest management policies to address current and future threats to the urban forest.
- Provide organic mulch where possible in planting beds.

Example of Planting Bed Layout with Room for Wide Area Mower



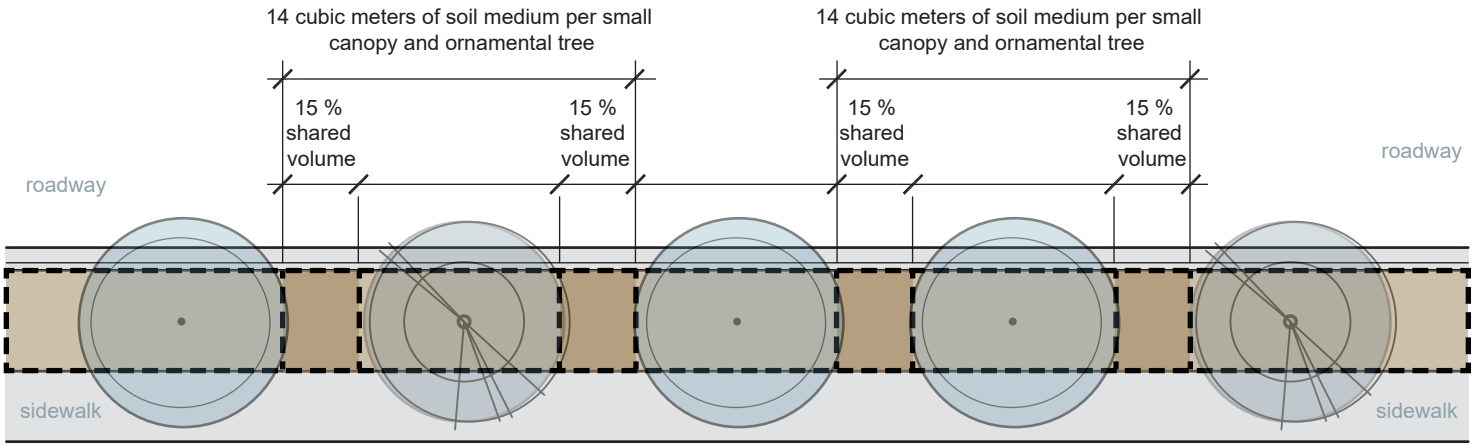
Sustainable Planting for Large Boulevard Trees (within Road R.O.W.)



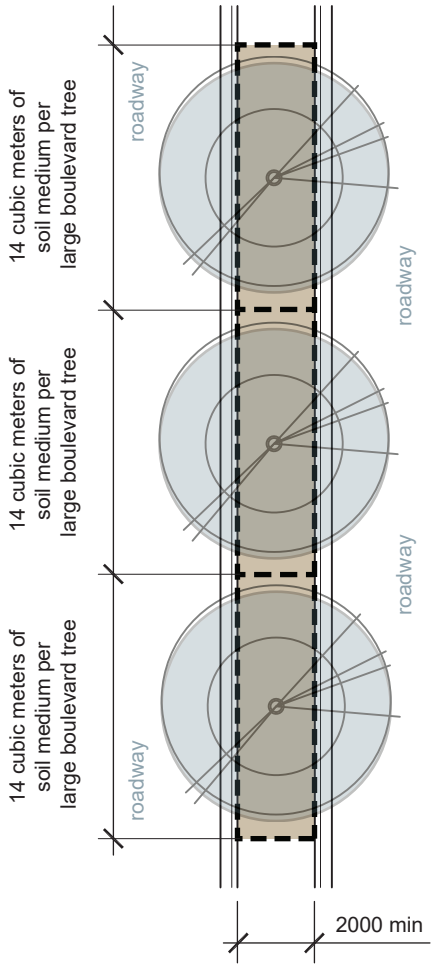
For sustainable sidewalk boulevard planting (within road right-of-way) provide the following:

- Minimum of 14 cubic meters of sandy loam soil per tree, with 30% shared soil volume for small canopy and ornamental trees.
- Provide a means of supplementary water capable of sustaining trees in optimum health.
- Provide a means of supplementary water capable of delivering 30 gallons of water per tree per day in spring to flush salts from soil profile. Flushing should occur after last ice event, but before plants bud out. Repeat 2-3 times. Also wash tree canopy at this time.
- Trees selected for uses next to vehicle lanes should have a structure that allows them to eventually be pruned to a minimum 4.25 meter clearance.
- Trees selected for uses next to pedestrian routes should have a structure that allows them to eventually be pruned to a minimum 2.4 meter clearance.
- Take visibility triangles into consideration for plant location – visibility triangles should be based on design speed of road.
- Provide maintenance with special attention to trees when they are young so that structural defects can be addressed early. Prune for structure to reduce long term maintenance and improve wind resistance.
- Control invasive species that degrade ecosystems.
- Utilize and continually update integrated pest management policies to address current and future threats to the urban forest.
- Provide organic mulch at base of trees.

Sustainable Planting for Small Canopy and Ornamental Trees (within Road R.O.W.)



Sustainable Planting for Median Landscaping



For sustainable median landscaping provide the following:

- Minimum of 14 cubic meters of sandy loam soil per tree (2 meters x 7 meters x 1 meter).
- Provide a means of supplementary water capable of sustaining trees in optimum health.
- Provide a means of supplementary water capable of delivering 30 gallons of water per tree per day in spring to flush salts from soil profile.
- Water harvesting and/or rain gardens are encouraged.
- Watering with tanker trucks is the least preferred option.
- Avoid planting trees in medians or islands narrower than 2 meters wide.
- Take visibility triangles into consideration for plant location – visibility triangles should be based on design speed of road.
- If trees and shrubs are used, they must be a minimum of 7.5 meters from the bull nose or back of walk through the island, whichever is greater, adjacent to primary streets.
- Provide maintenance with special attention to trees when they are young so that structural defects can be addressed early. Prune for structure to reduce long term maintenance and improve wind resistance.
- Control invasive species that degrade ecosystems.
- Utilize and continually update integrated pest management policies to address current and future threats to the urban forest.

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

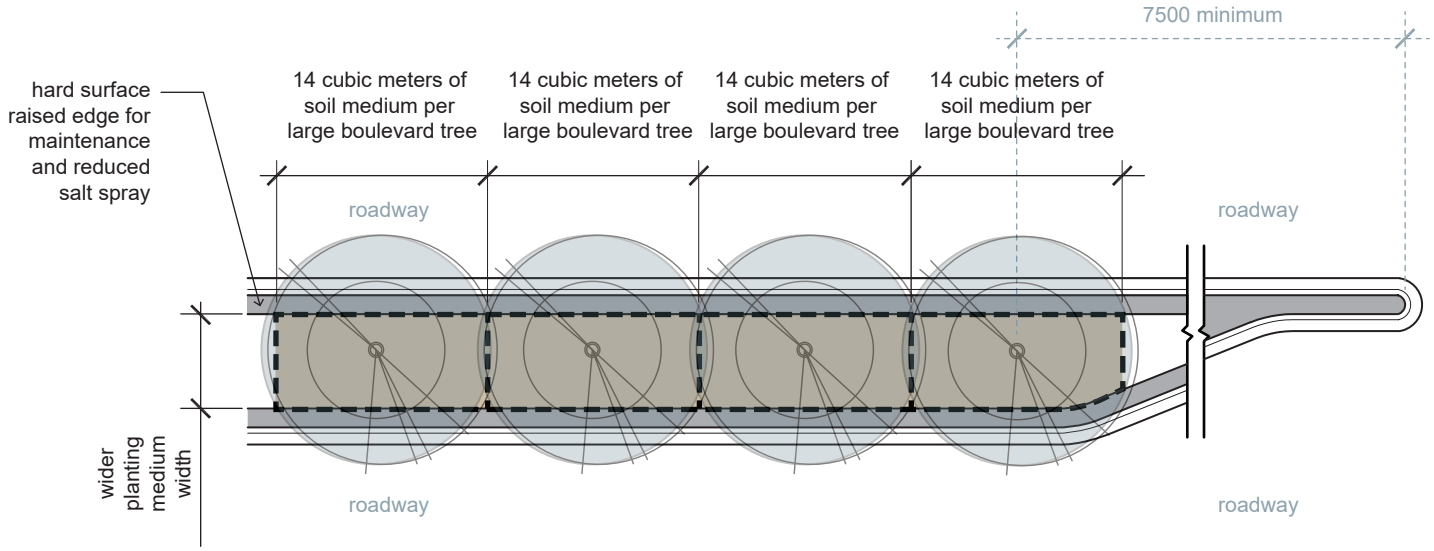
01. Winter is an inevitable part of Drumheller's climate. Winter brings with it the need to clear snow and de-ice streets and sidewalks. The prevailing cold winds are from the west and north, and these winds can be drying to plants. The winter sun can passively warm exposed trunks causing sunscald of 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:**

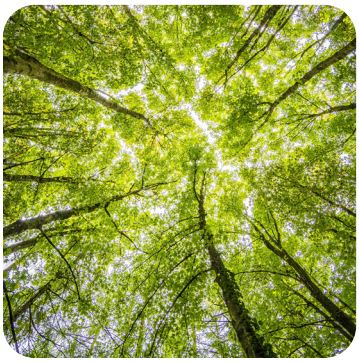
- Consideration should be given to the placement of trees and shrubs in relation to winter weather phenomena and winter sun.
- Ensure that both trunk and root stocks are winter hardy for Drumheller's winter conditions.
- Avoid thin-barked trees in locations exposed to winter sun or winds. Possible mitigation 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 6: PLANTING AND PLANTING MATERIAL



