BIODIVERSITY DESIGN GUIDELINES

SPRING 2021

CITY OF SURREY

ACKNOWLEDGEMENTS

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ZOETICA
WILDLIFE RESEARCH SERVICES

LEES+ASSOCIATES
LANDSCAPE ARCHITECTS + PLANNERS

INTRODUCTION

The Biodiversity Design Guidelines (BDGs) provide recommended actions to support implementation of Surrey's Biodiversity Conservation Strategy (BCS). These guidelines are designed for use on public and private land, and support land use planning and development activities within the City's Green Infrastructure Network (GIN) and the Urban Matrix (lands outside of the GIN). The BDGs are intended for implementation primarily at the site level.

Organized into eight modules, the BDGs incorporate available research, guidance and best management practices related to biodiversity conservation for the following topic areas:

- **Module 1** - Habitat Structures
- **Module 2** - Light & Noise
- **Module 3** - Road Ecology
- **Module 4** - Drainage
- **Module 5** - Green Roofs & Walls
- **Module 6** - Maintained Landscapes
- **Module 7** - Trails
- **Module 8** - Signage

The Biodiversity Design Guidelines address current management needs and are adaptable to future conditions. Biodiversity conservation requires going beyond a "one-size fits all" solution, particularly when it comes to addressing varying land use planning and community expectations. The guidelines are prioritized to ensure that the selected actions support City objectives, and are feasible to implement on the ground while considering organizational capacity. Successful implementation of the BDGs will help build momentum and support further buy-in from City staff, developers, and the public. The guidelines are a living document that can be adapted, expanded, or amended in response to changing needs, new research and best practices for biodiversity conservation.

Module Linkages:

Each of the eight BDG modules focuses on a specific biodiversity conservation theme; however, many of the modules are interrelated and should be considered as companion documents. For example, a biodiversity-enhanced road crossing or bioswale may incorporate elements taken from other modules such as Maintained Landscapes, Lighting, Habitat Structures, or Signage as part of their design. The following figure summarizes the interrelationships between each of the proposed modules.

