**BIODIVERSITY DESIGN GUIDELINES**

# DRAINAGE FEATURES

4

## Context

Constructed and modified drainage features like bioswales, rain gardens, amended topsoil, detention ponds, off-channel fish habitat, and artificial wetlands are engineered to mimic natural features, habitats, and processes. These semi-natural features (referred to as green infrastructure) provide beneficial services by helping to manage stormwater runoff quantity and quality, mitigate flooding, and support biodiversity. Implementation of green infrastructure is a strategy that encourages reduction of impervious (hard) surfaces by using vegetation, soil, and natural processes to capture, absorb, and filter rainwater at the point where it falls. This soft-engineering approach contrasts with traditional grey infrastructure approaches (e.g., underground pipes, berms, and detention tanks) to manage stormwater. A combination of green and grey approaches is often still necessary, particularly in built up urban areas; however, minimizing and disconnecting hard surfaces is essential to maintaining ecosystem health and biodiversity. For example, stream ecosystems show visible evidence of degradation when the percentage of hard surfaces within a watershed reaches 10%. When hard surfaces reach 30%, stream degradation is severe and sometimes irreversible.[1]

Constructed and modified drainage features can be designed to manage water (and support biodiversity) at different scales. Low Impact Development (LID) applications such as bioswales and rain gardens are designed to capture frequent storm events at a small, site-level scale. Larger community stormwater storage facilities (e.g., detention ponds) are designed to manage water at the sub-watershed scale. Employing a variety of green infrastructure approaches supports the City's Integrated Stormwater Management Plans (ISMP). ISMPs are watershed and sub-watershed plans that use an ecosystem-based approach to manage stormwater by balancing land use with the protection of natural assets and processes.

**Surrey South Operations Centre Rain Garden**
**Credit: City of Surrey**

## Key Considerations

Numerous guidelines exist that provide engineering specifications for construction of different drainage features, including green infrastructure. This module provides additional information related to biodiversity-targeted enhancements that can be included in base engineering designs. Some key considerations when implementing constructed and modified drainage features include:

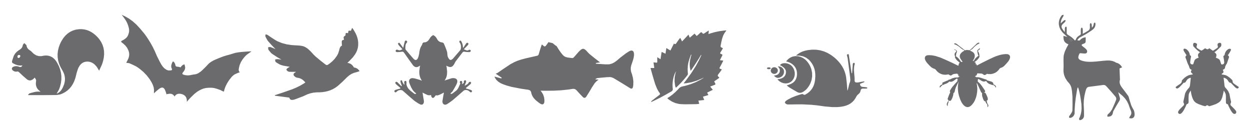
- ☑ Maintain natural areas (e.g., trees, shrubs, grass, soil, etc.) to help manage water at the source. Engineered green infrastructure can approximate natural habitat but is not a perfect replacement, particularly in terms of its ability to support biodiversity.
- ☑ Reduce hard surfaces. Use constructed and modified drainage features to replace hard surfaces and increase total green and permeable areas.
- ☑ Disconnect hard surfaces. Provide opportunities for surface runoff to drain to pervious features for absorption and filtering prior to discharge to grey infrastructure.
- ☑ Integrate green infrastructure throughout developed areas to improve habitat connectivity. Assess potential negative impacts on wildlife and other natural assets (e.g., groundwater) associated with site-level primary treatment to remove pollutants from air and water.

**Relevant Surrey Documents:**

- ☑ Biodiversity Conservation Strategy (2014)
- ☑ Official Community Plan (2013)
- ☑ Integrated Stormwater Management Plans (various years)
- ☑ Neighbourhood Concept Plans, Town Centre Plans, and Local Area Plans (various years)
- ☑ Engineering Design Criteria Manual (2020) and Supplementary Master Municipal Construction Documents (2020)
- ☑ Park Design Guidelines (2020)
- ☑ Parks Construction Documents (2017)
- ☑ Arterial Median Landscape Guidelines (2018)
- ☑ Stormwater Drainage Regulation and Charges By-law No. 16610 (2008)
- ☑ Coastal Flood Adaptation Strategy (2020)
- ☑ Climate Change Adaptation Strategy (2013)
- ☑ Community Climate Adaptation Strategy (2014)

Metro Vancouver also has developed Stormwater Source Control Design Guidelines (2012) which focus on the implementation of LID practices. These guidelines can be further complemented by the biodiversity-focused information contained in this module.

## ICON LEGEND:



*Small Mammals*, *Bats*, *Birds*, *Herptiles*, *Fish*, *Plants*, *Invertebrates*, *Pollinators*, *Large Mammals*, *Insects*

Cost Legend: Relative Cost: $ (low), $$ (medium), and $$$ (high).