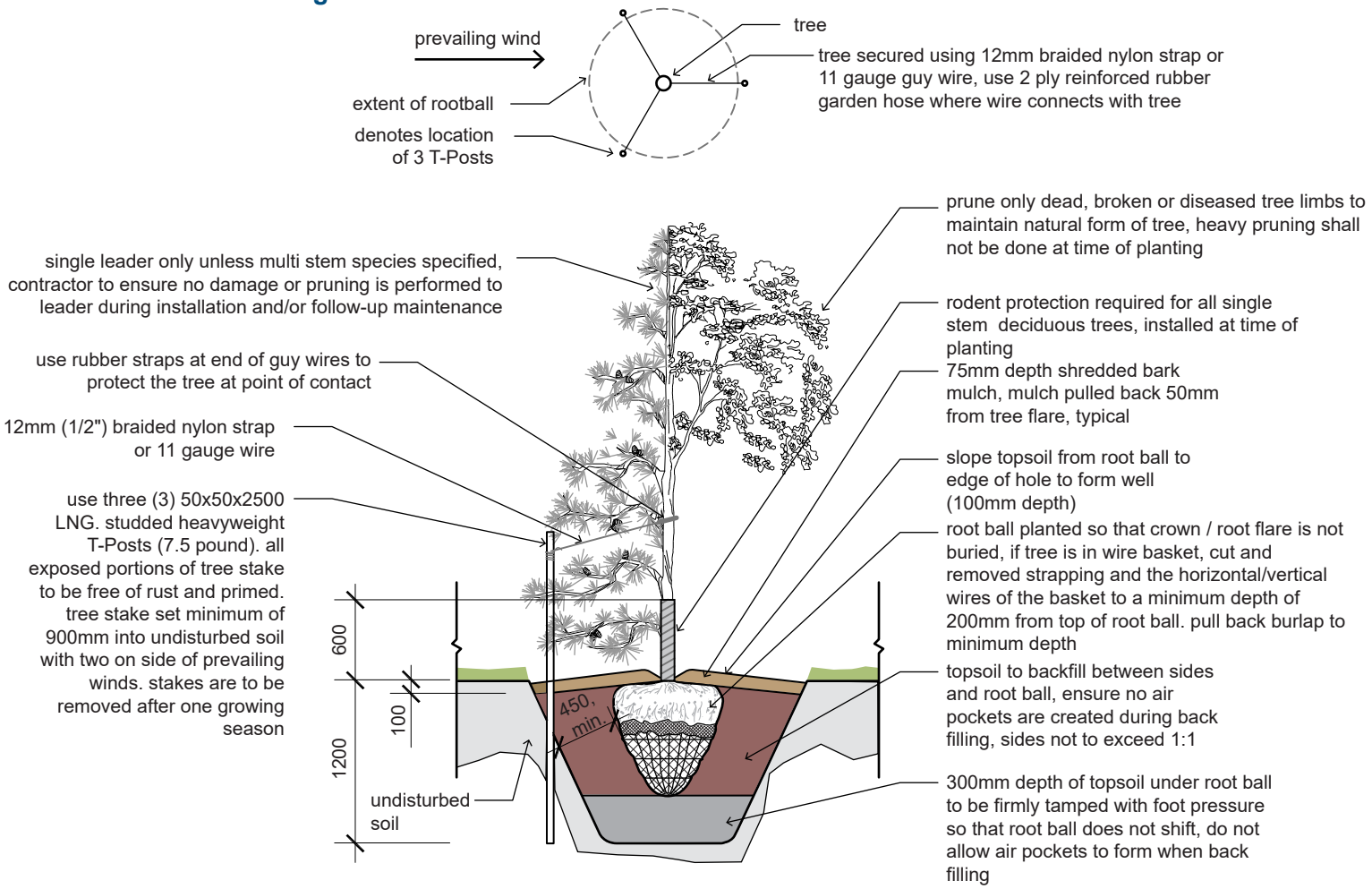
01. **Trees and Shrubs**

Trees generally have a natural life expectancy of many decades or in some cases hundreds of years. Therefore, it is important to plant good quality trees. For reasons of sustainability, it is important to select trees that have the greatest potential to live to a reasonable proportion of their natural life while conforming to the limitations of an urban environment. A properly grown and pruned nursery tree contributes to sustainability as it is easier and less costly to maintain.

02. **New Plantings of Trees and Shrubs - Guidelines and Specifications:**

- Trees should comply with the Canadian Nursery Certification Institute's Domestic Phytosanitary Certification Program standards (DPCP) whenever possible.
- Collected plants may be used when approved by development authority.
- Plant material must be free of pests.
- Plant material on which the root ball has been cracked or broken prior to or during the planting process may not be used.
- Root ball sizes for naturalized plantings will be approved by the authority on a site-by-site basis.

Standard Tree Planting Detail



Plant Material Size – Trees

Site Type	Minimum Size	Preferred Size
Parks & Roadways / Flood Mitigation Areas	40mm bare root	50mm container 60-75mm basket
Civic Buildings / Parking Lots	as per Land Use Bylaw	N/A
Natural Areas / Flood Mitigation Areas	seed / plugs / whips	container stock / whips / plugs
Afforestation / Flood Mitigation Areas	seed / plugs / whips	40 mm bare root / container stock /whips / plugs

03. **Existing Trees Adjacent to New Development - Guidelines and Specifications:**

- Only remove a tree if it is directly impacted by a new development.
- Existing trees adjacent or within new developments that are not directly impacted by the development are to remain in-situ. Existing trees within 6 meters of a proposed excavation must be protected with tree protection fencing. Tree protection fencing must be implemented and maintained for the duration of the construction period.
- Utilize anti-compaction devices such as rig matting to minimize root damage when working in close proximity to tree protection areas.
- If canopy clearing or root pruning is deemed necessary, this work must be undertaken by an arborist.
- Water and maintain trees within tree protection fencing for duration of construction period.

Plant Material Size – Shrubs and Perennials

Site Type	Minimum Size	Preferred Size
Parks & Roadways / Flood Mitigation Areas	1 gallon container	2 gallon container 5 gallon container
Civic Buildings / Parking Lots	1 gallon container	2 gallon container 5 gallon container
Natural Areas / Flood Mitigation Areas	seed / plugs / whips	seed/plugs/ whips 1 gallon container
Afforestation / Flood Mitigation Areas	seed / plugs / whips	seed/plugs/ whips 1 gallon container

04. **Seed and Sod**

Seed, and where possible sod, cover is important in the overall ecology of the landscape as it helps to reduce erosion, competes with invasive weeds, enhances the moisture availability in the soil and helps to control pests. Cover crops can assist in area reclamation by providing cover which prevents erosion and competition from undesirable species while allowing time for native seed mixes to establish.

Native sod or naturalized sod transplants may be appropriate in areas that are disturbed for construction activities, in order to reestablish the area quicker and to utilize existing green infrastructure that would otherwise be destroyed.

05. **Seed Guidelines and Specifications:**

- For park and open space landscaping provide the following seed mix including but not limited to:

Playground Mix - Kentucky Bluegrass, Creeping Red Fescue, Perennial Rye, Chewings Fescue

- For dike landscaping provide the following seed mixes in the appropriate situations:

Seed Mix 1 - Wet Tolerant: Seed below 1:2-year high water mark - application rate of 58 kg / ha.

Botanical Name	Common Name	Target Cover	% of Seed Mix (PLS)	Kg equired (PLS)
Deschampsia ceaspitosa	Tufted Hairgrass	25%	3%	1.97
Pascopyrum smithii / Agropyron smithii	Western Wheatgrass	20%	32%	18.60
Bromus carinatus	Mountain Brome	5%	10%	5.68
Elymus trachycaulus / Agropyron trachycaulum var.	Slender Wheatgrass	10%	11%	6.39
Elymus canadensis	Canada Wildrye	15%	23%	13.34
Spartina pectinata	Alkali Cordgrass	25%	21%	11.66

Cover crop for Seed Mix 1 – Wet Tolerant: Slough Grass – application rate of 5 kg / ha.

Seed Mix 2A - Upland Areas: Wet side slopes of dike, not likely susceptible to inundation - application rate of 58 kg / ha.

Botanical Name	Common Name	Target Cover	% of Seed Mix (PLS)	Kg Required (PLS)
Elymus lanceolatus / Agropyron dasystachyum	Northern Wheatgrass	15%	16%	9.30
Pascopyrum smithii / Agropyron smithii	Western Wheatgrass	20%	30%	17.36
Elymus trachycaulus / Agropyron trachycaulum var.	Slender Wheatgrass	10%	10%	5.97
Bouteloua gracilis	Blue Grama	10%	2%	0.88
Elymus canadensis	Canada Wildrye	10%	14%	8.30
Nassella viridula / Stipa viridula	Green Needlegrass	25%	27%	15.82
Koeleria macrantha	Junegrass	10%	1%	0.58

Cover crop for Seed Mix 2A – Upland Areas: Annual Ryegrass - application rate of 5 kg / ha.