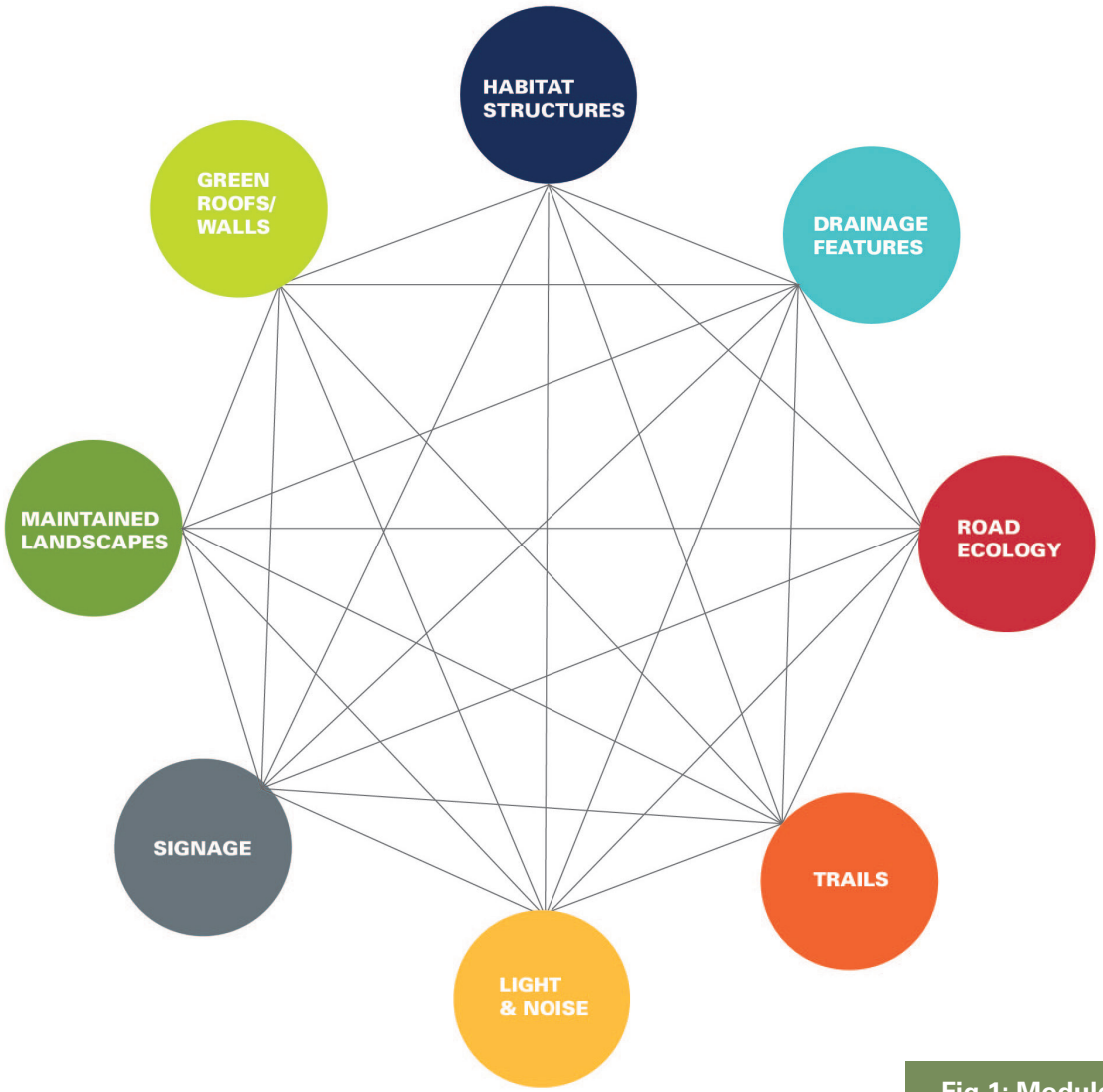

Fig.1: Module Linkages

BIODIVERSITY DESIGN PRINCIPLES

Eight principles provide a consistent framework for the guidelines. The principles integrate key considerations including climate change, ecosystem benefits (i.e., the value of natural assets), and linkages to City and Regional policies:

1. Maintain existing GIN components (hubs, sites, and corridors), and restore, create, and enhance new habitat in both the GIN and Urban Matrix.
2. Promote movement and dispersal of species by connecting fragmented habitat.
3. Minimize human disturbance and other threats that can impact biodiversity.
4. Allow natural ecological processes to occur, wherever possible.
5. Promote the variety of benefits and ecosystem services received from the City's natural assets including flood protection, crop pollination, carbon storage, air and water quality maintenance and energy savings.
6. Promote positive human-nature interactions. The guidelines should be educational, raise awareness of the value of nature, and promote a positive stewardship ethic and or approach.
7. Minimize potential conflicts between nature preservation and safety (e.g., Crime Prevention Through Environmental Design).
8. Support climate change adaptation and mitigation.

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Biodiversity Strategy
GREEN INFRASTRUCTURE NETWORK

- GREEN INFRASTRUCTURE NETWORK
- PROTECTED HUBS AND SITES (Crescent Park)
- UNPROTECTED HUBS AND SITES (F)
- REGIONAL CORRIDORS (8)
- LOCAL CORRIDORS (15)
- SUPPORTING PARK SITES
- AGRICULTURAL LAND RESERVE

JUNE 2014

Data Sources: City of Surrey
Data Developed By: Diamond Head Consulting Ltd.
Map Design: Ecoplan International

MANAGEMENT CONSIDERATIONS

Core considerations were identified that would increase uptake and integration of the BDGs into city operations and processes, and improve overall effectiveness:

- **Context.** The BDGs are Surrey-specific and consider the environmental, social, and political context of the City. However, biodiversity does not adhere to geopolitical boundaries. Regional connectivity considerations (where appropriate) have been considered as well.