## Module linkages:

# 4.1 WATER STORAGE

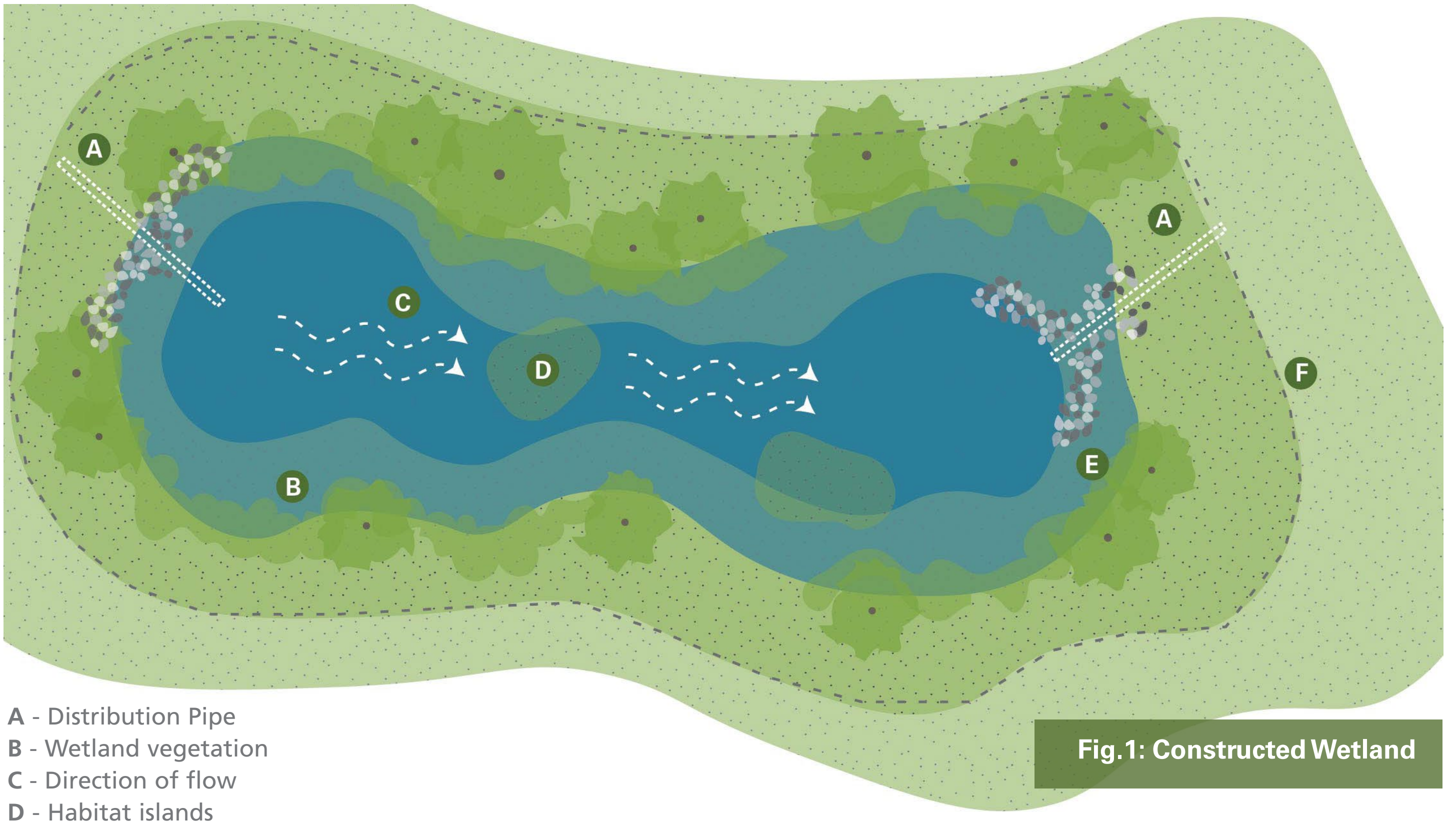
## 4.1.1 CONSTRUCTED WETLANDS

Constructed wetlands are artificial marshes or swamps with permanent or temporary standing water that capture, store, and treat stormwater runoff. Constructed wetlands are typically designed to remove contaminants and improve water quality using natural processes involving plant, soil, and microbial communities. They can also help to control peak water outflow rates. Constructed wetlands typically have a shallow depth, more vegetation, and much less water storage capacity compared to wet detention ponds.

Wetlands are unique habitats that are considered biologically productive due to the amount of organic matter present and nutrient cycling that occurs. As such, wetlands can support a wide diversity of plants and wildlife (many of which are Species of Conservation Concern) and contribute to the health and function of connected aquatic and terrestrial habitat as well.