Seed Mix 2B - Upland Areas: Dry side slopes of dike, not susceptible to inundation: Provide cover crop only with native soils – Annual Ryegrass – application rate of 5 kg / ha.

Seed Mix 3 – Top of Dike – application rate of 50 kg / ha

Botanical Name	Common Name	Target Cover	% of Seed Mix (PLS)	Kg required (PLS)
Elymus lanceolatus / Agropyron dasystachyum	Northern Wheatgrass	23%	46%	22.91
Pascopyrum smithii / Agropyron smithii	Western Wheatgrass	10%	23%	11.16
Bouteloua gracilis	Blue Grama	20%	6%	2.83
Hesperostipa comata / Stipa comata	Needle and Thread	2%	4%	2.13
Poa sandbergii	Sandberg Bluegrass	15%	6%	3.07
Nassella viridula / Stipa viridula	Green Needlegrass	5%	9%	4.24
Koeleria macrantha	Junegrass	23%	4%	2.13
Dalea purpurea	Purple Prairie Clover	2%	2%	1.02

Cover crop for Seed Mix 3 – Top of dike: Annual Ryegrass - application rate of 5 kg / ha.

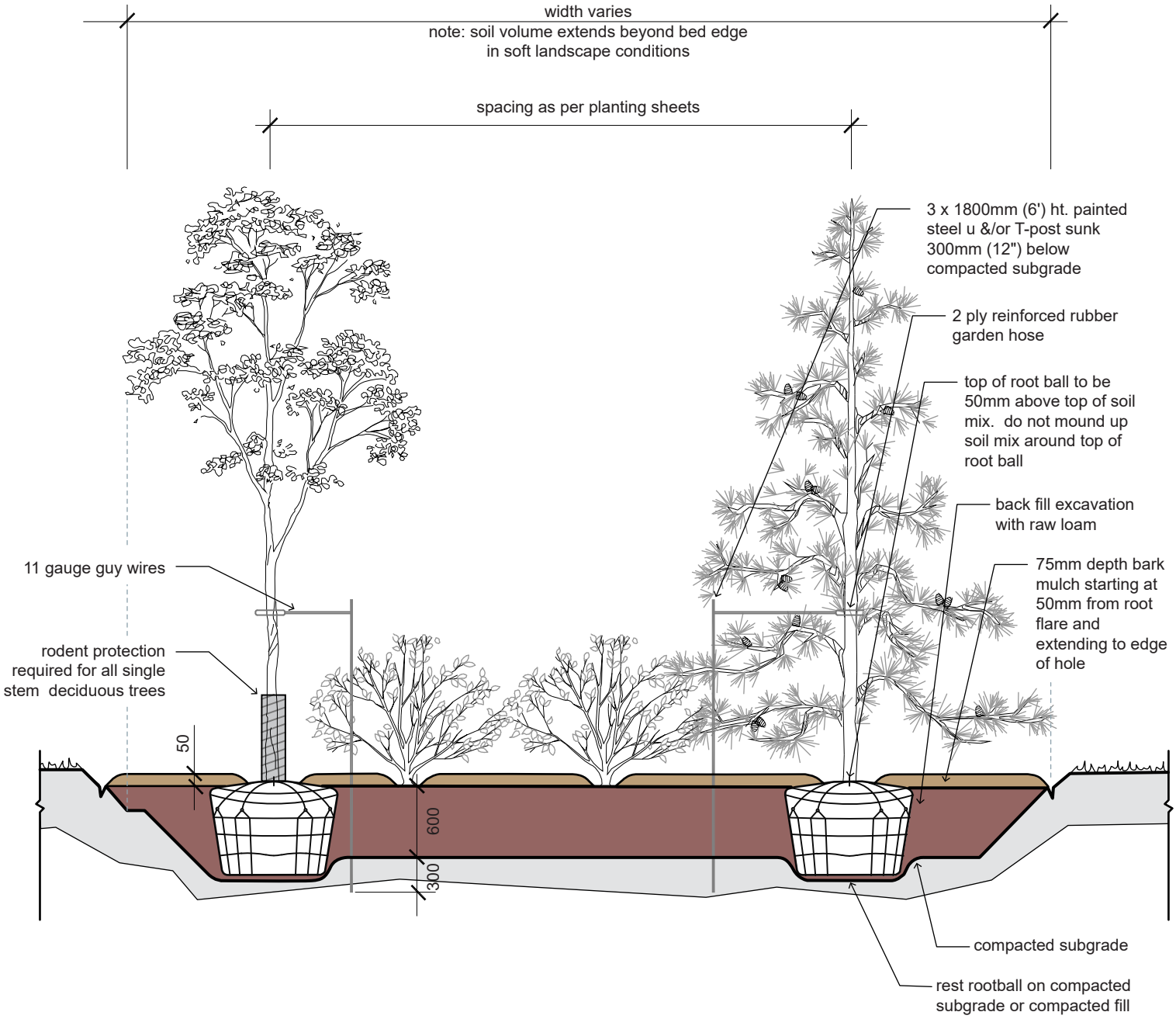
For installation of native seed mixes follow the following guidelines:

- Sow at the rate indicated with Seed Mixes, during calm weather and when soil moisture content is adequate for germination.
- For slopes 2:1 or flatter areas to be seeded that are easily accessible, apply seed using a mechanical dry spread “Brillion” Seeder that places seed at specified depth and rate and rolls in a single operation.
- For slopes steeper than 2:1 or slopes that are not easily accessible, use manually operated broadcast seeder, ATV Harrow, or hand rake.
- Sow seed in two directions, 50% of seed in one direction and remaining 50% of seed at right angles to first seeding pattern, using same method of seeding.
- Cover broadcasted seed by hand raking and ATV harrowing-in.
- Install native seed mixes under the following windows:
    - Mid to late May, to early June. No later than June 15th.
    - Late September after first frost, when plants go dormant. Do not seed near end of season until the risk of seed germination is low. Seed that germinates and does not fully establish prior to end of growing season will likely not overwinter.

06. **Sod Guidelines and Specifications:**

- For manicured park and open space landscaping (where applicable and appropriate) provide the following sod type:
    - Kentucky Bluegrass or Fescue i.e. Freedom Fescue
    - Kentucky Bluegrass sod is readily available.
    - Fescue sod requires less maintenance, water and fertilizer.
    - Fescue sod is less readily available.
- For native sod / naturalized sod transplants:
    - Assess existing sod to ensure acceptable / desired matrix is present and no invasive species exist.
    - Assess existing topsoil to ensure compatibility with transplant location.
    - Assess aspect to ensure compatibility with transplant location.
    - Properly cut and store existing sod during dormancy or periods of inactive growth.
    - Install native sod in transplanted location during dormancy or periods of inactive growth, or just prior to active growth period.
    - Stake native sod for slopes as required.
    - Water for establishment.

Mixed Planting Bed with Mulch Detail



07. **Soil**

From a plant's point of view, soil is its growth medium. The greater the volume of soil available for plants, the greater their health, vigour and sustainability. Soil quality and quantity can be even more important than the quality of trees or the quantity of irrigation. The volume of soil that is available for growth of vegetation is largely decided and established during design and construction. Design and construction practices can create a soil profile of different layers made up of different textures, types and compactions. Each change in a soil's makeup creates an interface or barrier which disrupts water flow and root penetration. These interfaces can restrict the volume of soil available for root growth.

08. **Design Practices:**

- Provide for natural drainage.
- Preserve native soils and soil structure.
- Plant trees and shrubs in native or existing soils to take advantage of seed sources and micronutrients.
- Planting bare root trees.

09. **Soil Guidelines and Specifications:**

- When removing existing topsoil from site for reuse:
    - carefully strip existing sod or surface materials and dispose of,
    - carefully strip upper topsoil horizon, ensuring no contamination of material,
    - stockpile in separate topsoil mounds, no higher than 1.5 meters in height, and
    - store topsoil for reuse for a maximum of 12 months.
- Supply sufficient depth of cultivated soil throughout site so that entire tree root ball is within one soil type.
- Rip subsoil to a depth below the depth of tree root balls or roots.
- Combine ripping subsoil and tillage on top of soil to create a smooth blending of soil types and profiles.
- Minimize soil compacting activities on the site such as driving and parking vehicles and equipment.
- Knock soil off of the roots in containerized plant material.
- Native topsoil shall be reasonably free from subsoil, root, vegetation, stones larger than 50 mm, and any other extraneous materials.
- Imported loam shall be composed of natural, fertile, friable, agricultural soil, and meet the following requirements:
    - Not less than 5% organic material.
    - pH value ranging from 6.0-7.5.
    - Non-toxic to plant growth.

- E.C.-Salinity reading not exceeding 1.5.
- Soil texture: loam soil as defined by Canadian System of Soil Classification.
- Reasonably free from subsoil, slag, clay, stone, lumps, live plants, roots, sticks, quack-grass, noxious weeds and foreign matter.
- Suitable for the growth of native trees, shrubs and grasses.
- When storing imported topsoil, stockpile in separate topsoil mounds, no higher than 1.5 meters in height.

- Organic soil amendments shall be:
  - substantially free from subsoil, sawdust, commercial wood products, stones, lumps, plants, roots, sticks, invasive and noxious plant parts and seeds per the Weed Control Act and Regulations, high seed content, chemical contaminants and other organic or inorganic materials harmful to plant life.