- **Linkages.** Linkages at the operational and policy level are essential. Operational linkages speak to what aspects of biodiversity are being managed, where they are being managed, and why. Policy linkages speak to the integration of the BDGs with other internal plans, policies, processes, standards, and bylaws. To be effective, the BDGs must clearly mesh with efforts at both levels and the associated frameworks in place. Specific plans/policies/procedures highlighted include:

    - Official Community Plan
    - Biodiversity Conservation Strategy
    - Sensitive Ecosystem Development Permit Area (SEDPA) Guidelines
    - Neighbourhood Concept Plans
    - Secondary Management Plans
    - Integrated Stormwater Management Plans
    - Natural Areas Strategic Management Plan
    - Shade Tree Management Plan
    - Design criteria for specific departments (e.g., Engineering Standards, Park Design Guidelines, Parks Standard Construction Documents)
    - Bylaws (e.g., Zoning, Stormwater Drainage)
    - Development Permit process
    - Environmental Assessment process

Table.1: BDG Policy Linkages

Plans, Policies, and Documents	Module 1- Habitat Structures	Module 2 - Light & Noise	Module 3 - Road Ecology	Module 4 - Drainage	Module 5 - Green Roofs & Walls	Module 6 - Maintained Landscapes	Module 7 - Trails	Module 8 - Signage
Biodiversity Conservation Strategy (2014)	X	X	X	X	X	X	X	X
Engineering Department Design Criteria Manual (2020)		X	X			X	X	
Park Design Guidelines (2020)		X	X	X		X		X
Supplementary Master Municipal Construction Documents (2020)		X	X	X	X			
Coastal Flood Adaptation Strategy (2020)				X				
Arterial Median Landscape Guidelines (2018)			X			X		
Light Rail Wildlife Crossings Design Guidelines (2018)			X					
Surrey Parks, Recreation and Culture Strategic Plan (2018-2027)	X	X					X	
Parks Standard Construction Documents (2017)			X	X		X	X	
Literature Review of Potential Effects on Wildlife – City of Surrey LED Streetlight Conversion Program (2016)		X	X				X	
Exterior Sign Standards (2016)			X					X
Graphic Standards Guide (2016)								X
Community Climate Action Strategy (2014)		X		X	X			
Climate Adaptation Strategy (2013)				X	X	X		
Official Community Plan (2013)	X	X	X	X	X	X	X	X
Greenways Plan (2012)		X	X				X	
Stormwater Drainage Regulation and Charges By-law No.16610				X				
Natural Areas Strategic Management Plan (2002)	X			X		X	X	
Access and Recreation Management Strategy (2002)	X	X					X	
Integrated Stormwater Management Plans			X	X	X	X		
Neighbourhood Concept Plans		X	X	X	X	X	X	

- **Benefits.** The City's natural assets and the ecosystem services they provide, like flood protection, carbon storage, and pollination, provide significant economic value, among other benefits. Demonstrating the benefits of implementing the Biodiversity Design Guidelines is important to encourage uptake. This includes achieving multiple management objectives. For example, the BDGs can support Low Impact Development (LID), integrated stormwater management, community health and well-being, and climate change adaptation and mitigation.

- **Innovation.** The City recognizes that to move forward requires new ways of doing business. Pilot projects are helpful for testing ideas. The BDGs will grow and evolve over time by incorporating new ideas and responding to changing conditions. Effectiveness monitoring can be used to assess the usefulness of the BDGs and identify further opportunities for application.

- **Internal Implementation**. Internal implementation of the BDGs by City staff can be supported in different ways:
    - Champions from multiple departments are needed to get the BDGs off the ground; allowing for institutional knowledge to be passed on and awareness of the BDGs to extend beyond individual staff to become adopted system-wide.
    - Internal communication emphasizing the importance of biodiversity as a supported city-wide value is essential. The BDGs need to be viewed with the same weight as other requirements.
    - The BDGs must be clear, relatable, and easy to use. Staff should be able to identify how the BDGs integrate into their day-to-day activities. There should be clear linkages to other relevant policies.
    - Staff require the knowledge and capacity to be able to review and implement recommended actions within the BDGs.
    - The BDGs take a long-term view, as integration and implementation will take time. Systemic buy-in will be key to adoption of BDG objectives.
    - Departmental capacity will be required. There should be clear understanding of capital, operational, and maintenance costs.

- **External implementation.** External implementation of the BDGs by the development community, the public and other stakeholders, can be supported in different ways:
    - Education and awareness must happen internally first in order to effectively engage external audiences.
    - The BDGs are intended to initially be implemented on City lands and City projects, with an intent to advance their adoption over time for use on private lands.