### Design Guidelines:

- ☑ Refer to *City of Surrey Engineering Design Criteria Manual* for specific design requirements.
- ☑ Consider hydrology (surface and groundwater drainage patterns), soil, topography, adjacent land use, and impermeable surfaces when selecting a site.
- ☑ Refer to local reference sites to determine indicative ecological conditions (e.g., plant communities, soil conditions, hydrology) for the site.
- ☑ Design for minimum catchment area of 4ha, unless constructing a pocket wetland that will have sufficient water input. The size of wetland can be adjusted based on the size of catchment area.[2] Note that the City of Surrey does not specify a catchment area for constructed wetlands, but does have a 20ha minimum catchment area for wet ponds.
- ☑ Avoid rectangular or straight channels and encourage more natural, sinuous edges.[3]
- ☑ Avoid conditions that could lead to stagnant water and avian botulism (which can affect birds, primarily waterfowl).
- ☑ Vary wetland depth to include permanent pools and elevated areas to suit diversity of aquatic and emergent vegetation.
- ☑ Include areas of open water and habitat islands for waterfowl.
- ☑ Use biodegradable geotextiles to stabilize slopes and allow root penetration.
- ☑ Establish a vegetated buffer (minimum of 10m or follow regulatory requirements where relevant) around the wetland that is planted with a diversity of native plant species.
- ☑ Plant fast growing native species such as willow and select native emergent and submergent plants with high wildlife value.




A - Distribution Pipe
B - Wetland vegetation
C - Direction of flow
D - Habitat islands
E - Shore stabilization
F - Habitat friendly fencing (see Module 3: Road Ecology)

**Fig.1: Constructed Wetland**

**Table. 1: Emergent and Submergent Vegetation with High Wildlife Value Suitable for Constructed Wetlands[4]**

| Common Name/Species | Form | Wildlife |
|---|---|---|
| Common rush (*Juncus spp.*) | Emergent | Small mammals, waterfowl, songbirds |
| Common duckweed (*Lemna spp.*) | Submergent/Emergent | Waterfowl, fish |
| Pondweed (*Potamogeton spp.*) | Submergent | Waterfowl, marshbirds, shorebirds |
| Sedge (*Carex spp.*) | Emergent | Waterfowl, songbirds, small mammals |
| Soft-stemmed bulrush (*Schoenoplectus tabernaemontani*) | Emergent | Water birds |
| Smartweed (*Polygonum spp.*) | Emergent | Waterfowl, songbirds |
| Woolgrass (*Scirpus spp.*) | Emergent | Waterfowl, small mammals |

- Allow for some natural colonization of plants and animals.
- Introduce habitat features including downed wood, wildlife trees, and artificial structures.
- Consider installing pre-treatment systems upstream to help remove sediment that may clog a wetland system.
- Include a forebay in design to capture pollutants.
- Provide sufficient access to support operation and maintenance activities.
- Locate trails (if desired) to manage public access and minimize potential disturbance to wildlife.

**Focal Guilds and Species:**

**Cost: $$$**

**Where to Implement**: Community Stormwater Management Facility. Locate appropriately within drainage system.

**What to Watch For:**

- Creating wetlands is challenging due to the need to introduce and store water on a site; particularly if the existing soil is not adapted to those conditions.
- Replicating the required conditions may mean replacing natural habitat that already exists; this trade-off must be considered in terms of cost and biodiversity.
- Constructed wetlands may not provide all biodiversity benefits and ecological functions of natural ecosystems.
- Locate wetland with consideration of flyways and wildlife corridors (e.g., Green Infrastructure Network).
- Consider potential water quality impacts. Constructed wetlands are designed to receive stormwater and poor water quality may be an issue for sensitive species. Groundwater and surface water may also be affected.
- Avoid wetland construction in areas where site conditions and/or adjacent land use are incompatible with biodiversity objectives.
- Plan for drought. Ensure there is a safe, dedicated water source that can support terrestrial and aquatic communities.[3]
- Assess and mitigate potential for introduction of invasive plants and/or animals.
- Do not build constructed wetlands in areas where wetlands or natural buffers already occur, as construction can disturb soils and hydrological patterns, which may degrade natural ecosystems.
- Ensure constructed wetlands consider future land use and development.
- Wetland projects are long-term. Monitoring, maintenance, and funding plans must be in place to allow for adjustments and adaptation (e.g., water level, planting and invasive species management, cleaning out polluted sediments if there are pre-treatment pools) over time.
- The Provincial Government must approve the construction of any wetland to ensure compliance with the Water Sustainability Act.

**East Clayton Pond**
**Credit: Markus Kishnick**

- ☑ Creating ponds and wetlands that are "connected" through surface flow or piped infrastructure will require Provincial Riparian Area Protection Regulation (RAPR) setbacks.
  - o Minimum setbacks for ponds and wetlands are measured from the 5-year high water mark, and are 15m to the West, North and East, and 30m to the South.

**Monitoring for Use:**

- ☑ Accumulation of sediment, trash, and toxins (heavy metals) may require occasional clean-up and/or dredging.
- ☑ Monitor water quality, water level, and hydrological processes.
- ☑ Vegetation control of aquatic plants (e.g., cattails) may be required.
- ☑ Monitor and manage invasive plants.
- ☑ Conduct regular inspections and after storm events.