- Compost shall be:
  - commercially prepared and shall meet the CCME Guidelines for compost quality.
  - Be substantially free from coliform, pathogens and chemical or organic contaminates that may be detrimental to plant or animal health.
  - Contain less than 0.5% by volume of contaminants such as stones, plastic, metal or glass.
  - Not exceed a 30:1 total carbon to nitrogen ratio.
  - Well-rotted wood residuals when found to be a component of compost are acceptable provided the total carbon to total nitrogen ratio for the topsoil shall be a maximum of 30:1.
  - Uncomposted wood residuals (wood chips, bark, sawdust and ground green wood) shall:
    - Not make up more than 40 percent of the organic content of any growing medium.
    - Have an appropriate fertilizer application, such as nitrogen or another approved nutrient.

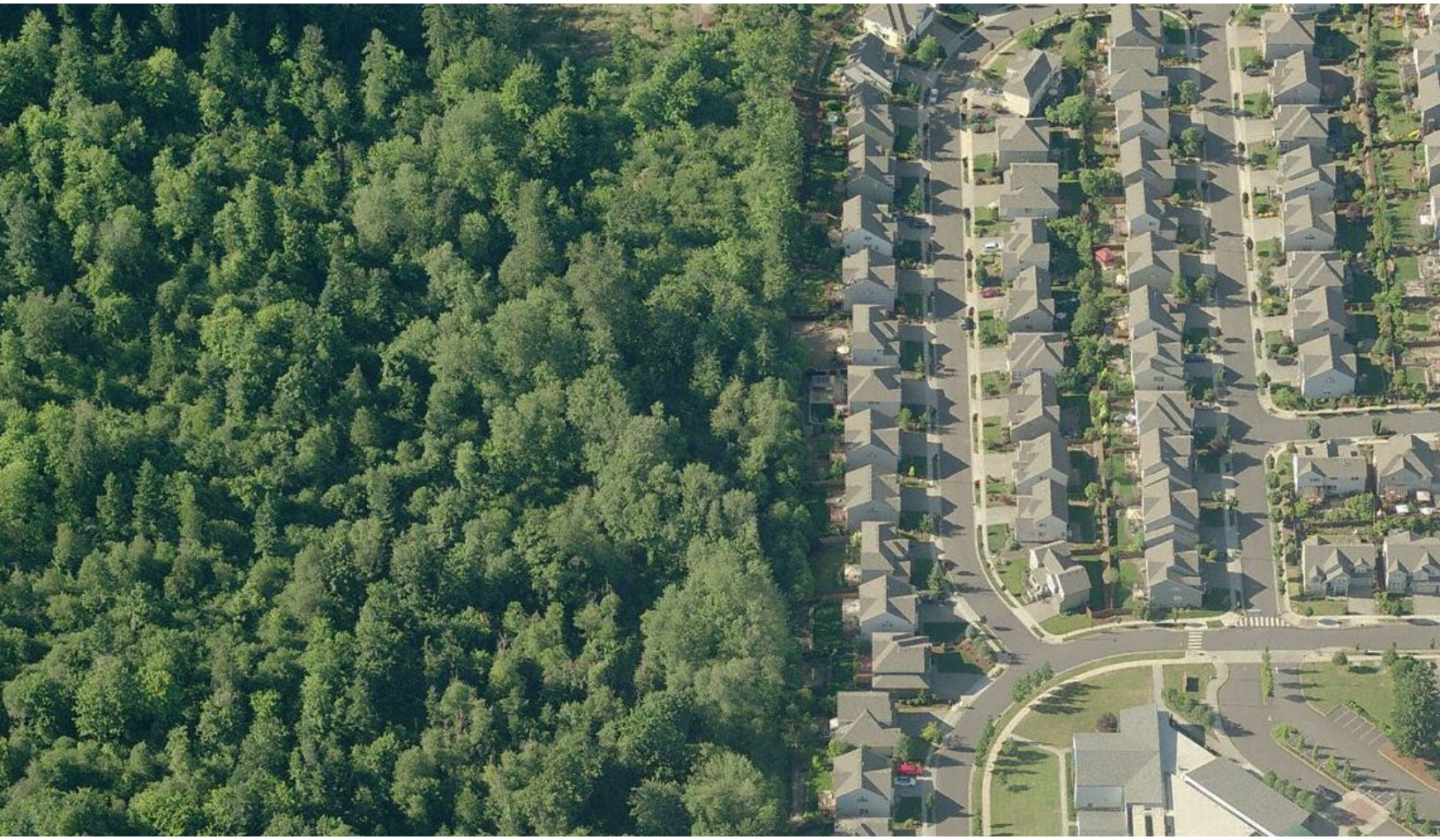
SECTION 7: STEWARDSHIP OF THE URBAN FOREST

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.

DRUMHELLER VALLEY

APPENDIX A: CARBON SEQUESTRATION INFORMATION

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.

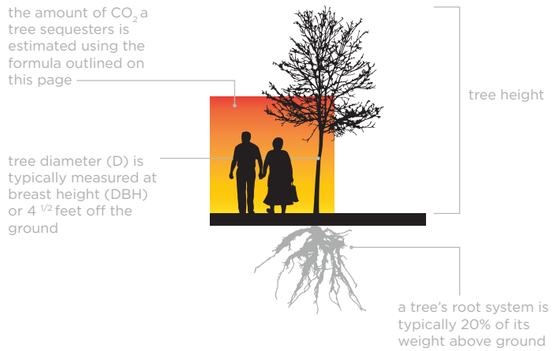
Nevertheless, there are various ways to estimate the amount of CO_2 sequestered by a tree.