- Guidelines need to be short, clear, and direct to ensure wider acceptance by public stakeholders.
- Public perceptions around traditional approaches to land use and development are a challenge that the BDGs must overcome.
- Biodiversity must be a widely recognized value with guidance for integrating it into decision-making and implementation. Incentivization of implementation should also be considered.

- **Capacity.** The strategies and actions included in the guidelines need to consider capacity challenges and opportunities including:
  - Communicating cost effectiveness of BDG interventions internally and externally (particularly to developers) to increase the likelihood of buy-in and support.
  - Planning around City resources and operational budget limitations by starting with smaller scale actions and scaling up to larger capital projects.

- **Maintenance. The strategies and actions included in the guidelines need to consider maintenance challenges and opportunities including:**
  - Low maintenance planting plans that incorporate resilient, non-invasive, native, and non-native species to achieve biodiversity objectives.
  - Managing public perception. For example, promoting and establishing native plant communities while educating the public on their benefits versus manicured, highly maintained, low biodiversity landscapes (e.g. mowed passive grass).
  - Managing invasive species and pests through innovative, integrated approaches that reduce pesticide use.

- **Low Barrier Strategies.** There are many relatively low barriers strategies (e.g., planting schemes, increasing the amount of natural areas in parks) that the City of Surrey could begin implementing in the near future to enhance and protect biodiversity.

- **Land Acquisition.** Work towards completing land acquisition objectives as identified in the BCS GIN.

MODULE SUMMARIES

Factors for consideration:

Each of the eight BDG modules includes various design actions that can be implemented at the site-level. A brief summary of each action is provided that includes a short description (i.e., what it is), BCS linkages (i.e., what and where it applies), a list of co-benefits (where applicable), and design, maintenance, and monitoring information (i.e., how to implement and what to watch for):

- **BCS Linkages –** Guilds (target species groupings), focal species (indicator species, Species of Conservation Concern/Species at Risk) and habitats that may be targeted with a specific action (see Icon Legend below).
- **Co-benefits –** Additional ecosystem services that an action may provide in addition to biodiversity conservation. Ecosystem services are the additional benefits provided to humans by healthy, functional ecosystems (i.e., the City's natural assets). Example, a bioswale can provide habitat for certain species, but will also capture rainwater and filter contaminants.
- **Design Guidelines –** General criteria for described actions, accompanied by illustrations or figures and additional resources and references for more specific and detailed design information are provided.
- **Maintenance/Monitoring Requirements –** Implementation of different actions requires capital investment, and may also require funding for maintenance and/or regular monitoring to assess implementation uptake and effectiveness. Maintenance funding is an important, long-term investment essential to meeting biodiversity objectives.

Cost - Relative cost of actions is provided on a 3-point scale ($, $$, $$$) that reflect assigned cost thresholds (where relevant) for each module. The relative costs of actions across all modules may vary due to wide disparities in magnitude and scale.

ICON LEGEND:

Small Mammals *Bats* *Birds* *Herptiles* *Fish* *Plants* *Invertebrates* *Pollinators*

APPENDIX A.
RECOMMENDED PLANTING PALETTES

This biodiversity-focused plant list includes those species recommended for planting within maintained landscape areas; however, retention of existing vegetation that provide biodiversity value is also recommended where possible.

Species: Plants considered valuable for biodiversity planting and establishment are categorized within forb, shrub, and tree categories. Plants marked with an '*' are considered to be of highest value for pollinators. Cultivars are generally not included in this list; however, cultivars may be selected as a proxy for plants on this list. Native species have been prioritized for the biodiversity list; additional non-native species within a plant family or genus (e.g., Milkweeds - *Asclepias*) may be suitable for some maintained landscapes.

Wildlife value: Plants that are used by species and/or species guilds such as Amphibians; Bees; Birds; Butterflies/Moths; Hummingbirds; Insects; and Mammals (Small/Large). Insects include beetles, flies, etc., that can also act as pollinators and are considered beneficial. Native host plants (e.g., those that support native butterfly or other insect species for essential life stages) are identified where relevant. Many ornamental plant species are host plants or have associations with certain insects in their natural home ranges; however, those insects may not occur in British Columbia and these host-plant associations are not indicated as such in this list. Plants that do not provide nectar but do provide valuable habitat for insects and invertebrates are indicated as wildlife cover.