**Co-benefits:**

- ☑ Intercept runoff and store stormwater.
- ☑ Store carbon.
- ☑ Improve water quality by capturing sediment and filtering pollutants.
- ☑ Control erosion.
- ☑ Recharge groundwater.
- ☑ Reduce flood damage.
- ☑ Improve visual aesthetics.
- ☑ Provide opportunities for recreation, including wildlife viewing.

## FURTHER READING:

**Diversity by Design – Wetland Communities.**[5]
**An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement.** [6]
**Guiding Principles for Constructed Treatment Wetlands: Providing for Water Quality and Wildlife Habitat.**[3]
**Stormwater Wet Pond and Wetland Management Guidebook.**[7]

# CASE STUDY

## Chantrell Creek Park

### Surrey, BC

New wetland habitat was created in the headwaters of Chantrell in Creek in 2019. This wetland project supports previous engineering works completed downstream to rehabilitate the creek's natural drainage system, improving fish accessibility, and maximize habitat potential. Some of the heavy lifting for this project included creating 'complexing' features in newly shaped pools that provide shade and shelter within the new wetland habitat. These areas will later fill with water to create deeper areas and shallow benches perfect for native frogs, salamanders and a variety of birds. The project also saw installation of new bird boxes along the pond to create a safe nesting place for swallows, improved beaver protection fencing, and removal of invasive plants. Much of this work was completed by members of Surrey's Natural Areas Partnership (SNAP) and Salmon Habitat Restoration Program (SHaRP).

Credit: City of Surrey

## 4.1.2 DETENTION PONDS

Wet detention ponds are primarily designed to collect and store stormwater runoff for a significant period of time, and then release the runoff at a controlled rate.  Some water quality benefits may also be achieved. Wet ponds have a permanent pool that rises in response to a storm event and then returns to its original elevation after runoff is released. Dry detention ponds also provide temporary storage of runoff and allow time for pollutants to settle; however, they do not have a permanent pool. Instead, dry ponds are designed to be empty (i.e., dry) between storm events.

### Design Guidelines (Wet Ponds/Dry Ponds*):

- ☑ Refer to *City of Surrey Engineering Design Criteria Manual* for specific design requirements.
- ☑ Establish a no-mow buffer around the perimeter of pond to support growth of native vegetation that can filter pollutants, stabilize banks, and help prevent erosion. Include plants of varying height. Plant emergent vegetation to control algae blooms and waterfowl access. See Constructed Wetlands section of this module for suitable biodiversity-focused plant lists.
- ☑ Maintain upland buffer zones with native vegetation to help reduce the introduction of unwanted plant species.
- ☑ Include features that break up large contiguous open water areas to deter large numbers of waterfowl that can affect water quality in permanent pools.
- ☑ *Consider naturalizing typical passive grass vegetative cover to increase structural diversity and enhance benefits for wildlife for dry detention ponds designed to capture extreme or seasonal runoff. Planting in and around dry ponds can also help filter out pollutants.

**Focal Guilds and Species:**

**Cost: $$$**

**Where to Implement**: Community Stormwater Management Facility. Locate appropriately within drainage system.

**What to Watch For:**

- ☑ Avoid siting wet ponds within or adjacent to low lying areas, riparian areas, and wetlands as they can impede surface and groundwater flow and degrade these natural ecosystems.
- ☑ Do not site dry ponds in areas with a high water table as permanent soil moisture can result in a mosquito breeding ground.
- ☑ Avoid or minimize turf (passive grass) landscaping  where possible.  If grass is preferred/necessary, maintain as early successional habitat (e.g., rough mow meadow) with native grass species.
- ☑ Limit mowing to annual or longer rotations (if possible) and leave grass a minimum 20cm tall when cutting.

**Monitoring for Use:**

- ☑ Manage aquatic and terrestrial vegetation to meet design goals. Vegetation may be harvested or maintained to avoid spread into unwanted areas, and to prevent establishment and spread of undesirable species (e.g., *Typha spp.*) and invasive plants that can create monocultures and outcompete other native species and reduce biodiversity.
- ☑ Conduct vegetation management September-January to avoid amphibian spawning periods (February-April) and the bird nesting window (March 1 to August 31).

## 4.1.2 BIOPONDS

Bioponds are constructed ponds that use plants to filter excess nutrients (e.g., nitrogen and phosphorus) from stormwater, wastewater, agricultural runoff, and other sources. Bioponds can also provide habitat for aquatic and riparian species. Bioponds have a smaller catchment area than wet/dry detention ponds and are not designed to control flow.

### Design Guidelines:

- ☑ Design water levels should provide a range of different habitats.
- ☑ Design elevations and drainage to prevent stranding of aquatic species when water levels are low.
- ☑ Use native plants suited to the specific site conditions and anticipated hydrologic regime. Water levels may fluctuate significantly depending on rainfall and the drainage area.
- ☑ Incorporate habitat structures such as rock piles and downed wood.

