City of Vancouver *Land Use and Development Policies and Guidelines*

Planning, Urban Design and Sustainability Department

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WATER WISE LANDSCAPE GUIDELINES

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Contents

1 Application and Intent

The primary audience for these guidelines is applicants considering or undertaking development on private property whose projects have a landscape component. The Water Wise Design Guidelines are intended to be used in combination with Vancouver's Zoning and Development By-law and other regulations, policies and guidelines (in particular, landscape guidelines or policies). Water wise planning works best as an integrated approach, using as many of the relevant strategies as possible. Prior to design and implementation, applicants should first contact the Enquiry Centre at the City of Vancouver to ensure compliance with City and/or area-specific plans and policies. If contemplating a landscape project on City lands (e.g. on a boulevard) applicants should contact Engineering Services at the City of Vancouver.

The Guidelines are best used as a reference in the design, implementation and maintenance of water wise landscapes for all scales of landscape development, from small garden restorations to high-density developments. They are designed to be used either alone or in combination with other City of Vancouver landscape design guidance, such as the Urban Agriculture Design Guidelines. A series of principles and strategies are outlined through which water conservation can be integrated into urban landscaping. Methods can apply to a variety of sites and micro-climates, with varying design opportunities and constraints. This is a voluntary guide, in which there is ample room for creative design.

The Water Wise Landscape Guidelines are part of the City of Vancouver's Green Building Strategy. The City recognizes its role in working toward ecologically-based landscape strategies, and protecting the availability and quality of water as a resource. As Vancouver grows, impervious surfaces place an increasing strain on local infrastructure. If left unchecked, our urban environments can lose natural biodiversity that is important to regional ecology. As well, some landscape designs can increase the need for potable water and chemical fertilizers. The Guidelines respond to these concerns by drawing on proven successes and highlighting promising advances in order to draw out design principles, strategies, relevant resources, and local plant lists.

2 What are Water Wise Landscapes?

"Water wise" is a term widely used in landscape and gardening literature to describe practices that help reduce water requirements. Vancouver is fortunate to have natural conditions that allow an abundance of flora and fauna to thrive throughout the year. The Water Wise Landscape Guidelines suggest site-specific treatments to help reduce the consumption of potable water for irrigation while maintaining the quality of the urban landscape. Any landscape design can be water wise; from formal to naturalistic, traditional to modern.

3 Benefits of Water Wise Landscapes

Water wise landscapes can help to:

- preserve water quality and availability;
- create healthy ecological environments;
- increase quantity of plant life or "biomass";
- reduce the urban heat island effect;
- reduce greenhouse gas emissions, and mechanical and energy inputs related to maintenance;
- reduce maintenance efforts;
- reduce strain on local infrastructure;
- reduce environmental impacts by recycling and reusing materials and resources; and
- reduce costs.

4 Design Objectives

Maximize the ratio of planted surfaces to non-planted surfaces: Water wise landscape strategies reduce unnecessary hard surface cover wherever possible.

Reduce the demand and consumption of potable water: The City's Green Buildings Strategy set out a goal of 50% reduction in water use for irrigation in new developments over 2008 levels, on a site-by-site basis.

Enhance liveability and urban ecology: A water wise approach can improve the ecological biodiversity of our everyday landscapes and create places that are sustainable and enjoyable throughout the year.

Increase long term viability: Whether planting a tree, designing a roof garden or creating a public plaza, use materials, methods and strategies that will ensure longevity and durability to the project. Take the time to research best practices, seek out experienced professionals, use local materials and build on the successes of others.

5 The Vancouver Context

5.1 Vancouver Regional Ecology

Vancouver has extreme conditions – extreme wet in winter and usually dry in summer. The city is positioned within the Coastal Western Hemlock bio-geo-climatic zone, where the dominant species at maturity of the natural ecosystem is Western Hemlock. To some extent, the Vancouver urban condition is more like the adjacent Coastal Douglas Fir zone which has less precipitation, except that Vancouver's seasonal temperature differences are more severe. Generally, larger urban centres like Vancouver have an effect on local weather patterns and microclimate. As well, off-gassing from buildings and carbon combustion can influence the local ambient air temperature and air quality. And the water cycle is disrupted by changes to surfacing, micro-climate and ecosystem. These conditions can stress the environments that living organisms depend upon.

5.2 Water Availability in Vancouver

Seasonal Patterns

Metro Vancouver depends on the Capilano, Seymour and Coquitlam water reservoirs to supply potable water. Each year the combined capture and storage is approximately 22% of the watersheds' average 1.80 m of annual precipitation. During most of the year, precipitation exceeds the reservoirs' storage capacities. However during the summer months, when precipitation is at its lowest, water demand increases by nearly 50%. This causes consumption of the greatest amount of water when the least amount is available.

Consumption Patterns

Outdoor uses account for approximately 40% of the average Vancouver household's total potable water use (2008), which is almost as much used for baths, showers (20%), and laundry (23%) combined. In an effort to minimize this demand, the region has implemented watering regulations (the Water Shortage Response Plan) to limit the unnecessary use of water in the driest months.

Future Plans and Resources

As the Metro Vancouver population grows, so will the demand for clean water. The result is that we all need to become wiser in the way we use our water. Each household can take steps to reduce its water consumption, and in the process help reduce the costs associated with increasing water supply and storage capacity. The City of Vancouver undertakes a wide range of related projects each year, from education to infrastructure replacement to distribution main flushing. For more information, please see the City of Vancouver's annual Drinking Water Quality Report (available at www.vancouver.ca).

6 Water Wise Landscape Principles

6.1 Water Wise by Design

Planning a series of incremental water reduction strategies is the best way to achieve larger overall reductions. For example, planning for a naturalized garden design with adaptive plant species can attract birds and insects and reduce maintenance, and also will thrive with minimal watering (once established). Other examples include: letting grass go dormant during the summer, amending soils and applying mulch.

6.2 Reduce Water Use

Where possible, find alternatives to using potable tap water for irrigation purposes. It is better to water less frequently and deeply than to water everyday. To reduce water loss via evaporation, water gardens and lawns in the early morning.

6.3 Maximize Re-Use and Collection

The use of non-potable water for small scale irrigation purposes is encouraged whenever possible (barring any major plumbing alterations). Collect, store and re-use water from rainfall and runoff to irrigate lawns and gardens (see The City of Vancouver Rain Barrel Program, Section 11, Resources). For larger applications, rainwater harvesting systems can store significant quantities of water. *Note: there are significant health, safety and building code issues involved with water storage and reuse systems. Contact a professional or City of Vancouver Licenses and Inspections for further information.

6.4 Provide Healthy Soils and Mulch

Healthy soils create healthy landscapes. They absorb water easily, retain moisture, and drain well. Ensure proper depths, amend regularly, and limit or eliminate the use of synthetic chemicals. Use composted or rock mulch to prevent soil water loss through evaporation from sun and wind exposure.

6.5 Choose the Right Plants for the Right Place

Before designing or planting a landscape, research the suitable growing conditions and growth habit of plants. Consider how plants relate to each other spatially and through time when combined in groups. Through layering trees, shrubs, vines and groundcovers, biodiversity and structural diversity can be increased. Layered foliage also intercepts rainfall and reduces water volumes that would normally flow into stormwater systems. For smaller projects, consult plant books, gardening stores or local plant information sources. For larger projects, it is recommended that a landscape designer or professional be consulted.