Flowering Season: Early (E) to May; Mid (M) - June to August; Late (L) - September onwards.

Height: Maximum plant height expected within urban environment to nearest 0.5 meter interval.

Status: Native (N), Ornamental (O), Introduced (I). Native plants are indigenous to British Columbia. Ornamental plants are non-native plants that are grown for garden or landscaping purposes. Introduced plants are non-native plants but are considered part of BC Flora (i.e., well-established outside of gardens, etc.).

Ecology: Modal Biogeoclimatic Ecosystem Classification (BEC) Zone Class of native plants and secondary BEC Zone association (if significant) (BEC). BEC associations are provided for native plant species and all native and non-native tree species.

Typology: Refers to a plant's suitability to different landscapes (pollinator garden, park, boulevard, median, utility corridor) based on characteristics such as height, hardiness, and status.

ICON LEGEND:


Hummingbirds


Birds


Herptiles


Fish


Insects


Bees


Host Plant


Mammals


Invertebrates


Plants


Butterflies


Small Mammals

MEDIANS & BOULEVARDS - FORBS

NAME	WILDLIFE VALUE	FLOWERING	HEIGHT	STATUS	ECOLOGY
*Heuchera spp.** Coral bells		M	<1M	O	
Lavendula angustifolia English Lavender		M	<1M	O	
Rosmarinus officinalis Rosemary		E-M	<1.5m	O	

MEDIANS & BOULEVARDS - SHRUBS

NAME	WILDLIFE VALUE	FLOWERING	HEIGHT	STATUS	ECOLOGY
*Calluna vulgaris** Heather		M	<5m	O	
Cotoneaster Bearberry Cotoneaster		E-M	<0.5m	O	
Cotinus Coggygria Smokebush		M	<5m	O	

MEDIANS & BOULEVARDS - SHRUBS

NAME	WILDLIFE VALUE	FLOWERING	HEIGHT	STATUS	ECOLOGY
Cornus sericea Red-osier dogwood		M	<5m	N	CDF CWH
Hydrangea paniculata Panicle Hydrangea		M-L	<5m	O	
Osmanthus burkwoodii Burkwood osmanthus		E	<3m	O	
Rosa nutkana Nootka Rose		M	<3m	N	CDF CWH
Spiraea douglasii Hardhack		E	To 2m	N	CDF CWH

WIDE MEDIANS & BOULEVARDS - TREES

NAME	WILDLIFE VALUE	FLOWERING	HEIGHT	STATUS	ECOLOGY
Acer campestre *Field maple*		E	To 8m	O	CDF CWH
Acer ginnala Amur maple		E	To 6m	O	CDF CWH
Acer griseum Paperbark maple		E	To 8m	O	CWH
Carpinus betulus Hornbeam		E	To 12m	O	CWH
Cercidiphyllum japonicum Katsura		E	To 12m	O	CWH
Cercis canadensis American redbud		E	To 9m	O	CWH
*Cornus kousa** Chinese dogwood		M	To 6m	O	CWH
Gleditsia triacanthos Honey locust		E-M	To 12m	O	CDF CWH
Fagus sylvatica Copper Beech		E	To 12m	O	CWH

WIDE MEDIANS & BOULEVARDS - TREES

NAME	WILDLIFE VALUE	FLOWERING	HEIGHT	STATUS	ECOLOGY
Fraxinus americana White ash		E	To 20m	O	CDF CWH
Liquidambar styraciflua Sweetgum		E	To 13m	O	CWH
Liriodendron tulipifera Tulip tree		E-M	To 20m	O	CWH
Magnolia kobus Kobus magnolia		E	To 9m	O	CWH
Metasequoia glyptostroboides Dawn redwood		n/a	To 20m	O	CDF CWH
Nyssa sylvatica Tupelo		E-M	To 12m	O	CDF CWH
Pinus nigra Austrian pine		n/a	To 20m	O	CDF CWH
Pseudotsuga menziesii Douglas-fir		n/a	To 40m	O	CDF CWH
Quercus coccinea Scarlet oak		E	To 16m	O	CDF CWH
Quercus phellos Willow oak		E	To 13m	O	CWH
Quercus robur English Oak		E	To 16m	O	CDF CWH
Sorbus aucuparia European mountain-ash		E	To 9m	O	CWH
Tilia cordata Small-leaved lime		E-M	To 11m	O	CDF CWH
Ulmus Americana American elm		E	To 20m	O	CDF CWH