**Focal Guilds and Species:**

**Cost: $$-$$$**

**Where to Implement**: Street/park/facility LID. Where suited to drainage system.

**What to Watch For:**

- ☑ Ensure biopond capacity matches drainage area requirements.
- ☑ Trees and plant cover are essential to keep water temperatures down.
- ☑ Bioponds should be designed as "offline" systems that feed into the storm drain system and should not be built in existing natural areas.
- ☑ Bioponds are engineered structures, and therefore must meet engineering standards, and health and safety requirements.
- ☑ Centralized stormwater management features like bioponds work well as part of a larger stormwater treatment approach that includes reduction of effective impervious areas and other Low Impact Development strategies such as bioswales and rain gardens.

**Monitoring for Use:**

- ☑ Irrigation is generally needed during the plant establishment phase, similar to other planted landscapes.
- ☑ Invasive species monitoring is needed.

# CASE STUDY

## Robson Park Detention Ponds

### Surrey, BC

The Robson Park stormwater management project responded to a requirement to detain stormwater in the headwaters of Robson creek to mitigate downstream erosion. The project retrofits a storm detention/management system into a traditionally constructed neighbourhood. The project was designed to detain frequent event storms, with the expectation of operating approximately 46 days per year (with most of those days occurring from October to March). Maximum water storage is 10,130 cubic meters. Community support for the park revitalization project was significant as the park would be more user friendly, safer, and relevant to neighbourhood needs, in addition to providing environmental benefits.

The City entered into a memorandum of understanding with the Province of BC and Fisheries and Oceans Canada (DFO) to implement the stormwater management strategies while ensuring no net loss in fish productivity. Habitat restoration included daylighting parts of the stream and creating new spawning & rearing habitat for fish. The project also improved aeration in the stream and also provides some degree of water quality treatment on the urban storm drainage prior to it discharging to fisheries habitat. Additional planting was completed to restore riparian habitat and support natural succession.

Credit: City of Surrey

# 4.2 BIORETENTION

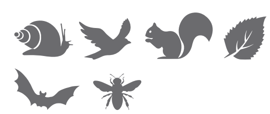
## 4.2.1 BIOSWALE

Bioswales are linear bioretention features situated in shallow troughs and depressions next to roads and parking lots. These features have gently sloped channel profiles and typically include native plants, soil, and a porous substrate to capture, store, treat, and discharge/convey stormwater. Bioswales can also help to recharge groundwater. Bioswales provide biodiversity benefits by creating a variety of micro-habitats that can host plants, insects, and wildlife.

### Design Guidelines:

- ☑ Refer to M*etro Vancouver Stormwater Source Control Guidelines and Surrey Parks Construction Documents* for specific engineering requirements.
- ☑ Include curb cuts, gutters, or other conveyance structures that will carry or direct water to the bioswale.
- ☑ Install geotextile or geogrid, depending on the application, over bottom porous layer to prevent accumulation of sludge and plant roots.
- ☑ Provide an overflow to the grey drainage infrastructure system to provide relief during larger storm events.
- ☑ Install rocks, soil, and native plants on top layer.
- ☑ Plant vegetation that is suited to a range of moisture regimes and fluctuating water levels.[8] Plants at the top of swale should be suited to dryer, sunnier conditions, and plants at bottom of swale suited to more shaded, saturated conditions.
- ☑ Select plants with high vegetative surface area and ability to uptake nutrients.
- ☑ Integrate trees into bioswale design. Trees should be selected based on transpiration rate (high), size at maturity (large), and health and condition (able to withstand road pollution). *Ulmus, Fraxinus,* and *Quercus* genera are good examples.[9] Ensure tree placement does not inhibit hydraulic capacity of the bioswale. Care should be taken to ensure leaf accumulation does not affect bioswale function and maintenance.
- ☑ Select deep rooted shrubs, forbs, and grasses. Plant densely to build soil structure and allow water infiltration.