6.6 Reduce Run Off: Infiltration, Absorbent and Permeable Landscapes

Absorbent and permeable landscapes allow water to infiltrate the ground, reducing runoff and filtering and storing water in the soil. Consider contouring softscapes to resemble a soft dish to encourage infiltration, and install permeable paving for hardscape areas. Rainwater can be directed to planted areas for absorption by the soil and plant roots.

7 Strategies for Ecological & Water Wise Landscapes

7.1 Site Planning

Due to the complexity of hydrology, plumbing systems, grading and soils in and around buildings, it may be necessary to consult a professional to assist in the site planning. Generally, water should be directed away from the building.

General Design and Watering Zones

- Plan with water conservation in mind from the beginning to incorporate as many water wise strategies and techniques as possible.
- Begin by documenting the site's micro-climate and physical conditions.

- Consider creating a plan of the site's hydro zones to identify areas of distinct watering needs. This will help provide rationale when picking the "right plants for the right place" (e.g. water loving plants should be planted in low-lying areas).
- Group plants with similar water needs. The plant lists in Appendix C will help to create a planting plan that is water wise throughout all seasons.
- Areas needing the most irrigation should be kept as small as is reasonably possible and located where they can be watered most efficiently.

Orientation and Shading

- Identify windy or exposed areas. When selecting plants, keep in mind these areas will dry out faster. Use plants appropriate for the conditions.
- Identify sun/shade exposure. Areas exposed to afternoon sun will dry out faster due to evapotranspiration. Consider appropriate drought tolerant plants for these areas. Areas in shade will have lower rates of evapotranspiration. Use plants that are appropriate for the identified exposure.
- Plan to use hardscape efficiently. Impermeable hardscape areas in sunny locations can absorb heat, creating hotspots. Use trees, trellises and arbours in these areas to help create shade, reducing temperature. Permeable paving should be considered as it allows water to percolate into the soil. Where possible, substitute contiguous hard surface paving with permeable pavers or stepping stones.
- For driveways, consider using hard surface "wheelstrips" in the straight section that aligns with the wheels. Where side to side manoeuvring is required, modular grass grid paving is an option.
- Reflective building walls can heat adjacent landscape areas. Note how buildings affect the site, plant appropriately, and shade building walls where possible.

Grading

- Create a plan identifying above and below ground utilities (stormwater), drainage patterns, grading, water table, and soil conditions.
- Contour the land to slow the flow of water. This will reduce the speed and quantity of runoff in wet winter periods, which reduces the strain on local sewer systems in periods of high precipitation.
- Proper grading also encourages infiltration in dry periods.
- Use plants that like more water in areas where rainwater collects. For relative high points use plants that prefer dry conditions.

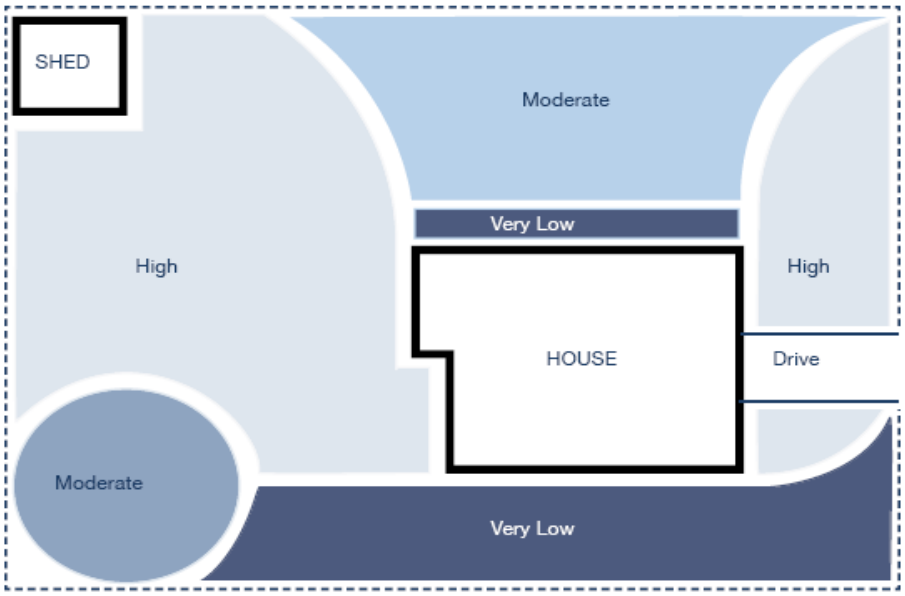

Figure 1. Hydrozoning

Examine existing conditions such as sun exposure, wind, soil types, and drainage patterns to map different areas of water consumption on your site. High indicates areas of high water requirements and low indicates areas of low water requirements.

7.2 Components/Materials

Soils and Growing Medium

- Soil health is important to the health of plants. Building and maintaining healthy soils will help retain moisture and allow plants to flourish.
- Amend soils with compost when planting, replanting, dividing or potting plants to suit the requirements of the specific plant species. For new plantings, amend the entire bed to a continuous depth of 150-300 mm (6-12"), not just individual holes for each plant. Composted soil is available through soil suppliers and the City of Vancouver compost program.
- Test soils to ensure they have the appropriate pH levels (typically between 6 and 7). After testing, amend as needed. Detailed soil tests can be done at most garden centres or nurseries.
- Protect soils from compaction when possible to allow for infiltration to occur. Mechanical compaction can occur from heavy machinery such as excavators and large trucks, or by heavy pedestrian use. Avoid compaction beneath trees. Compacted soils can be repaired by using an air spade under trees and a mechanical aerator for lawns. Contact a professional tree or landscape company.
- Chemical fertilizers can sterilize soil by killing the micro-organisms. Consider natural fertilizers such as composted manure.
- Cover exposed soil with mulch and amend with compost regularly.
- Stock pile native soils for re-use. Do not dispose of native soil unless infested by noxious weeds. Imported sterile growing medium often comes with undesirable weed fragments that may compete for water and soil nutrients.
- Create compost on site from fallen leaves and twigs, or allow them to remain in place to act as a natural mulch and fertilizer.

Native and "Adaptive" Plants

- Native and hardy non-native Adaptive Plants have adapted to our regional climatic and soil conditions. This adaptation helps them survive wet winters and dry summers without requiring regular watering. While native plants are encouraged wherever possible, particularly to provide food and habitat for native wildlife, many non-native plant species are commonly used and readily available that will also contribute to healthy landscapes.
- To understand what plants thrive in your particular area, walk around nearby natural areas, and consult local garden centers or native plant societies.
- Do not collect plants from natural areas. Disturbance to natural populations can be harmful to ecology, and transplants often do not survive. Buy collected seeds and cuttings of native plants propagated in nurseries from responsible suppliers.
- When selecting plants in the nursery, look for a balance between plant growth and pot size. Choose plants with rigorous growth and healthy foliage with no yellowing.
- Water generously during transplanting, and avoid transplanting container or root stock in hot weather. Check with the supplier about methods for transport. Always cover exposed roots and foliage. Hand mist the roots and leaves as needed.
- Plant in the spring or late fall to reduce stress from summer heat and drought. Summer droughts often extend into October, which is why late fall is preferred. By planting in late fall most plants root systems have time to acclimatize and establish throughout the winter. They can then begin growing when warmer weather begins.
- Though native plants do not require "watering" in nature, they do often require watering in cultivation depending on where they are planted. Typically, native plants require watering for the first few years after planting to increase the probability of successful establishment.
- Try to use native plants in the same types of places they choose to grow naturally.
- For specific plant information refer to the section below on plants, and the selected plant lists in Appendix C.