UTILITY CORRIDORS - FORBS

NAME	WILDLIFE VALUE	FLOWERING	HEIGHT	STATUS	ECOLOGY
*Achillea millefolium** Western Yarrow		M-L	<1m	N	CDF CWH
*Allium cernuum** Nodding Onion		E-M	<0.5m	N	CDF
Aquilegia formosa Red Columbine		M	<1m	N	CDF CWH
Asclepias speciosa Showy Milkweed		M	<1m	N	CWH
Collomia grandiflora Large-flowered collomia		M	<1m	N	CDF
Camassia quamash Common camas		E	<1m	N	CDF CWH
Eriophyllum lanatum Woolly Sunflower		E-L	<0.5m	N	CDF CWH
Fragaria virginiana/ *F. vescacatum** Wild Strawberry*		E	<0.5m	N	CDF CWH
*Helenium autumnale** Sneezeweed		M-L	<2m	N	CWH
Lomatium utriculatum Spring Gold		E-M	<0.5m	N	CDF
Lupinus polyphyllus Bigleaf lupine		E	<1 m	N	CWH
Plectritis congesta Sea Blush		E-M	<0.5m	N	CDF
Prunella vulgaris Selfheal		M	<0.5m	N/I	CWH
Solidago canadensis Canada goldenrod		L	<2m	N	CWH
Symphyotrichum subspicatum Douglas Aster		L	<1m	N	CWH CDF

UTILITY CORRIDOR - SHRUBS

NAME	WILDLIFE VALUE	FLOWERING	HEIGHT	STATUS	ECOLOGY
Amelanchier alnifolia Saskatoon		E	To 3m	O	CDF CWH
Holodiscus discolor Oceanspray		L	<7m	N	CDF CWH
Oemleria cerasiformis Indian plum		E	<5m	N	CDF CWH
Philadelphus lewisii Mock orange		E-M	<3m	N	CDF
Physocarpus capitatus Pacific ninebark		M	<3m	N	CDF CWH
Ribes sanguineum Red-flowering currant		E-M	To 3m	N	CDF CWH
Rubus parviflorus Thimbleberry		M	<3m	N	CWH
Rubus spectabilis Salmonberry		E	<4m	N	CWH
Salix bebbiana Bebb's willow		E	To 3m	N	CWH
Salix hookeriana *Hooker's willow*		E	To 20m	N	CWH
Sambucus racemosa Red elderberry		E-M	To 3m	N	CDF CWH
Rosa nutkana Nootka Rose		M	<3m	N	CDF CWH
Spiraea douglasii Hardhack		E	To 2m	N	CDF CWH