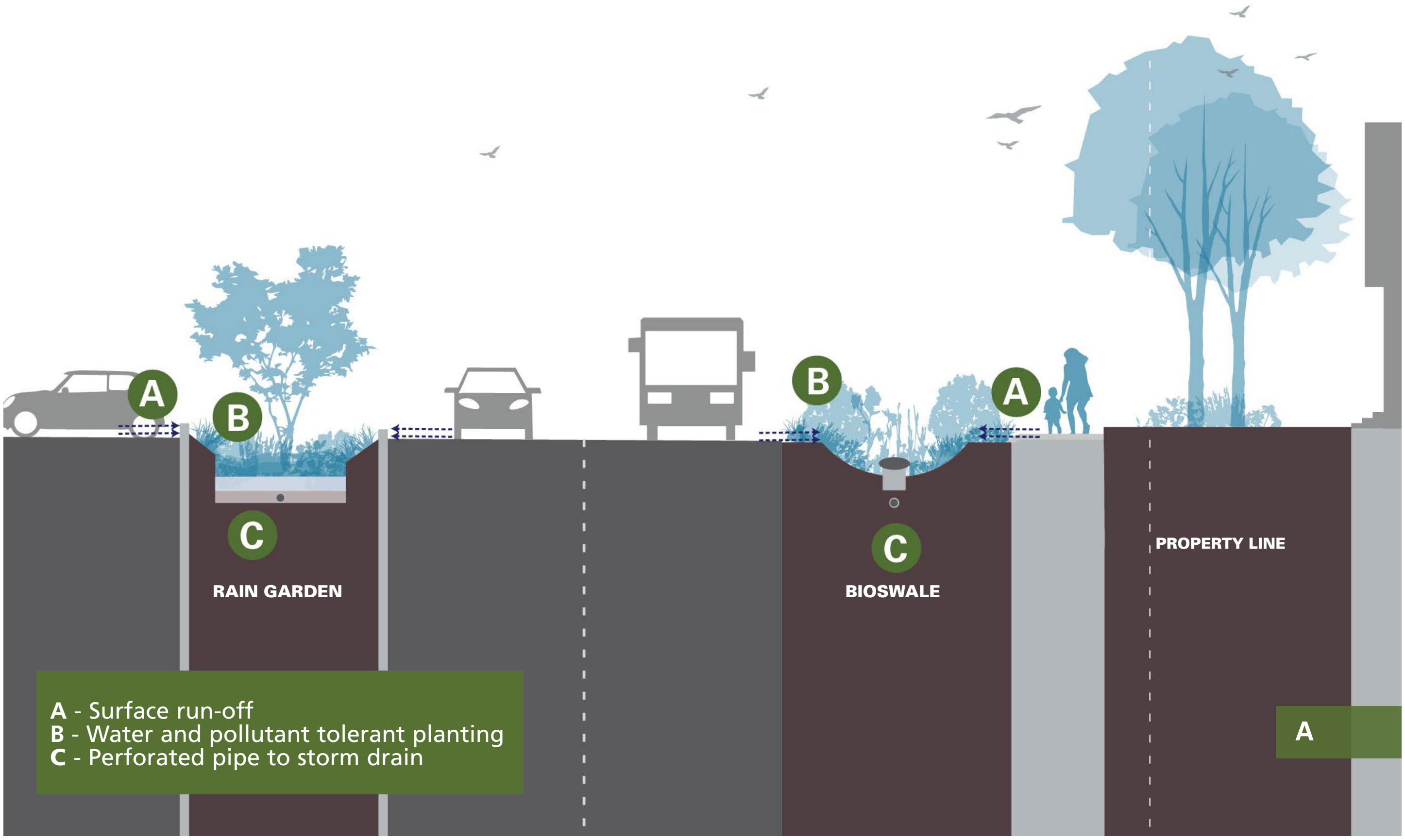
**Focal Guilds and Species:**
**Cost: $-$$**



**Where to Implement**: Street/park/facility LID. Integrate adjacent to linear features (e.g., roads) and parking lots.

**What to Watch For:**

- ☑ Best designed to handle small, frequent rain events.
- ☑ Groundwater should not come within 2m of bottom of bioswale.
- ☑ Be aware of potential for bioswales to encumber boulevard tree planting. Integrate suitable trees into bioswale design.






**A** - Fig. 2: Rain garden and bioswale
**B** - Rain garden example - Credit: Carla Stewart
**C** - Bioswale example - Credit: Carla Stewart

- ☑ More plant diversity will increase root volume and permeability but will decrease storage capacity by a minor amount ( <1%).
- ☑ Select plants that have minimum irrigation requirements to reduce maintenance.
- ☑ Select plants that have appropriate growth habit and mature size for the location to reduce maintenance.
- ☑ Avoid placement on steep and/or unstable slopes due to potential for erosion. Terracing can be implemented to address slope concerns.
- ☑ Avoid the use of chemical sprays when maintaining bioswales as these systems may be connected to stormwater infrastructure and streams.
- ☑ Connect to other green infrastructure including constructed wetlands, green roofs, rain gardens, or green streets.
- ☑ Install signage to increase awareness of bioswales and their benefits, and to promote buy-in from community.

**Co-benefits:**

- ☑ Improve water quality.
- ☑ Reduce total volume of stormwater runoff.
- ☑ Improve water quality by capturing sediment and filtering pollutants.
- ☑ Increase infiltration and recharge groundwater.
- ☑ Improve visual aesthetics.

## 4.2.2 RAIN GARDEN

Rain gardens are a small scale form of bioretention designed with native, water tolerant plants to increase groundwater infiltration (not hold water). Rain gardens generally collect water from downspouts, roads, and/or upland areas and can be easily implemented on both private and public land.