Structural Soils

- Structural soils provide more room for the development of tree and shrub roots, allowing them to grow deeper and gain more access to water.
- Some research has suggested that aggregates within soils can increase soil moisture content through condensation.

7.3 Techniques

Mulching

- Mulching helps to retain moisture by protecting the soil from drying winds, insulating soil temperature and reducing evapotranspiration.
- Collect leaves in the fall and store over the winter for later use. Mulch can be applied on the soil in the fall to protect it from rainfall erosion in winter. More importantly, gardens should be mulched in the spring to help retain moisture during the summer periods.
- For most shrubs, perennials and groundcovers mulch to 50 mm (2") depth and refresh as required to maintain this depth.
- Mulch maintains the state of the soil moisture content and temperature when it is applied. It is critical that the soil be thoroughly and well watered. If mulch is placed on dry soil, the soil will remain dry even after subsequent rainfall or watering events.
- Mulch lightly with organic matter to improve soil nutrients. Mulch generously to minimize evaporation.
- Composted bark mulch will help add nutrients and organic matter to soils. Wood chip mulches may draw nitrogen out of soils, whereas stone mulches are typically neutral.
- Mulch material should consist of large enough particles so that the mulch will not hold water, allowing it to percolate into the soil.
- Mulch helps to increase microbial activity that "fixes" nutrients, a part of healthy soils.
- Mulch helps prevent weeds from establishing and competing for water and soil nutrients.
- Consult garden centers, tree companies or landscape professionals for the best types of mulch to use.

Irrigation

- While Vancouver's warm, dry summers may create the need for irrigation; several strategies can be used to reduce the amount of water used when irrigating lawns and gardens.
- Always take into consideration the amount of water from rainfall before using irrigation. Use a measuring container or soil moisture meter to monitor weekly rainfall, or install a rain sensor to work with your irrigation system.
- Consider timers and programmable irrigation systems to avoid overwatering.
- Water in early morning to avoid water loss due to evapotranspiration.
- Water deeply and infrequently. Adjust watering according to the season, length of day, temperature, humidity and wind.
- Look for leaf wilt caused by dehydration and stress during hot weather.
- Allow the top 25-50 mm (1-2") of soil to dry between waterings. This will encourage deeper roots.
- Ensure that sprinklers are not spilling onto driveways, patios or other hard surfaces.
- Use more efficient spray heads and calibrate sprinklers to reduce consumption.
- Use drip irrigation, micro-sprays, soaker hoses or bubblers on all areas except lawns.
- Apply water at a slow enough rate for the soil to absorb it. Adjust the system controls if puddling occurs when irrigating.
- For shrub beds, use soaker hoses covered in mulch (recommended 50 mm [2"] depth) to reduce evapotranspiration and ensure that water percolates into the soil, beyond the mulch.
- Regularly check irrigation systems for leaks, blocks, breaks or poorly positioned spray heads.
- As plants become more established their watering requirements decrease. Irrigation systems should be adjusted according to plant maturity.
- Collect, store and re-use rainwater. Ensure that an overflow is provided to drain surplus water. Refer to the City of Vancouver's Rain Barrel program.
- Irrigation systems may require seasonal maintenance such as removing water from the lines with compressed air before winter.
- In high density residential developments, provide hose bibs for all common areas and patios greater than 9.25 m (100 sq. ft.), so that homeowners are not inconvenienced accessing indoor water sources for their outdoor gardening needs.
- When planting on structures, provide access to water or efficient irrigation for the purposes of establishing, and periodic maintenance of, high quality landscapes.
- Only potable water is to be used for urban agriculture planters.

Irrigation Type	Water Consumption
Drip	2.5 - 18 litres per hour
Bubbler	2.5 - 9 litres per minute
Hose	22 litres per minute

Table 1 - Relationship between irrigation type and water consumption

Integrated Pest Management (IPM)

- Prevention of undesired invasive plants ("weeds" or "pests") is the best measure. Eliminate weeds manually as they compete with plants for water.
- Limit use of synthetic chemicals as they can sterilize soils.
- When an insect related problem appears, use physical controls first such as traps and barriers. If the problem persists consider horticultural soaps, oils or biological agents. For example, ladybugs are a beneficial insect that helps reduce aphid infestations.
- Begin weed control by spot spraying using horticultural vinegar. To learn more, contact you local garden centre.
- Pest infestation is sometimes a symptom of plant stress that may be reduced by improving plant health, or replacement with a more suitable species.

- For larger applications, it is recommended that a specialist in pest identification or IPM be consulted. Consult the City of Vancouver Pesticide By-law for regulations and prohibited substances.

7.4 Design Considerations

Plant Layering

- Aim for diversity when designing with plants to maximize habitat diversity and increase the year round visual appeal to the garden.
- In nature, plants grow in layers forming plant communities. Birds and wildlife depend on this layering to feed and seek shelter. To replicate this, plant smaller species under taller species. Use smaller shrubs, perennials, and groundcovers under taller trees and shrubs. This has many benefits including solar shading, rain shading, and reducing the flow of rainwater through the layers. This minimizes the impact on the ground surface, enhancing soil infiltration and retention, and protecting against erosion.
- Plant a mixture of deciduous and evergreens, young and old, and species of varying heights.
- Use shade tolerant species under taller species.

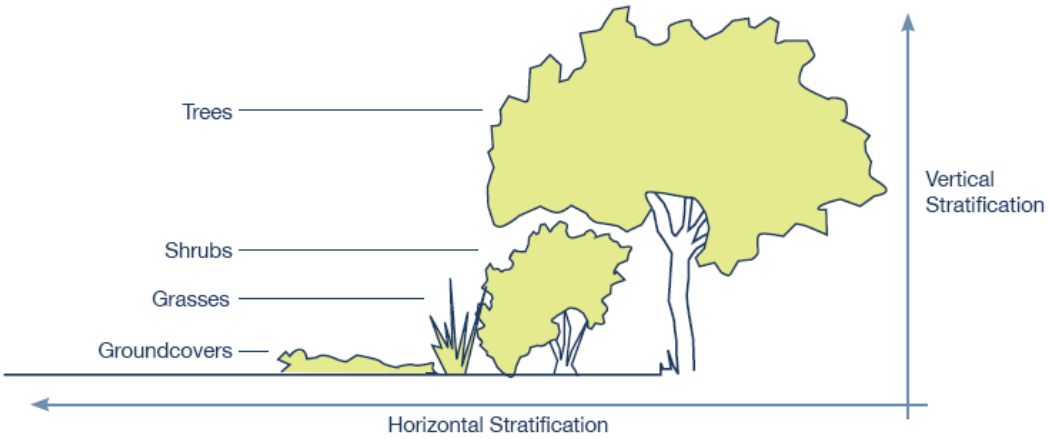

Figure 2. Plant Layering

Layer trees, shrubs, grasses, perennials, and groundcovers to maximize biodiversity and increase the amount of rainfall intercepted by plant foliages.