PARKS - FORBS

NAME	WILDLIFE VALUE	FLOWERING	HEIGHT	STATUS	ECOLOGY
*Achillea millefolium** Western Yarrow		M-L	<1m	N	CDF CWH
*Allium cernuum** Nodding Onion		E-M	<0.5m	N	CDF
Aquilegia formosa Red Columbine		M	<1m	N	CDF CWH
Asclepias speciosa Showy Milkweed		M	<1m	N	CWH
Collomia grandiflora Large-flowered collomia		M	<1m	N	CDF
Camassia quamash Common camas		E	<1m	N	CDF CWH
*Campanula poscharskyana** *Serbian Bellflower*		E-M	<0.5m	I/O	
Eriophyllum lanatum Woolly Sunflower		E-L	<0.5m	N	CDF CWH
Fragaria virginiana/ *F. vescacatum** Wild Strawberry*		E	<0.5m	N	CDF CWH
*Helenium autumnale** Sneezeweed		M-L	<2m	N	CWH
Lomatium utriculatum Spring Gold		E-M	<0.5m	N	CDF
Lupinus polyphyllus Bigleaf lupine		E	<1 m	N	CWH
Plectritis congesta Sea Blush		E-M	<0.5m	N	CDF
Prunella vulgaris Selfheal		M	<0.5m	N/I	CWH
Solidago canadensis Canada goldenrod		L	<2m	N	CWH
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Physocarpus capitatus Pacific ninebark		M	<3m	N	CDF CWH
Ribes sanguineum Red-flowering currant		E-M	To 3m	N	CDF CWH
Rubus parviflorus Thimbleberry		M	<3m	N	CWH
Rubus spectabilis Salmonberry		E	<4m	N	CWH
Salix bebbiana Bebb's willow		E	To 3m	N	CWH
Salix hookeriana *Hooker's willow*		E	To 20m	N	CWH
Sambucus racemosa Red elderberry		E-M	To 3m	N	CDF CWH
Rosa nutkana Nootka Rose		M	<3m	N	CDF CWH
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Camassia quamash Common camas		E	<1m	N	CDF CWH
Eriophyllum lanatum Woolly Sunflower		E-L	<0.5m	N	CDF CWH
Fragaria virginiana/ *F. vescacatum** Wild Strawberry*		E	<0.5m	N	CDF CWH
*Helenium autumnale** Sneezeweed		M-L	<2m	N	CWH
Lomatium utriculatum Spring Gold		E-M	<0.5m	N	CDF
Lupinus polyphyllus Bigleaf lupine		E	<1 m	N	CWH
Plectritis congesta Sea Blush		E-M	<0.5m	N	CDF
Prunella vulgaris Selfheal		M	<0.5m	N/I	CWH
Solidago canadensis Canada goldenrod		L	<2m	N	CWH
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Salix hookeriana *Hooker's willow*		E	To 20m	N	CWH
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Rosa nutkana Nootka Rose		M	<3m	N	CDF CWH
Spiraea douglasii Hardhack		E	To 2m	N	CDF CWH

APPENDIX B.
BIODIVERSITY CHECKLIST

The Biodiversity Checklist summarizes the design actions within each module and application for separate biodiversity management and land use categories. Management categories are broadly defined as areas within Sensitive Ecosystem Development Permit Areas (SEDPA), which includes the Green Infrastructure Network and watercourses, and the urban matrix, which includes all lands outside of the GIN.

The Biodiversity Design Guidelines are intended for use across Surrey's landscape, with an initial focus on internal rollout (City lands). The City may consider additional strategies in the future to increase uptake of the Biodiversity Design Guidelines on private land. For example, incentivizing or requiring the use of the BDGs during the development permitting process. The City of Seattle Green Factor (SGF) could serve as a model for this type of initiative. The SGF is a score-based code (i.e., bylaw) requirement that increases the amount and improves the quality of landscaping in a new development, while also recognizing associated co-benefits (e.g., reduction of stormwater runoff). A minimum score must be achieved depending on the zoning of the property; however, the score can be achieved by selecting from a variety of different landscaping options (e.g., green roofs, native plants, etc.), with each option having a different credit depending on different factors such as area covered. Similarly, credits could be attached to specific biodiversity design guideline actions, with the aim of reaching specific biodiversity targets within a neighbourhood or planning area.

Additional information on the Seattle Green Factor can be found here.

Action	SEDPA		Urban Matrix				
	GIN	Streams (includes riparian area)	Parks	Single Family Residential	Multi-Family Residential	Commercial/ Industrial	Agricultural
Habitat Structures (Module 1)							
Nest box	x	x	x	x	x	x	x
Nest platform	x	x	x		x	x	x
Raptor perch	x	x	x			x	x
Bat box	x	x	x	x	x	x	x
Insect hotel			x	x	x	x	x
Wildlife tree	x	x	x	x	x	x	x
Downed wood	x	x	x	x	x	x	x
Brush/leaf pile	x	x	x	x	x	x	x
Exposed soil/sand piles	x	x	x	x		x	x
Riprap	x	x	x				x
Artificial hibernacula	x	x	x	x	x	x	x
Vernal Pool	x	x	x	x	x	x	x
Large wood	x	x					
Artificial ponds and water features			x	x	x	x	x
Bird bath			x	x	x	x	x
Bird feeder				x	x	x	x
Cat enclosure				x	x		x
Pollinator Garden			x	x	x	x	x
Light and Noise (Module 2)							
Bird-friendly lighting	x	x	x	x	x	x	x
Natural darkness	x	x	x	x	x	x	x
Directional and shielded lighting	x		x	x	x	x	x
Low mounted lighting	x		x	x	x	x	x
Vegetative Buffers	x	x	x	x	x	x	x
Earth berms			x	x	x	x	x
Low-height barriers			x	x	x	x	x
Artificial barriers	x		x	x	x	x	x
Road Ecology (Module 3)							
	x	x	x	x	x	x	x
One-way gates	x						
Wildlife crosswalks	x		x	x	x	x	x
Wildlife curbs	x		x	x	x	x	x
Diversionary Structures	x		x	x	x	x	x
Speed bumps	x		x	x	x	x	x
Signage	x		x	x	x	x	x
Medians	x		x		x		