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

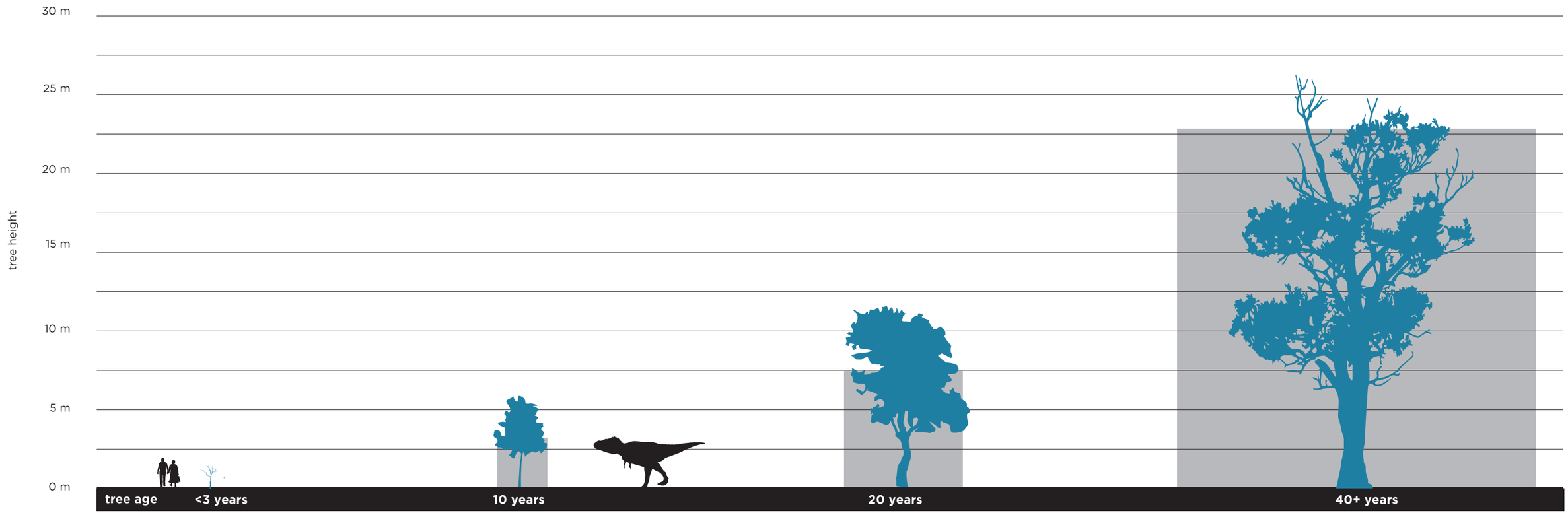
[2] Method adapted from EcoMatcher.com

[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

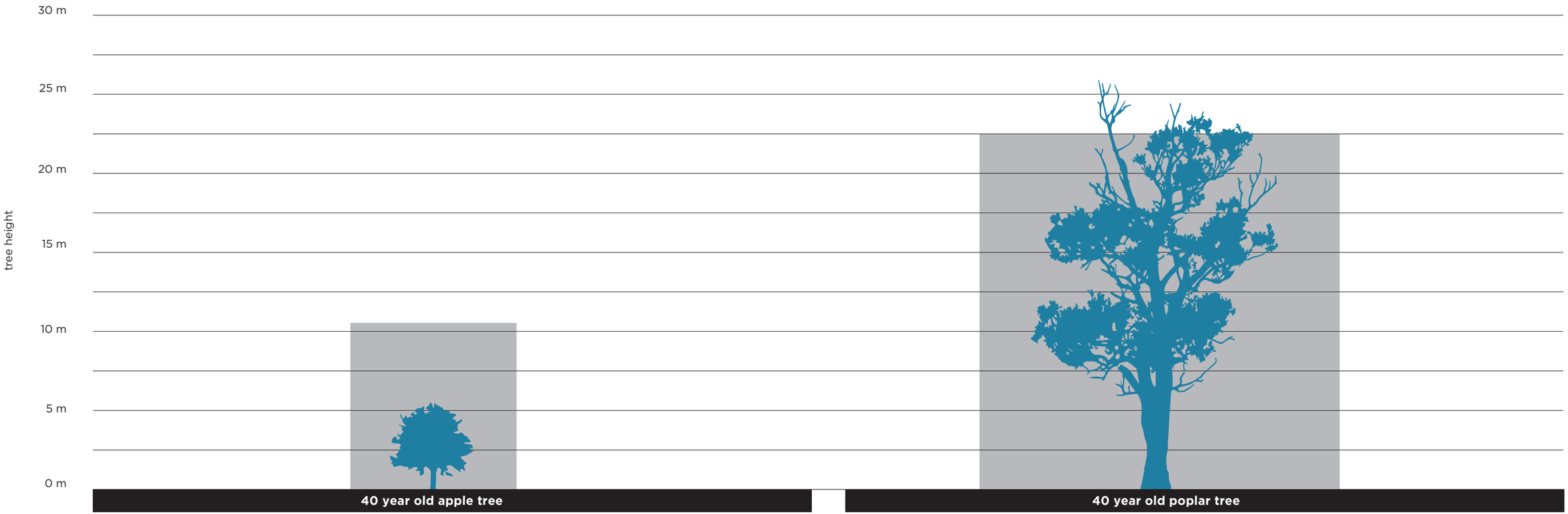
height: 25.0 m
trunk diameter: 775 mm
CO_2 sequestered: 8291.7 kg (lifespan)
CO_2 sequestered: 207.3 kg (annual avg.)

**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

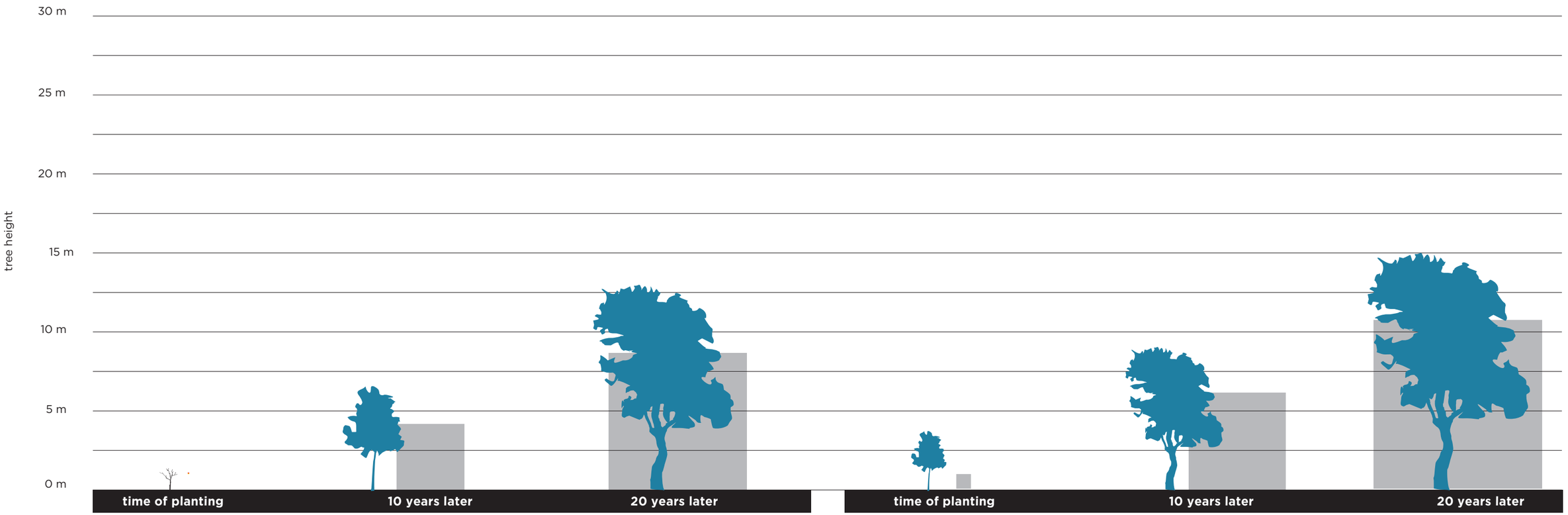
mature native tree

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 amount of CO_2 sequestered by replacement trees



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: 7.2 m
trunk diameter: 210 mm
CO_2 sequestered: 292.3 kg (lifespan)
CO_2 sequestered: 24.4 kg (annual avg.)

**assumed age of 12 years*

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*

70 mm caliper

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*

early mature tree

height: 9.0 m
trunk diameter: 270 mm
CO_2 sequestered: 604 kg (lifespan)
CO_2 sequestered: 40.3 kg (annual avg.)

**assumed age of 15 years*

mature tree

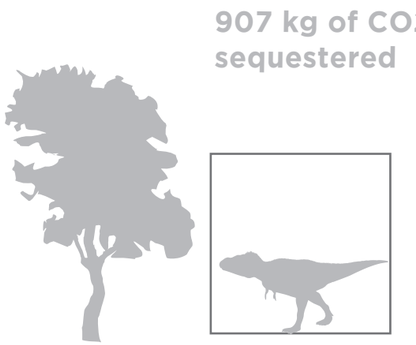
height: 15.0 m
trunk diameter: 470 mm
CO_2 sequestered: 1829 kg (lifespan)
CO_2 sequestered: 73.2 kg (annual avg.)

**assumed age of 25 years*

amount of CO_2 sequestered by 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*

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

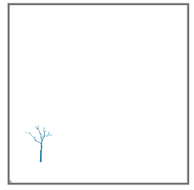


907 kg of CO2 sequestered

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*

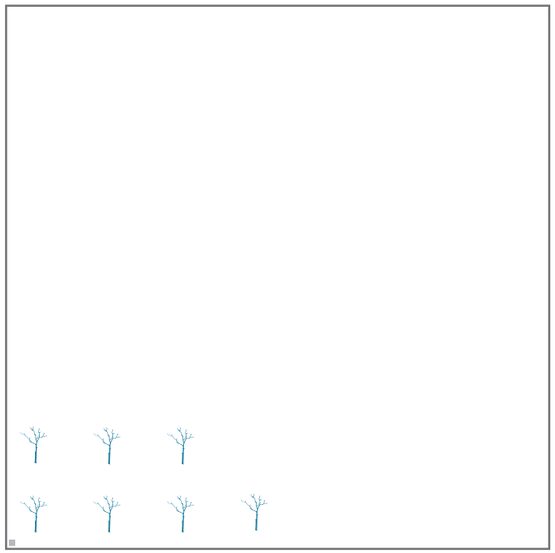
amount of CO_2 sequestered by removed tree for reference

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	0.7 kg of CO_2 sequestered	8582 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*

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*

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

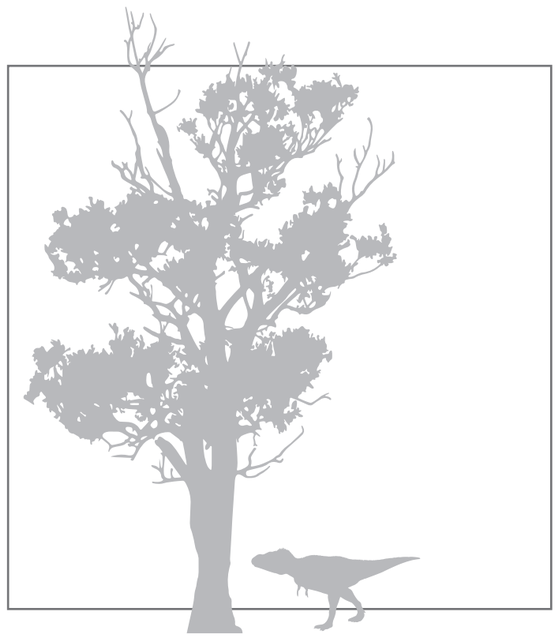
amount of CO_2 sequestered by tree over lifespan