Lawn vs. Groundcovers

- When planning new sites, use lawn alternatives such as plant beds, perennials, groundcovers, sedums, or clovers. Planned appropriately this will limit watering requirements and increase biodiversity.
- Consider reducing the lawn on existing sites by replacing turf grass with lawn alternatives such as groundcovers or planting beds.
- Chemical inputs such as fertilizers associated with lawn maintenance and watering regimes can migrate to our streams, rivers, and local waterways affecting water quality, which can be damaging to local ecology.
- Where lawns are necessary use the water wise tips outlined in this document in the section on lawns.

Green Facades and Living Walls

- Using green facades and living walls to shade buildings and exterior spaces has the potential to cool ambient temperatures reducing the urban heat island effect and immediate watering needs of plants in proximity.
- Green facades and living walls can mitigate undesirable blanks walls and prevent reflected light from heating and drying landscapes next to buildings. For information on designing and installing green facades or living walls, refer to the Metro Vancouver Ecological Site Development Manual.

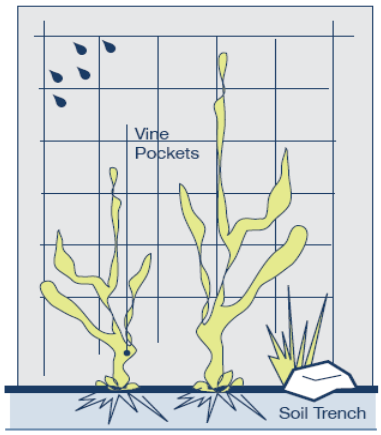

Figure 3a. Green Façade

Structural cables of trellis panels support climbing plants rooted at the base of the wall in a continuous soil trench.

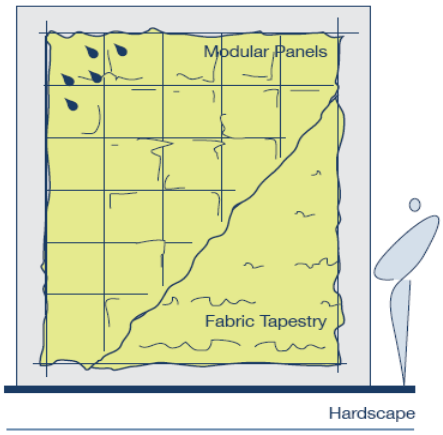

Figure 3b. Living Wall

Using plants as part of a building envelope system helps reduce the urban heat island effect. Consider using collected stormwater for irrigation.

Urban Agriculture

- In urban agriculture plots, consider using softer mulch materials that break down faster as this will replenish soil nutrients.
- For new development projects, provide a starter plant list to improve visual appeal and minimize soil erosion until such time that the community can cultivate their own plants and gardens.
- Please refer to the City of Vancouver's Urban Agriculture Guidelines for more information.

Stormwater Source Control (see the Metro Vancouver Stormwater Source Control Guidelines)

Rain Gardens and Bio-Swales

- All sites vary. Water systems must be individually designed and managed to direct water away from the foundation of buildings.
- When using water detention systems, always have an overflow drain to the municipal stormwater system.
- Never encourage water to pool near foundations without proper drainage.
- Consult a professional to ensure that the specific site conditions support these features.

- Use rain gardens, small scale water collection systems that attempt to provide a more natural appearance and function than traditional stormwater catchment systems. These typically allow for infiltration back into the soil and are often decorated with paving, plants and rocks. They can be integrated into a variety of settings, from urban streetscapes to wild land areas. Size will vary depending on soil conditions and how much run-off will be collected from roof and lawn areas, although a typical residential size is 10–30 m².
- Bio-swales are similar to rain gardens, except that they employ methods of biological water treatment (bio-filtration) using plants and layered soils. They are often designed to resemble a natural planted drainage channel or ditch.
- Rain gardens and bio-swales should be planned in a way to maximize the capture of stormwater runoff to allow water to filter slowly into the ground.
- Although it is tempting to put rain gardens in areas of your lawns that are already wet, do not. Areas of standing water indicate poor infiltration, most likely due to impervious soils or compaction.
- Current regulations permit infiltration trenches to collect rainwater from garage roofs or smaller structures. These are below-grade linear trenches filled with drain rock and designed to allow for the slow release of stormwater. Refer to Vancouver by-law requirements.

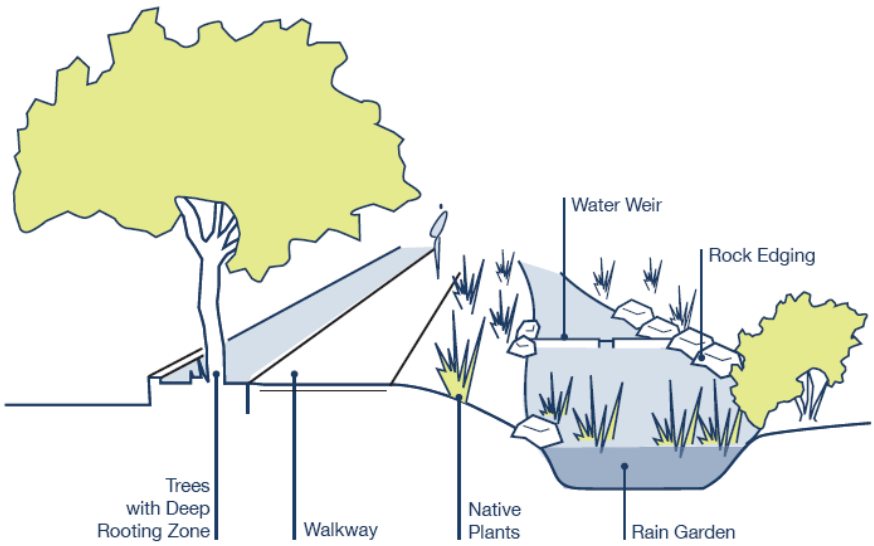

Figure 4. Absorbent Landscapes with Rain Garden

A typical open space walkway can easily adopt water wise landscape principles with the right planning and design.

Permeable Paving and Drainage

- Permeable paving is permeable as a result of specialized base preparation. It is important to research the specifications of any product or brand, as they vary in their efficacy and application. Their performance will depend on soil and drainage. Many of the most advanced systems rely on sub-grade cells to retain water and overflow drains. If unsure, consult a professional.
- Permeable paving can reduce stormwater runoff rates, if installed properly.
- Permeable paving can allow water to infiltrate and recharge groundwater while filtering silt and debris.
- Work with existing topography and drainage patterns when possible.

*__Note__: Water falling on paved surfaces is addressed by the Vancouver Building By-law and may require an Alternative Solution Application. Contact a professional or City of Vancouver Licenses and Inspections for further information how a design can meet the requirements of the By-law.