### Design Guidelines:

- ☑ Refer to *Metro Vancouver Stormwater Source Control Guidelines and Surrey Park Design Guidelin*es for specific engineering requirements.
- ☑ Design size of rain garden to accommodate drainage area.
- ☑ Locate sites with partial to full sun.
- ☑ Use a meandering edge versus a rectangular shape.
- ☑ Locate on gentle slopes away from tree roots and highly compacted soils, and away from buildings and large trees (to allow the rain garden to dry out between storm events)
- ☑ Design bigger to accommodate a wider diversity of plants.
- ☑ Plant vegetation suited to three moisture zones. Low, wet zones hold water for longer periods, middle (mesic) zones drain more quickly, and drier, upland zones.
- ☑ Include native and acceptable non-native plants that bloom at different times of the year. Include a mixture of low, medium, and tall plants.

Rain Garden
Credit: Carla Stewart

- ☑ Diversify planting to include ecologically suitable grasses, sedges, forbs, and shrubs. Trees may be included; however, care should be taken to ensure leaf accumulation does not affect rain garden function and maintenance.
- ☑ Introduce habitat features including downed wood, wildlife trees, and artificial habitat structures.
- ☑ Include natural barriers (e.g., tall shrubs) to control access where required. Eliminate or minimize use of fencing where possible.

**Focal Guilds and Species:**
**Cost: $-$$**

**Where to Implement**: Street/park/facility LID. On-lot LID (property owner).

**What to Watch For:**
- ☑ Rain gardens can be designed to be permanent ponds, but most are intended to hold standing water for only a few hours after a rainfall event.
- ☑ Rain gardens may be difficult to establish on steep slopes; however, terracing can be implemented to address slope concerns.
- ☑ Avoid placing in areas where water already ponds.

**Monitoring for use:**
- ☑ General garden maintenance is required, with more weeding and watering in the first couple of years until plants establish.
- ☑ Monitor to see if water is infiltrating sufficiently.

**Co-benefits:**
- ☑ Capture and filter stormwater.
- ☑ Increase infiltration and recharge groundwater.
- ☑ Prevent flooding.
- ☑ Improve visual aesthetics.

## 4.3.1 ABSORBENT LANDSCAPES

Absorbent landscapes reduce the impacts of impervious areas on stormwater runoff by replicating natural conditions using layered vegetation (trees, shrubs, forbs, grasses) and soil to manage rainwater through interception, capture, infiltration, and evapotranspiration.

### Design Guidelines:
- ☑ Refer to *Metro Vancouver Stormwater Source Control Guidelines* and *City of Surrey Engineering Design Criteria Manual* for specific engineering requirements.
- ☑ Conserve existing natural areas where possible.
- ☑ Maximize tree canopy cover. Prefer evergreen trees over deciduous species.
- ☑ Prefer native plant species where possible.
- ☑ Provide soil depth of a minimum 45cm for lawns and shrub/tree areas, or as outlined in the corresponding ISMP. Avoid significant compaction of underlying native subgrade before placing absorbent soil to promote infiltration into the native\ subgrade.