* *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

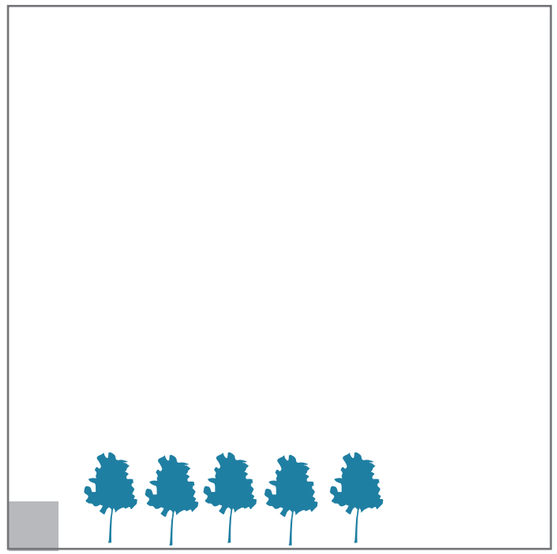


1 x mature tree removed

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

APPENDIX B: TREE LIST

DECIDUOUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Amur Maple	*Acer ginnala*	no	tolerant of various soil types	tolerant of all moisture levels, prefers well drained soils	full sun to part shade	* dioecious - plant either male or female trees * large shrub to small tree * tolerant of atmospheric pollution	* focal or specimen tree * contrast / ornamental * urban conditions * drought tolerant once established - xeriscape
Boxelder Maple / Manitoba Maple	*Acer negundo*	yes	tolerant of various soil types	tolerant of all moisture levels	full sun	* dioecious - plant either male or female trees * brittle wood - not suitable on very windy sites *sensitive to salt spray - avoid planting near roadways	* riparian habitats * naturalized settings * rehabilitation areas
Horsechestnut	*Aesculus hippocastanum*	naturalized	loamy to sandy soils	average to medium moist soils, prefers well drained soils	full sun to part shade	* dioecious - plant either male or female trees * slow growing * tolerant of windy sites * tolerant of atmospheric pollution	* focal or specimen tree * contrast / ornamental * urban conditions
Ohio Buckeye	*Aesculus glabra*	yes	tolerant of various soil types	average to moist soil	full sun to part shade	* dioecious - plant either male or female trees * slow growing * high maintenance requirements * highly tolerant of atmospheric pollution	* focal or specimen tree * boulevard tree * contrast / ornamental * urban conditions
Red Birch / Water Birch	*Betula occidentalis*	yes	loamy to sandy soils	moist conditions, prefers well drained soils	sun to semi-shade	* monoecious * large shrub or small tree * tolerant of windy sites	* riparian habitats * naturalized settings
White Birch / Paper Birch	*Betula papyrifera*	yes	sandy to loamy soils but will tolerate many soil types	prefers well drained dry soils	sun to semi-shade	* monoecious * single trunk or multistem * medium tolerance to windy sites * tolerant of salt spray	* focal or specimen tree * large open spaces * rehabilitation areas * urban conditions
Toba Hawthorn	*Crataegus x mordenensis* ‘Toba’	no	tolerant of various soil types	tolerant of all moisture levels	full sun to part shade	* hardy ornamental * requires wind sheltered area * tolerant of atmospheric pollution * do not plant in areas with junipers due to juniper-hawthorn rust	* boulevard tree * ornamental * smaller areas or residental areas * urban conditions
Green Ash	*Fraxinus pennsylvanica*	yes	tolerant of various soil types	tolerant of all moisture levels	full sun	* tolerant of windy sites * somewhat tolerant of atmospheric pollution * tolerant of salt spray	* boulevard tree * medium to large open spaces * naturalized settings * fencerows or shelterbelts * urban conditions
Foothills Green Ash	*Fraxinus pennsylvanica* “Heuver”	yes	tolerant of various soil types	tolerant of all moisture levels	full sun	* tolerant of windy sites * somewhat tolerant of atmospheric pollution * tolerant of salt spray	* boulevard tree * medium to large open spaces * naturalized settings * fencerows or shelterbelts * urban conditions

DECIDUOUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Patmore Green Ash	*Fraxinus pennsylvanica* “Patmore”	yes	tolerant of various soil types	tolerant of all moisture levels	full sun	* tolerant of windy sites * somewhat tolerant of atmospheric pollution * tolerant of salt spray	* boulevard tree * medium to large open spaces * naturalized settings * fencerows or shelterbelts * urban conditions
Prairie Spire Green Ash	*Fraxinus pennsylvanica* “Rugby”	yes	tolerant of various soil types	tolerant of all moisture levels	full sun	* tolerant of windy sites * somewhat tolerant of atmospheric pollution * tolerant of salt spray	* boulevard tree * medium to large open spaces * naturalized settings * fencerows or shelterbelts * urban conditions
Siberian Larch	*Larix sibirica*	no	tolerant of various soil types	average to dry soil	full sun to part shade	* monoecious and layering vegetative reproduction * no seed dormancy * deciduous conifer * whorled needles * intolerant of atmospheric pollution	* large open spaces * contrast * naturalized settings
Apple and Crabapple Varieties	*Malus spp.*	no	* prefers clay loams and sandy clay loams * tolerant of various soil types	average to moist soil	full sun	* most are dioecious - plant male and female trees, self-incompatible * choose varieties that have resistance to fireblight * food source to mammals and avian species * very tolerant of atmospheric pollution	* focal or specimen * contrast / ornamental * urban conditions
Assiniboine Poplar	*Populus x* “Assiniboine”	yes	tolerant of various soil types	adaptable to dry and moist locations	full sun to part shade	* male clone and vegetative reproduction through colonizing / suckering * drought tolerant * very tolerant of atmospheric pollution * tolerant of salt spray	* shelterbelt * rehabilitation areas * large open space * urban conditions * drought tolerant once established - xeriscape
Balsam Poplar	*Populus balsamifera*	yes	* alluvial sites * tolerant of various soil types	moist conditions, but tolerates dry soils	full sun	* dioecious - plant only male trees * brittle wood - not suitable on very windy sites * aggressive rooting systems - avoid planting in confined areas or near building foundations	* riparian habitats and moist woods * naturalized settings * large open spaces * rehabilitation areas
Black Poplar / Black Cottonwood / Western Balsam Poplar	*Populus trichocarpa / Populus balsamifera subsp. trichocarpa*	yes	* alluvial sites * tolerant of various soil conditions	moist conditions, but tolerates dry soils	full sun	* dioecious - plant only male trees * brittle wood - not suitable on very windy sites * aggressive rooting systems - avoid planting in confined areas or near building foundations	* riparian habitats and moist woods * naturalized settings * large open spaces * rehabilitation areas

DECIDUOUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Plains Cottonwood / Eastern Cottonwood	*Populus deltoides*	yes	* alluvial sites * tolerant of various soil types	moist conditions, but tolerates dry soils	full sun	* dioecious - plant only male trees * brittle wood - not suitable on very windy sites * aggressive rooting systems - avoid planting in confined areas or near building foundations	* riparian habitats and moist woods * naturalized settings * large open spaces * rehabilitation areas
Trembling Aspen / Quaking Aspen	*Populus tremuloides*	yes	* alluvial sites * tolerant of various soil types	moist conditions, but tolerates dry soils	full sun	* flattened petioles create the “trembling” sound this tree is known for * dioecious - plant only male trees * brittle wood - not suitable on very windy sites * aggressive rooting systems - avoid planting in confined areas or near building foundations * clonal reproduction typical	* riparian habitats and moist woods * naturalized settings * medium to large open spaces * rehabilitation areas
White Poplar / European White Poplar	*Populus alba*	no	* alluvial sites * tolerant of various soil types	moist conditions, but tolerates dry soils	full sun	* introduced to North America - mostly female plantings *reproduces primarily through clonal or hybridization	* best avoided as female varietals are dominant
Amur Cherry	*Prunus maackii*	no	tolerant of various soil types	evenly moist soils, prefers well drained dry soils	full sun	* monoecious * requires sheltered site, susceptible to winter wind injury * black knot concern	* small areas or residential areas * winter interest / contrast / ornamental
Pin Cherry	*Prunus pensylvanica*	yes	tolerant of various soil types	evenly moist soils, prefers well drained dry soils	full sun	* monoecious and vegetative reproduction through colonizing / suckering * large shrub to small tree * requires sheltered site, susceptible to winter wind injury * somewhat tolerant of urban pollution * black knot concern	* focal or specimen * winter interest / contrast / ornamental * urban conditions * drought tolerant once established
Chokecherry	*Prunus virginiana*	yes	tolerant of various soil types	tolerant of all moisture levels	full sun	* monoecious and vegetative reproduction through colonizing / suckering * large shrub or small tree * brittle wood - not suitable on very windy sites * food source to mammals and avian species * black knot concern	* riparian habitats and moist woods * naturalized settings * rehabilitation areas * residential areas * fencerows and shelterbelts * xeriscape

DECIDUOUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Schubert Chokecherry / Purple Leaf Chokecherry	*Prunus virginiana* “Schubert”	yes	tolerant of various soil types	tolerates dry to medium moist soils, prefers well drained soils	full sun	* monoecious and vegetative reproduction through colonizing / suckering * large shrub or small tree * brittle wood - not suitable on very windy sites * food source to mammals and avian species * black knot concern	* riparian habitats and moist woods * naturalized settings * rehabilitation areas * residential areas * fencerows and shelterbelts * xeriscape
Bebb Willow / Beaked Willow / Red Willow	*Salix bebbiana*	yes	tolerant of various soil types	moist conditions	full sun	* dioecious and vegetative reproduction through colonizing / suckering * large multi-stemmed shrub or small tree	* riparian habitats * naturalized settings
Laurel Leaf Willow / Bay Willow	*Salix pentandra*	no	tolerant of various soil types	tolerant of all moisture levels, tolerates standing water	full sun	* dioecious * large fast growing tree * drought tolerant * very tolerant of atmospheric pollution	* riparian habitats * large open space * urban conditions * naturalized settings * xeriscape
Pyramidal Mountain Ash / Rowan Tree	*Sorbus aucuparia* “Fastigiata”	no	tolerant of various soil types	tolerant of all moisture levels, requires well drained soils	full sun	* monoecious * food source to mammals and avian species * very tolerant of atmospheric pollution	* focal or specimen * winter interest / contrast / ornamental * urban conditions * drought tolerant once established
Russian Mountain Ash / Major Rowan	*Sorbus aucuparia* “Rossica”	no	tolerant of various soil types	tolerant of all moisture levels, requires well drained soils	full sun	* monoecious * food source to mammals and avian species * very tolerant of atmospheric pollution	* focal or specimen * winter interest / contrast / ornamental * urban conditions * drought tolerant once established
Showy Mountain Ash / Northern Mountain Ash / Dogberry	*Sorbus decora*	yes	tolerant of various soil types	tolerant of all moisture levels, requires well drained soils	full sun	* monoecious * food source to mammals and avian species * very tolerant of atmospheric pollution	* focal or specimen * winter interest / contrast / ornamental * urban conditions * drought tolerant once established
Ivory Silk Tree Lilac	*Syringa reticulata* “Ivory Silk”	no	tolerant of various soil types	average to moist conditions	full sun	* monoecious * very tolerant of atmospheric polllution	* small open spaces or private residences * urban conditions * boulevard trees
American Elm / White Elm	*Ulmus americana*	yes	tolerant of various soil types	tolerant all moisture levels, prefers well drained soils	full sun	* dioecious - plant either male or female trees * extremely hardy * tolerant of windy sites	* large open spaces * boulevard trees * urban conditions

CONIFEROUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
White Spruce	*Picea glauca*	yes	tolerant of various soil types	tolerant of all moisture levels	full sun	* tolerant of windy sites * somewhat tolerant of atmospheric pollution * tolerant of salt spray	* large open spaces * fencerows or shelterbelts * urban conditions * xeriscape
Colordo Spruce / Blue Spruce	*Picea pungens*	yes	tolerant of various soil types	tolerant of all moisture levels, prefers well drained soils	full sun	* monoecious * drought tolerant once established * tolerant of atmospheric pollution * tolerant of salt spray	* contrast * large open spaces * fencerows or shelterbelts * urban conditions * xeriscape
Lodgepole Pine / Rocky Mountain Lodgepole Pine / Black Pine	*Pinus contorta var. latifolia*	yes	tolerant of various soil types	prefers average moisture levels, well drained soils	full sun	* monoecious with serotinous or nonserotinous cones * 2 needle fascicles * tolerant of windy sites * tolerant of atmospheric pollution	* large open spaces * fencerows or shelterbelts * urban conditions * xeriscape
Limber Pine	*Pinus flexilis*	yes	tolerant of various soil types	prefers average moisture levels, well drained soils	full sun	* monoecious with serotinous or nonserotinous cones * 2 needle fascicles * very slow growing * drought tolerant * tolerant of atmospheric pollution * very tolerant of wind * food source to small mammals and avian species	* large open spaces * fencerows or shelterbelts * urban conditions * xeriscape
Scots Pine	*Pinus sylvestris*	no	tolerant of various soil types, but prefers sandy soils	prefers dry to average moisture, well drained soils, will not tolerate standing water	full sun	* 2 needle fascicles * medium to fast growing * drought tolerant * very tolerant of atmospheric pollution * food source to mammals and avian species	* fencerows or shelterbelts * specimen * urban conditions * xeriscape

APPENDIX C: SHRUB LIST

DECIDUOUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Saskatoon / Serviceberry / Juneberry	*Amelanchier alnifolia*	yes	tolerant of various soil types	prefers moist soil	full sun to part shade	* monoecious and vegetative reproduction through colonizing / suckering * large shrub or small tree * food source to mammals and avian species	* small yards and informal borders * coulee bottomland * drought tolerant once established
Leadplant	*Amorpha canescens*	yes	does well in poor soil, but prefers well drained soils	dry soils	full sun	* hermaphroditic flowers, and vegetative reproduction through colonizing / suckering * nitrogen fixer	* naturalization areas, soil stabilization and roadside plantings * xeriscape
Chokeberry / Black Chokeberry	*Aronia melanocarpa*	yes	tolerant of various soil types	tolerant of all moisture levels	full sun to part shade	* monoecious * somewhat tolerant of atmospheric pollution * saline tolerant * food source to mammals and avian species	* urban conditions * contrast * small yards * naturalization areas * roadside plantings
Red Osier Dogwood / Red Twig Dogwood	*Cornus stolonifera / Cornus sericea*	yes	tolerant of various soil types	tolerates drier soils, prefers moist soil	part shade to sun	* monoecious * food source to mammals and avian species	* bank stabilization * contrast / ornamental
Cotoneaster / Hedge Cotoneaster / Peding Cotoneaster	*Cotoneaster lucidus*	no	tolerant of various soil types	tolerant of all moisture levels	full sun to part shade	* monoecious * tolerant of atmospheric pollution * somewhat saline tolerant	* contrast * mass plantings, fencerows, hedgerows * urban conditions
Russian Olive / Silverberry	*Elaeagnus angustifolia*	no	clay and alkaline soils	dry to moist	full sun to part shade	* hermaphroditic flowers, and vegetative reproduction through colonizing / suckering * large shrub or small tree * drought tolerant once established * very tolerant of atmospheric pollution * saline tolerant * nitrogen fixer * food source to mammals and avian species	* urban conditions * soil stabilization and roadside plantings * xeriscape
Wolf Willow / Silverberry	*Elaeagnus commutata*	yes	tolerant of various soil types	dry to moist	full sun	* hermaphroditic flowers, and vegetative reproduction through colonizing / suckering * large shrub or small tree * saline tolerant * nitrogen fixer * food source to mammals and avian species	* naturalization areas, soil stabilization and roadside plantings * urban conditions * xeriscape

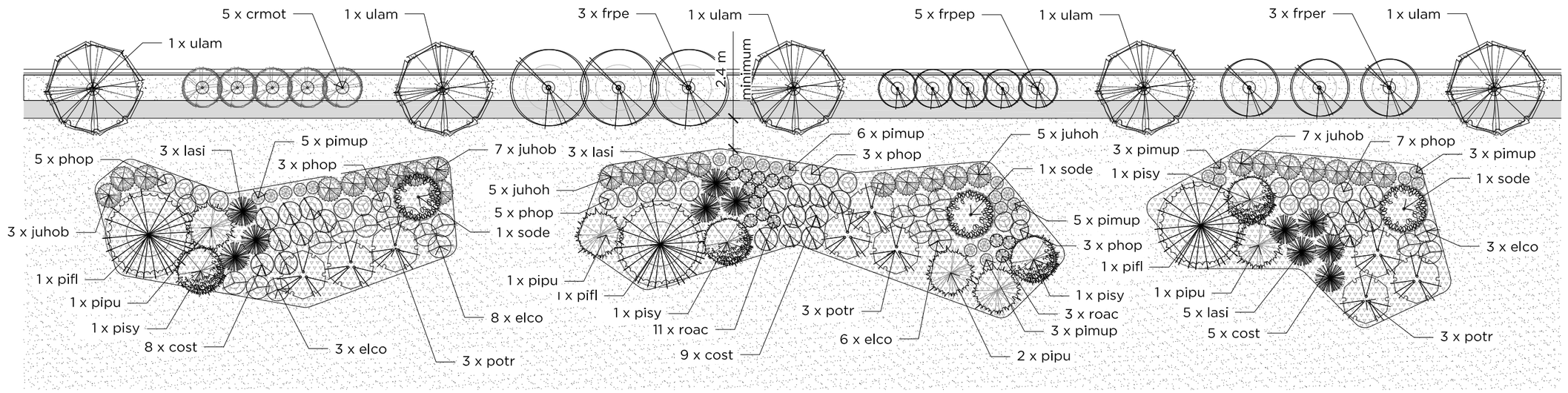
DECIDUOUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Siberian Salt Bush / Salt Tree	*Halimodendron halodendron*	no	clay and alkaline soils	average to dry soil	full sun	* hermaphroditic flowers, and vegetative reproduction through colonizing / suckering * drought tolerant * very tolerant of atmospheric pollution * saline tolerant	* soil stabilization and roadside plantings * xeriscape
Sea Buckthorn	*Hippophae rhamnoides*	no	clay and alkaline soils	average to dry soil	full sun	* dioecious, plant female plants for fruit, and vegetative reproduction through colonizing / suckering, layering * very tolerant of atmospheric pollution * saline tolerant * drought tolerant * food source to avian species	* accent * mass plantings
Honeyberries / Haskapberry	*Lonicera caerulea var. edulis spp.*	no	tolerant of various soil types	average to evenly moist soils, will not tolerate standing water	full sun to part shade	* hermaphroditic flowers, two varieties required for pollination * drought tolerant * very tolerant of atmospheric pollution * food source for avian species	* small open spaces or residential areas
Ninebark / Eastern Ninebark / Atlantic Ninebark	*Physocarpus opulifolius spp.*	yes	tolerant of various soil types	tolerant of all moisture levels	full sun to part shade	* monoecious, and vegetative reproduction through colonizing / suckering * very tolerant of atmospheric pollution	* mass planting * fencerows and shelterbelts * residential areas
Shrubby Cinquefoil / Potentilla	*Potentilla fruticosa spp.*	yes	tolerant of various soil types	prefers evenly moist soils	full sun	* dioecious * small floriferous shrub * drought tolerant	* foundation plantings or mixed borders * mass planting
Chokecherry	*Prunus virginiana*	yes	tolerant of various soil types	tolerant of all moisture levels	full sun to shade	* monoecious, and vegetative reproduction through colonizing / suckering * large shrub or small tree * brittle wood - not suitable on very windy sites * food source to mammals and avian species * black knot concern	* riparian habitats and moist woods * naturalized settings * rehabilitation areas * residential areas * fencerows and shelterbelts * xeriscape
Fragrant Sumac / Skunkbush	*Rhus trilobata / Rhus aromatica var. aromatica*	yes	does well in poor soil, but prefers well drained soils	tolerant of all moisture levels	full sun	* dioecious and vegetive reproduction through colonizing / suckering * drought tolerant * saline tolerant * food source for avian species	* naturalized settings * urban conditions * residential areas
Golden Currant	*Ribes aureum*	yes	tolerant of various soil types	tolerant of all moisture levels	full sun to part shade	* drought tolerant * food source to mammals and avian species	* naturalized settings * residential areas * xeriscape

DECIDUOUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Gooseberry	*Ribes hirtellum*	yes	tolerant of various soil types	average to wet, and will tolerate standing water	full sun to part shade	* monoecious, self-pollinating * somewhat tolerant of atmospheric pollution * food source to avian species	* naturalized settings * residential areas
Prairie Rose	*Rosa arkansana*	yes	prefers rich soils	tolerant of all moisture levels	full sun	* monoecious, and vegetative reproduction through seeds, colonizing / suckering and layering * drought tolerant * food source to avian species	* naturalized settings * mass plantings
Wood's Rose / Common Wild Rose / Western Wild Rose	*Rosa woodsii*	yes	pefers sandy or light clay soils	tolerant of all moisture levels	full sun to part shade	* monoecious, and vegetative reproduction through seeds, colonizing / suckering and layering * drought tolerant * somewhat tolerant of atmospheric pollution	* naturalized settings * mass plantings * urban conditions
Wild Red Raspberry	*Rubus idaeus*	yes	tolerant of various soil types	dry to moist	full sun to shade	* monoecious, and vegetative reproduction through seeds, colonizing / suckering * biennial canes on long-lived perennial rootstock * food source to mammal and avian species	* naturalized settings * mass plantings * disturbed or degraded sites
Coyote Willow / Narrowleaf Willow / Sandbar Willow	*Salix exigua / Salix interior*	yes	tolerant of various soil types	tolerant of all moisture levels, can tolerate standing water	full sun	* dioecious - plant male and female plants, and vegetative reproduction through colonizing / suckering * drought tolerant * very tolerant of atmospheric pollution * food source to mammal and avian species * shelter to mammal, avian and aquatic species	* riparian habitats and moist woods * naturalized and reclamation settings * urban conditions * rehabilitation areas * hedgerows * xeriscape
Shining Willow	*Salix lucida*	yes	sandbars and alluvial soils	wet to moist	full sun	* dioecious - plant male and female plants, and vegetative reproduction through colonizing / suckering * food source to mammal and avian species * shelter to mammal, avian and aquatic species	* riparian habitats and moist woods * naturalized and reclamation settings * rehabilitation areas

DECIDUOUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Yellow Twig Willow	*Salix lutea*	yes	sandbars and alluvial soils	wet to moist	full sun	* dioecious - plant male and female plants, and vegetative reproduction through colonizing / suckering * food source to mammal and avian species * shelter to mammal, avian and aquatic species	* riparian habitats and moist woods * naturalized and reclamation settings * rehabilitation areas
Silver Buffaloberry / Thorny Buffaloberry	*Shepherdia argentea*	yes	tolerant of various soil types but prefers loam or sandy loam	prefers moist soil but is tolerant of dry soils	full sun to light shade	* dioecious - plant male and female plants for fruit * drought tolerant * food source to mammals and avian species * nitrogen fixer	* naturalized settings * riparian areas *disturbed or degraded sites
Spirea	*Spiraea spp.*	no	tolerant of various soil types	average to moist	full sun	* monoecious * very tolerant of atmospheric conditions	* small yards and informal borders * mass plantings * contrast /accent * urban conditions
Western Snowberry /Buckbrush / Wolfberry / Coralberry	*Symphoricarpos occidentalis*	yes	tolerant of various soil types except pure sand	tolerant of all moisture levels	full sun to full shade	* monoecious, and vegetative reproduction through seeds, colonizing / suckering * somewhat tolerant of atmospheric pollution * food source to mammal and avian species	* naturalized settings * urban conditions * protected slopes and lower coulees * disturbed or degraded sites
Lilac varieties	*Syringa spp.*	no	tolerant of various soil types	adaptable to dry and moist conditions	full sun	* monoecious and vegetative reproduction through colonizing / suckering * large shrub or small tree * tolerant of atmospheric pollution	* smaller areas or residential areas * fencerows and shelterbelts * mass plantings * urban conditions
Highbush Cranberry	*Viburnum trilobum*	yes	tolerant of various soil types	average to moist well drained soils	full sun to part shade	* hermaphroditic flowers, self-fertile * very tolerant of atmospheric pollution * food source to mammal and avian species	* larger planting beds * naturalized settings * contrast / accent * urban conditions

CONIFEROUS							
Common Name(s)	**Latin Name**	**Native**	**Soil Preference**	**Moisture Preference**	**Solar Aspect**	**Significant Characteristics**	**Environments Best Suited**
Common Juniper	*Juniperus communis*	yes	tolerant of various soil types	prefers well drained soils, but is adaptable to dry and moist, but will not tolerate standing water	full sun	* dioecious, plant either male or female plants * drought tolerant * very tolerant of atmospheric pollution	* large, small and medium open spaces * mass plantings and ground cover * urban conditions * xeriscape
Creeping Juniper	*Juniperus horizontalis*	yes	tolerant of various soil types	prefers well drained soils, but is adaptable to dry and moist, but will not tolerate standing water	full sun	* dioecious, plant either male or female plants * drought tolerant * very tolerant of atmospheric pollution	* large, small and medium open spaces * mass plantings and ground cover * urban conditions * xeriscape
Mugo Pine	*Pinus mugo*	no	tolerant of various soil types	dry to average moist, but will not tolerate standing water	full sun	* monoecious * very tolerant of atmospheric pollution * saline tolerant * drought tolerant	* ornamental * urban conditions

APPENDIX D: EXAMPLE SPECIES DIVERSITY TARGET COMPLIANT PLANTING PLAN



wood mulch bed

manicured turf

sidewalk

<u>species diversity target</u>

no more than 25% of trees represent any one genus
no more than 20% of trees represent any one species
no more than 10% of trees represent any one cultivar

Example of latin naming convention:

Fraxinus *pennsylvanica* 'Patmore'

genus — species — cultivar

<u>total number of trees (deciduous & coniferous)</u>
= 56 trees

max number single genus (25% of total trees)
= 14 trees

max number of single species (20% of total trees)
= 11 trees

max number of single cultivar (10% of total trees)
= 6 trees

<u>total number of shrubs (deciduous & coniferous)</u>
= 133 shrubs

max number single genus (25% of total shrubs)
= 34 shrubs

max number of single species (20% of total trees)
= 27 shrubs

max number of single cultivar (10% of total shrubs)
= 14 shrubs

	code	*botanical* / common name	qty	hght	sprd	calp	root	spcg	remarks
deciduous trees	crmot	*crataegus x mordenensis 'toba'*	5	3m	2m	---	---	shown	non-native
		toba hawthorn							
	frpe	*fraxinus pennsylvanica*	3	15m	12m	---	---	shown	native
		green ash							
	frpep	*fraxinus pennsylvanica 'Patmore'*	5	12m	8m	---	---	shown	native
		patmore green ash							
	frper	*fraxinus pennsylvanica 'Rugby'*	3	10m	5m	---	---	shown	native
		prairie spire green ash							
	lasi	*larix sibirica*	11	12m	5m	---	---	shown	non-native
		siberian larch							
	potr	*populus tremuloides*	9	10m	6m	---	---	shown	native
		trembling aspen							
	sode	*sorbus decora*	3	6m	4m	---	---	shown	native
		showy mountain ash							
	ulam	*ulmus americana*	5	20m	15m	---	---	shown	native
		american elm							

	code	*botanical* / common name	qty	hght	sprd	calp	root	spcg	remarks
coniferous trees	pifl	*pinus flexilis*	3	8m	3m	---	---	shown	native
		limber pine							
	pipu	*picea pungens*	5	12m	5m	---	---	shown	native
		colorado spruce							
	pisy	*pinus sylvestris*	4	12m	6m	---	---	shown	non-native
		scots pine							

	code	*botanical* / common name	qty	hght	sprd	calp	spcg	remarks
shrubs	cost	*cornus stolonifera*	22	2m	3m	---	shown	native
		red osier dogwood						
	elco	*elaeagnus commutata*	20	2m	2m	---	shown	native
		wolf willow						
	juhob	*juniperus horizontalis 'blue chip'*	17	0.15m	2.0m	---	shown	native
		blue chip juniper						
	juhoh	*juniperus horizontalis 'hughes'*	10	0.3m	3.0m	---	shown	native
		hughes juniper						
	phop	*physocarpus opulifolius*	26	2.5m	2m	---	shown	native
		common ninebark						
	pimup	*pinus mugo pumilo*	25	1.0m	1.0m	---	shown	non-native
		dwarf mugo pine						
	roac	*rosa acicularis*	14	1m	1m	---	shown	native
		prickly rose						