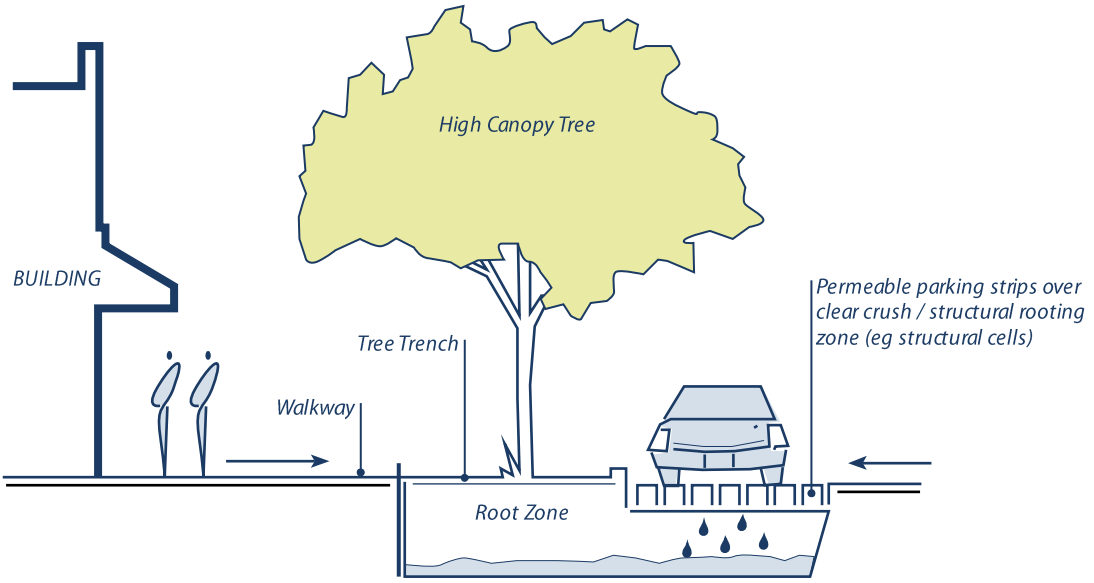

Figure 5. Permeable Paving

Through integrated design, permeable paving can be incorporated in a variety of urban settings. Refer to Metro Vancouver's Stormwater Source Control Design and Guidelines

Innovative Stormwater Treatment

- This can include measures to improve surface run-off as well as wastewater from buildings. These technologies can reduce the amount of off-site wastewater treatment and have the potential to reduce the amount of water required on-site (e.g. engineered wetlands, bio-filtration systems).
- Full or partial treatment of water on-site indirectly using natural landscape processes can reduce the strain on local infrastructure and the need to expand and upgrade storm-water capacities.
- Grey water treatment systems can be used to direct water from showers, washing machines and sinks to be re-used for other non-potable purposes. Standards are currently under development.
- Mechanical separator systems are available that help increase the quality of run-off from urban surfaces. At a larger scale, aquatic and biological based filtration systems can be used to treat wastewater that can then be used for the irrigation and recycling for building use, depending on the degree of purification.

*__Note__: While standards are under development, there are currently significant health, safety and Vancouver Building By-law issues involved with grey water reuse systems. Contact a professional or City of Vancouver Licenses and Inspections for further information.

Green Roofs

- There are two key types: extensive and intensive (for definitions refer to Appendix B)
- Green roofs are a specific roofscape treatment using vegetative cover. Benefits can include:
  - down pipe improvements in storm-water quality and quantity;
  - mitigation of the urban heat island effect;
  - opportunities for ecological biodiversity and amenity space for people; and
  - insulation and protection from ultraviolet sunlight damage.
- Water wise measures for on-grade landscapes also apply to landscapes on structures.
- Some green roof systems feature measures to retain stormwater and reduce the need for irrigation.
- Extensive green roofs typically require temporary irrigation for an establishment period of approximately three years.
- Intensive green roofs require permanent high efficiency irrigation and/or hose bibs due to limited soil volumes and exposure.
- For information on designing and installing green roofs, refer to the Metro Vancouver Ecological Site Development Manual and refer to the Vancouver Building By-law for related requirements.

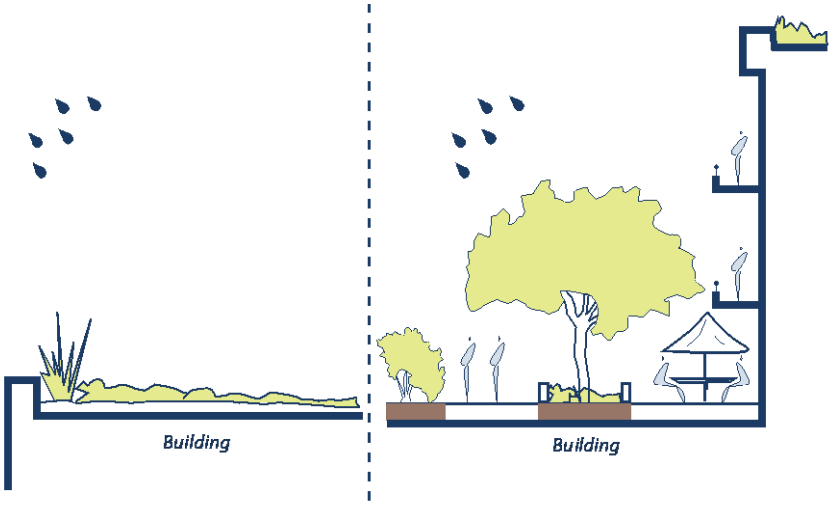

Figure 6a. Extensive Green Roof

Often inaccessible, extensive roofs can play an important role in an overall Water wise Landscape by minimizing stromwater runoff and reducing the urban heat island effect.

Figure 6b. Intensive Green Roof

As accessible amenity space, intensive roofs can also use a variety of water wise techniques and strategies.

Water Balance Method

The City of Vancouver receives most of its annual rainfall in the winter when the majority of plant species are in dormancy and uptake less water. Consequently, a large portion of winter rainwater empties into the stormwater systems and adjacent water bodies. In the summer months, there is significantly less precipitation available for plants during their primary growth cycle when they need it the most. This creates a demand for outdoor irrigation resulting in potable water consumption. Water balance modeling, at the site scale, seeks to offset the imbalances in this cycle through a systems design approach. Rainwater is collected and stored in storage tanks on site for availability in the summer months.

*__Note__: There are significant health, safety and Vancouver Building By-law issues involved with water storage and reuse systems. Contact a professional or City of Vancouver Licenses and Inspections for further information.

7.5 Plants

Trees - General

- Refer to the City of Vancouver Tree By-Law Guidelines for information on tree care and maintenance.
- Trees that provide shade can help to lower ambient air and soil temperatures, helping the soil to retain moisture and minimize evaporation.
- Tree canopies intercept rainfall, slowing its flow through the canopy and reducing stormwater runoff and erosion.

Plant Choice

- Consider planting deciduous trees on the south and west sides of building. In the summer the leaves will help decrease building temperatures while allowing sunlight to warm the building in winter when the leaves are gone.

Design Considerations

- Consider planting trees in valleys and depressions. Rainwater will collect in these areas and consequently be partially absorbed by the tree's roots.
- Position trees to block the wind to minimize evaporation.
- Consider the root habits of different species. Some plants and trees may require special root management measures such as "root barrier" to help direct roots to a desired location.