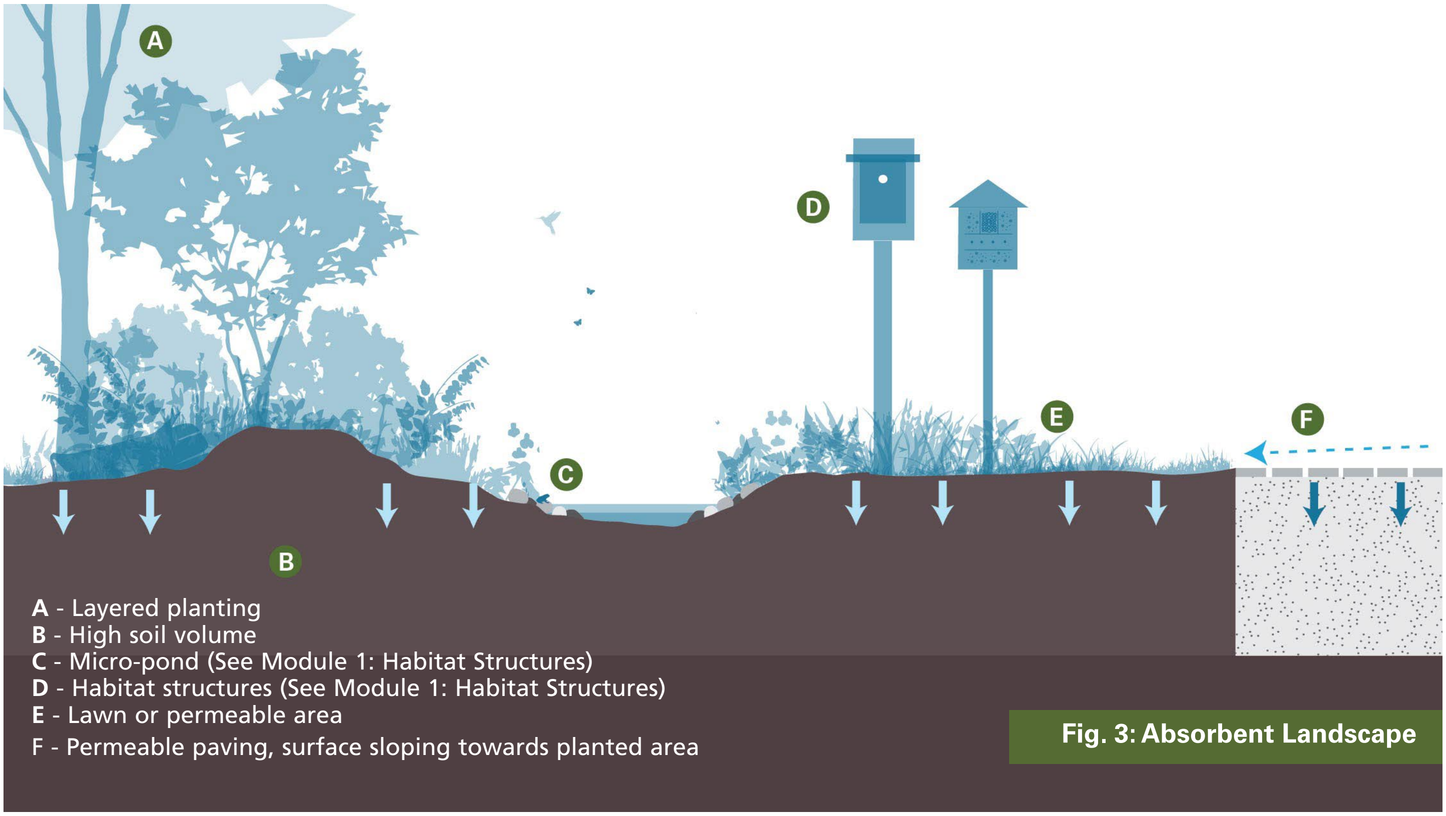



Fig. 3: Absorbent Landscape

- ☑ Direct runoff from impervious areas to absorbent landscapes to disconnect impervious features.
- ☑ Include shallow depressions to temporarily slow and store runoff while it infiltrates the ground.

**Focal Guilds and Species:** 

**Cost: $-$$**

**Where to Implement**: Street/park/facility LID. On-lot LID (property owner).

**What to Watch For:**

- ☑ Establish plant cover quickly to maintain soil permeability and reduce erosion.
- ☑ Avoid compacting soil and mulch (if added).
- ☑ Minimize the amount of impervious surface and disconnect impervious surfaces by directing independently to absorbent landscape areas.
- ☑ Absorbent landscapes are more suited to large areas; however, impervious surfaces should always be minimized. Match the area of absorbent landscape with drainage requirements for the site.

**Co-benefits:**

- ☑ Absorb and infiltrate rainwater.
- ☑ Improve visual aesthetics.
- ☑ Control erosion.
- ☑ Increase soil permeability.

## FURTHER READING:

**Low Impact Development: A Design Manual for Urban Areas.**[2]

**Rain Gardens. A Guide for Homeowners and Landscapers.**

**Stormwater Best Practices.**[10]

## 4.3.2 SOIL CELLS

Soil cells or soil vaults are underground structural systems that allow increased soil volume for street trees under impervious areas, allowing for improved tree health and growth potential. They also contribute to stormwater management by increasing the interception and evapotranspiration capacity of street trees, reducing peak flows, improving water quality, and increasing infiltration compared to traditional street tree planting assemblies.

### Design Guidelines:

☑ Specific dimensions and design specifications are provided by product manufacturers.

☑ The greatest benefits are gained by creating continuous soil cells that provide space for multiple trees.

**Focal Guilds and Species:**

**Cost: $-$$**

**Where to Implement**: Street/park/facility LID. Soil cells can be used along sidewalks, boulevards, on slab, under plazas, in parking areas, and on green roofs.

**What to Watch For:**

☑ Soil cells are most useful in urban areas with high proportions of impermeable surfaces and high foot traffic areas where planting beds are not practical.

☑ Consider the relationship of the soil cells to other infrastructure and utilities so that they are installed properly and future maintenance requirements and impacts are minimized.

☑ Soil volume and properties are critical to success. The soils used within the soil cells must meet the recommendations from the product supplier and should provide adequate volume for the specific tree species.

☑ Soil cells are part of the stormwater system and should be sized appropriately for the stormwater management target volumes.

☑ Can create conflicts with underground utilities if not properly planned in advance. A variety of strategies are available to mitigate conflicts depending on utility design requirements.

☑ Minimal maintenance and monitoring once installed.

**Co-benefits:**

☑ Improve urban tree health and increase canopy cover.

☑ Absorb and infiltrate stormwater.

☑ Reduce peak overflow volumes.

☑ Increase space efficiency.

☑ Improve visual aesthetics.

### FURTHER READING:

**Silva Cell.** [10]

**Stratavault/ Stratacell.** [11]



A - Silva Cell installation - Credit: Deep Root
B - Fig. 4: Soil Cell
* Diagram adapted from [Innovex]

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