Establishment

- Trees take longer to establish than most other landscape plants and need special consideration when watering.
- For new trees, irrigate using a low flow bubbler irrigation head. Build a small soil ring around the tree at the edge of the root ball, and apply mulch, to hold water. Ensure water is directed inside the soil ring.
- Water on a weekly basis as required in the first year, if possible. Two years after planting, water less frequently and within the tree canopy drip line.
- During periods of extended hot weather, trees need extra water. Focus the watering in a zone at a radial distance from the trunk of three (3) times the trunk diameter. A deep watering garden tool will direct water down into the soil and roots, minimizing water loss.

Proper Maintenance

- Soak soil 600-900 mm (2'-3') deep as tree roots are usually located in the top 900 mm (3') of the soil.
- Irrigate 0.05 m^3 (10 gallons) of water per 25 mm (1") diameter of tree trunk each week. More established trees do not require weekly watering, unless signalling stress.
- Signals of stress due to drought include; wilted leaves, yellow scorching, and brown leaf veins. If these signals are noticeable, water immediately to prevent long term damage to the tree. Watering during drought should aim to sustain the tree through that period. It is not intended to maximize growth. Trees under stress may not display visual symptoms until their condition is advanced.
- Do not fertilize trees during drought periods.
- Remove dead and weak or damaged branches.
- A Certified Arborist should be consulted to assess your trees for specific maintenance requirements.

Special Considerations

- In general, coniferous trees will evapotranspirate more than deciduous trees due to their leaf shape and full year activity.
- Some trees thrive in wet locations (e.g. willows) and others do well in dry locations (e.g. redbud).
- Anticipate and plan for the size and water requirements of trees at full maturity.

7.6 Shrubs, Vines, Ornamental Grasses and Perennials

General

- A mix of shrubs, climbers, grasses, and perennials will help increase biodiversity.
- Layering foliage will help intercept rainfall and shade the soil surface. Consider the effect of shading and drying when choosing plants to be established under larger plants and trees.
- Establish climbing plants on landscape structures and facades to help cool or moderate temperatures.

Plant Choice

- Use native or hardy adaptive shrubs. They are better adapted to our climate and require less water.
- Use only non-invasive species. This will protect against invasive species from entering natural areas and disturbing drainage patterns.

Design Considerations

- When designing, group new and existing shrubs and perennials with similar water requirements.
- Generally, the higher the leaf surface area a plant has the more water it loses due to transpiration. In response, some plant species have thick, waxy leaves to help retain moisture.
- Hairs on the leaves of some plants reduce the speed of wind over the leaf surfaces, minimizing evaporation.
- Most shrubs and perennials have shallow roots making them easy to transplant.

Establishment

- Generally, planting of nursery stock may occur all year long. Exercise caution and care before, during and after periods of extended summer heat when plants are highly susceptible to root dieback and dehydration, whether in transport or recently planted.
- Dig holes equal to the depth of the root ball and twice as wide as the root ball to encourage root growth.
- Create a soil ring around the root ball of plants.

Proper Maintenance

- Soak slowly and infrequently using soaker hoses or drip-lines. Note that shrub roots are usually located in the top 600 mm (2') of the soil.
- Sagging stems or wilting leaves are a sign that shrubs and perennials need watering.
- For container plants, check soil regularly. Use enough water so that some drips out the drainage hole.
- Water plants according to their different moisture needs to maximize watering efficiency.
- Improve soil with compost instead of fertilizing.
- Prune dead or weak parts to support new growth.

Special Considerations

- Some perennials require dividing as they mature. Root systems can become compounded and compete for water and nutrients, ultimately affecting the plant's health.
- When considering aesthetics think about how each plant will look through all seasons. There are plant species that spread slowly as part of their natural habit, but are not considered "invasive". Use caution in their application.

7.7 Lawns

General

- Turf grass areas can often use large amounts of water and fertilizers, require a lot of maintenance and eliminate potential biodiversity.
- A properly maintained and well-established lawn can easily survive and thrive all summer without watering.

Plant Choice

- Turf grass use is best limited to areas where a hard wearing planted surface is desired, such as flexible open space and recreational areas. When possible, consider using lawn alternatives such as groundcovers or planting beds.

Design Considerations

- Irrigation systems should be designed to accommodate different exposures, as they require different watering needs.

Establishment

- Soil should be at least 15-30 cm (6-12") depth.
- For new lawns, seeding will establish a healthier root system than sod.
- Ask a local garden centre about a low water use variety seed mix.
- When establishing new lawns, wait until grass reaches 5-6 cm (2-2½") height before first mowing.

Proper Maintenance

- Water lawns according to the time of year and weather.
- For most lawns, 25 mm (1") of water per week, including rainfall, is all that is required. A deeper, less frequent watering that soaks 150-200 mm (6-8") into the lawn's root zone will promote deeper and healthier root growth. If needed, only water those areas of the lawn that are used for pedestrian activity.
- Water only when your lawn is under stress. To test, walk across your lawn. If your footprints do not bounce back it is a sign the lawn needs watering.
- Watering in the early morning or cool part of the day will minimize water loss due to evaporation. Watering in the evening may promote disease.
- During the summer months let lawns go dormant. Grass may turn brown but will be revived after a healthy rainfall.
- Keep lawns at a height of 8-10 cm (3-4"). Cut no more than one third of the grass blade at once and always use sharp tools. Grass clippings should be left in place. They break down rapidly and will provide nutrients to the soil. A mulching mower will chop-up clippings better.
- Push mowers cleanly cut the grass blades as opposed to rotary mowers blades that tear the grass blades and can damage root systems. Push mowers are also portable, do not require fuel, and do not contribute to pollution. If grass blades go brown at the tip shortly after mowing, then your mower blades need sharpening.
- For existing lawns de-thatch and fertilize in the spring and aerate in the fall.
- Observe Vancouver's watering restrictions during the summer.

Special Considerations

- Consider watering only the part of your lawn that is highly visible. For example, mow and maintain the front while letting the rest of the lawn go dormant.
- Consider limiting lawn areas to functional areas with heavier use; for example, as children grow older lawn areas usually become less used and could be converted to garden.

7.8 Lawn Alternatives

General

- Alternatives to turf grass can increase biodiversity, and greatly reduce water and fertilizer requirements.
- Turf grass alternatives can require no mowing, and often require no watering after they are established.

Plant Choice

- Use plants that require less water and maintenance.

Design Considerations

- It is important to consider how lawn alternatives will hold up to regular foot traffic of a particular area.
- Consider different alternatives for different exposures. Mixing different alternatives will also help increase biodiversity and reduce potential devastation from disease.

Establishment

- Turf grass is very competitive. Be aware when replacing an existing lawn to ensure all turfgrass remnants are removed.
- Soil depth will depend on the type of alternative being used.
- Start native perennials from seed.

Proper Maintenance

- Native perennials require intensive maintenance when first established to eliminate invasive weeds, once established they require less maintenance, and watering.
- For most areas water less than 25 mm (1") per week (including rainfall), depending on alternative used, this will allow water to soak 150-200 mm (6-8") into the plants root zones.

Special Considerations

- Native perennials, though beautiful to some, may be considered messy and unattractive to others. To give an indication of maintenance, consider mowing a strip around the perimeter of the area.
- Using more plant types will help prevent against devastation from disease.

This report has been prepared as part of the City of Vancouver's *Green Building Strategy* by the City's Sustainability Office, Development Services/ Landscape Architecture Review Group and Sharp & Diamond Landscape Architecture.

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Staff Advisory:	Rick Michaels, Anita Molaro, Sandra Korpan

Resources

City of Vancouver Resources

Water Conservation Programs:

http://vancouver.ca/engsvcs/watersewers/environment/conservationprograms.htm

Engineering Services: Be Water wise:

http://vancouver.ca/engsvcs/solidwaste/grownatural/waterwise.htm

Engineering Services: Lawn Sprinkling Regulations:

http://vancouver.ca/engsvcs/watersewers/environment/sprinkling.htm

Rain Barrels: Barrels can be purchased in Vancouver from the Transfer Station at

377 West Kent Avenue North ☎ 604.873.7350

Other Resources

Metro Vancouver: Water wise Gardening; A Guide for British Columbia's Lower Mainland

http://www.metrovancouver.org/about/publications/Publications/WaterwiseGardening.pdf

Metro Vancouver: Ecological Site Development; Strategies for Design, Construction and Maintenance

http://www.metrovancouver.org/about/publications/Publications/ecologicalsitedevelopmentguidefinal1.pdf

Metro Vancouver: Stormwater Source Control Guidelines

http://www.metrovancouver.org/about/publications/Publications/Storm_Source_Control_PartV.pdf

Saving Water Partnership

http://www.savingwater.org/outside.htm

Environment Canada: Water Efficiency and Conservation

http://www.ec.gc.ca/water/en/manage/effic/e_weff.htm

Be Water Wise

http://www.bewaterwise.com

Native Plant Society of British Columbia

http://www.npsbc.org/

*__Note__: Links provided are valid as of July 2009. The precise links often change or are updated regularly over time. We recommend that users enter the title provided into their internet search engine to source electronic copies of the documents if link becomes outdated.

Definitions

The following definitions apply to their use throughout this document, unless otherwise stated.

Absorbent Landscapes: landscapes that allow water to soak into the ground, temporarily infiltrating and storing stormwater.

Adaptive Plants: Often described as "hardy", "drought tolerant" or "low maintenance", adaptive plants have been introduced to the region from other places. Tested by decades of gardeners in many kinds of applications, they are an important plant group in the urban landscape because of their versatility and success. They represent a significant portion of the widely available nursery plant stock available to consumers and landscape professions.

Aggregate: formed from a loosely compacted mass of fragments or particles (e.g. gravel).

Bio-Swales: constructed landscape features that facilitate in the collection of water runoff, trapping and filtering both silt and pollution. They are typically linear, for surface flow of water, and always vegetated.

Bio-geoclimatic Zone: a geographic area having similar patterns of energy flow, vegetation and soils as a result of a broadly homogenous macroclimate.

Biodiversity: the amount of variation of life forms within a given ecosystem or landscape. Biodiversity is often used as a measure of the health of biological systems.

Climbing Plants: those that have the ability to be trained to grow vertically onto structures or surfaces.

Ecological Design: the process of designing landscapes to emulate natural systems. It considers the biogeoclimatic zones at the large scale and shade tolerance, soil moisture, soil nutrient, and ground surface materials conditions at the smaller scale.

Edible Landscape: produces food fit for human and wildlife consumption.

Evapotranspiration: the combined loss of water as vapour from the land and plants to the atmosphere.

Green Facades: vegetated exterior walls that use vertical systems to support climbing plants growing from the ground or planters. Also see living walls.

Green Roofs – Extensive: features lightweight growing medium usually less than 150 mm (6") in depth. This type of green roof requires minimal ongoing maintenance once established. Typically, these types of roofs may have a more natural appearance with sedums, various grasses, and perennials.

Green Roofs – Intensive: have a greater soil depth than extensive green roofs. Typically depths are 300-900 mm+ (12-36"+). These types of roofs more commonly involve larger tree and shrub plantings. Irrigation and maintenance requirements are higher than typical extensive green roofs.

Greywater: cloudy waste water produced by bathing and laundering, as long as it contains no more than negligible amounts of contaminants, such as fecal matter, food particles or toxic chemicals.

Growing Medium: any material in which a plant can successfully survive.

Heat Island Effect: comparing the temperature differences between cities and outlying areas. Causes for heat gain in cities are attributed to: energy released from traffic and buildings; heat energy released by exterior surfaces that absorb solar energy; lower evapotranspiration rates from lower biomass and natural land area; and, disruptions in wind patterns caused by buildings. Chemical processes may also be a factor.

Hydrozone: an area of landscape with similar enough water conditions to be classified as its own unit. For example, low areas that pond may be considered one hydrozone and higher areas that dry out quickly may be considered another hydrozone.

Integrated Pest Management (IPM): a systematic approach to pest control that aims to reduce or minimize the use of pesticides, often using biological methods instead of chemical.

Innovative Wastewater Treatment: alternative methods of removing contaminants (toxic or inorganic) from wastewater through creative design solutions. This normally is site specific and uses biological processes in place of chemical processes. (Note: There are some concerns, especially from a municipal standpoint, over how water should be re-used if it has not passed through a treatment process.)

Integrated Design Process (IDP): a multi-disciplinary and collaborative approach to creating design solutions where team members of all disciplines are involved in the project resolution from the beginning, through project commissioning, and landscape establishment.

Infiltration: the process by which water permeates the ground.

Living Wall: vegetated walls that use modular panels or fabric systems to grow plants on a structural wall or frame. This is often integrated with a building envelope system.

Lawn Alternatives: include groundcovers, ornamental grasses, clover, perennials, or other low maintenance plantings in place of planting a traditional lawn.

LEED™ (Leadership in Energy and Environmental Design): is a environmental performance certification program that strives to recognize building projects' commitments to sustainability. LEED™ is administered by the Canada Green Building Council.

Microclimate: the climate of a small geographic area, such as a city, city block or back yard, compared to the climate of a region.

Mulch: a material used for covering the soil around plants. Usually this material is in the form of decomposed bark, compost, or other organic material, although mulches may also be inorganic, such as gravels. Mulch assists in retaining water and minimizing evaporation.

Permeable Paving: porous hardscape surface treatment that allows and facilitates the movement of water into the ground, while supporting vehicular and pedestrian traffic.

Potable Water: treated water that is safe for human consumption.

Professional: an expert in the respective discipline that will provide services of a technical, design, safety or compliance nature. Professionals involved in projects at the municipal level are engineers, architects, landscape architects, surveyors and Arborists.

Rain Gardens: landscape elements that resemble vegetated depressions usually wider than swales and shorter in length. They are designed to absorb and treat stormwater runoff.

Structural Soil: a medium that uses a specific combination of aggregate and soil to support hardscape treatments in a stable manner. At the same time this allows plants to achieve deep and lateral root growth.

Transpiration: the loss of water as vapour from plant material through the process of evaporation.

Urban Agriculture: the activity of growing plants for food production and other related purposes.

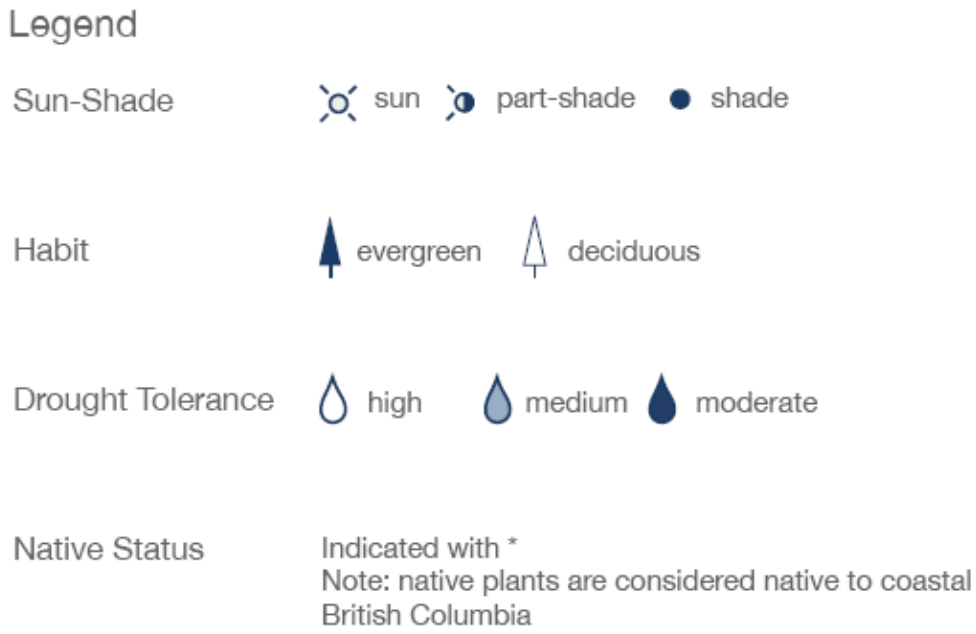
Xeriscaping: a style of landscape design requiring little to no irrigation or other maintenance. Xeriscaping is most appropriate for areas with little rainfall and long periods of drought.

Plant Lists

Rationale for Selections

The plants identified for each category do not represent an exhaustive list. Rather, these plants are an indication of the typical plant families to consider. Before using any specific plant, research as thoroughly as possible to understand its needs, characteristics and watering requirements.

For planting near areas where children gather, consult the City of Vancouver Childcare Design Guidelines.



Trees

Botanical Name	Common Name	Exposure	Habit	Height (M)	Drought Tolerance
*Acer glabrum**	Douglas Maple			7.0	
*Crataegus douglasii**	Douglas Hawthorn			4.5	
Ginkgo biloba	Maidenhair Tree			24.0	
Gleditsia triacanthos	Honey Locust			11.0	
Picea omorika	Siberian Spruce			9.0	
*Pinus nigra**	Austrian Pine			12.0	
*Psuedotsuga menziesii**	Douglas Fir			25.0	
Sorbus spp.	Mountain Ash			5.0	
*Thuja spp**	Cedar			13.0	

* Indicates species native to British Columbia

Vines

Botanical Name	Common Name	Exposure	Habit	Bloom	Drought Tolerance
Campsis radicans	Trumpet Creeper			S	
*Clematis jackmanii**	Jackman Clematis			Sp	
*Lonicera spp**	Honeysuckle			Sp/S	
Parthenocissus quinquefolia	Virginia Creeper			Sp	
Wisteria spp.	Wisteria			Sp-S	
Vitis spp.	Grapevine			Sp-S	

* Indicates species native to British Columbia

Shrubs

Botanical Name	Common Name	Exposure	Habit	Height (M)	Drought Tolerance
*Amelanchier alnifolia**	Saskatoon berry			4.5	
*Arctostaphylos uva-ursi**	Kinnikinnick			0.2	
Ceanothus spp.	Ceanothus			3.5	
*Cornus sericea**	Red Osier Dogwood			4.0	
Lavandula augustifolia	English Lavender			1.0	
*Mahonia aquifolium**	Oregon Grape			2.4	
*Philadelphus spp**	Mock Orange			2.0	
*Rhododendron spp**	Rododendron			2.5	
*Potentilla fruticosa**	Cinquefoil			1.0	
*Rhus glabra**	Smooth Sumac			4.0	
*Ribes spp**	Currant			3.0	
*Rosa nutkana**	Nootka Rose			3.0	
Rosemarinus officinalis	Rosemary			1.0	
*Rubus spectabilis**	Salmonberry			3.2	
Sambucus cerulea	Blue Elderberry			6.0	
*Symphoricarpos spp**	Snowberry			2.5	
Taxus x media 'Hicksii'	Yew			3.0	
*Vaccinium ovatum**	Evergreen Huckleberry			2.5	

* Indicates species native to British Columbia

Perennials

Botanical Name	Common Name	Exposure	Bloom	Height (cm)	Drought Tolerance
*Achillea spp**	Yarrow	☼	S/F	150	
*Aquilegia formosa**	Red Columbine	☼ ◑	Sp/F	60	
Fragaria chiloensis	Coastal Strawberry	☼	S	30	
Dryopteris spp	Wood Fern	●	-	750	
Echinacea purpurea	Purple Coneflower	☼	S	900	
Hemmerocallis spp	Daylily	☼ ◑	Sp-F	varies	
Perovskia atriplicifolia	Russian Sage	☼	S/F	150	
Rudbeckia spp	Blackeyed Susan	☼	S	800	
Thymus spp	Creeping Thyme	☼ ●	Sp	10	
*Tiarella trifoliata**	Foamflower	☼ ●	S	300	
*Sedum spp.**	Stonecrop	☼ ●	Sp	30	
*Heuchera micrantha**	Alum Root	☼	S	120	

* Indicates species native to British Columbia

Ornamental Grasses

Botanical Name	Common Name	Exposure	Season	Height (cm)	Drought Tolerance
Agrostis pallens	Dune Bentgrass	☼	C	300	
Calamagrostis x acutiflora	Feather Reed Grass	☼	C	400	
*Festuca spp**	Fescue Grass	☼	C	300	
Helictotrichon spp	Blue Oat Grass	☼	C	100	
Koeleria glauca	Blue Hair Grass	☼	C	55	
Pennisteum alopecuroides	Dwarf Fountain Grass	☼ ◑	W	100	
*Stipa spp**	Feather Grass	☼	C	100	

* Indicates species native to British Columbia

Extensive Green Roof Less than 150mm / 6”

Botanical Name	Common Name	Exposure	Bloom	Height (cm)	Drought Tolerance
*Allium spp.**	Onion		S	80	
*Brodiaea hyacinthina**	Fool’s Onion		S-F	70	
*Carex pansa**	Sand Dune Sedge		-	40	
*Eriophyllum lanatum**	Wooly Sunflower		S	40	
*Fragaria vesca**	Woodland Strawberry		S	20	
*Olsynium douglasii**	Blue-Eyed Grass		Sp	25	

* Indicates species native to British Columbia

Intensive Green Roof

Botanical Name	Common Name	Exposure	Habit	Height (M)	Drought Tolerance
*Achillea millefolium**	Yarrow			0.5	
Buxus sempervirens	Dwarf Boxwood			1.0	
Malus spp	Ornamental Crabapple			4.5	
*Mohnia nervosa**	Low Oregon-Grape			1.0	
Molinia caerulea	Purple Moor Grass			1.5	
*Ribes sanguineum**	Flowering Currant			3.0	
Taxus x media ‘Hicksii’	Yew			2.5	

* Indicates species native to British Columbia