Action	SEDPA		Urban Matrix				
	GIN	Streams (includes riparian area)	Parks	Single Family Residential	Multi-Family Residential	Commercial/ Industrial	Agricultural
Speed reductions	x		x	x	x	x	x
Underpass (small)	x	x	x	x	x	x	x
Underpass (large)	x	x					
Underpass (multi-use)	x	x	x	x	x	x	x
Culvert (terrestrial)	x		x	x	x	x	x
Culvert (aquatic)	x	x	x	x	x	x	x
Underpass (aquatic)	X	x					
Canopy crossing	x						
Landscape bridge	X						
Drainage (Module 4)							
Constructed wetland			x		x	x	x
Wet detention pond					x	x	x
Biopond			x		x	x	x
Bioswale			x	x	x	x	x
Rain garden			x	x	x	x	
Absorbent landscapes			x	x	x	x	
Soil cells			x	x	x	x	
Green Roofs & Walls (Module 5)							
Intensive green roof			x		x	x	
Extensive green roof			x	x	x	x	
Vegetated mat			x	x	x	x	
Green facade			x	x	x	x	
Living wall			x	x	x	x	
Green retaining wall			x	x	x	x	x

Action	SEDPA		Urban Matrix				
	GIN	Streams (includes riparian area)	Parks	Single Family Residential	Multi-Family Residential	Commercial/ Industrial	Agricultural
Maintained Landscaping (Module 6)							
Narrow medians	x		x	x	x	x	
Wide Medians	x				x	x	
Boulevards	x		x	x	x	x	
Edge Interfaces	x			x	x	x	x
Utility Corridors	x		x		x	x	x
Trails (Module 7)							
Trail surfacing	x		x		x	x	
Foot bridges	x	x	x				
Elevated boardwalks	x	x	x				
Signage (Module 8)							
Interpretive signs	x	x	x	x	x	x	x
Standard warning sign	x		x		x	x	x
Enhanced warning sign	x		x			x	x
Temporal warning sign	x		x	x	x	x	x
Animal detection system	x		x		x	x	x

APPENDIX C.

This section includes a summary of important linkages between the Biodiversity Design Guidelines and the Biodiversity Conservation Strategy (BCS) such as species groupings, focal species and habitat types. Linkages between modules and species groupings are highlighted to emphasize important interrelationships.

SPECIES GROUPINGS AND BDG MODULES

Species Groupings	BDG Modules							
	Habitat Structures	Light and Noise	Road Ecology	Drainage	Green Roofs/Walls	Maintained Landscaping	Trails	Signage
Birds	x	x	x	x	x	x	x	x
Aerial Insectivores	x	x	x	x	x	x		
Raptors	x	x	x	x		x		x
Wetland Birds (e.g., bitterns, cranes, rails)		x	x	x				x
Seabirds (e.g., cormorants, gulls, terns)				x	x	x		
Shorebirds (e.g., sandpipers, plovers, oystercatcher, yellowlegs, killdeer)		x		x	x	x		x
Songbirds	x	x	x	x	x	x	x	
Wading Birds (e.g., herons, night-herons)		x	x	x				x
Waterfowl (e.g., coots, ducks, geese, grebes, loons, swans)	x	x	x	x		x	x	x
Woodpeckers/Sapsuckers	x	x				x		x
Mammals	x	x	x	x		x	x	x
Medium to Large Mammals		x	x	x		x	x	x
Semi-aquatic Mammals		x	x	x				
Small Mammals	x	x	x	x	x	x	x	
Bats	x	x	x	x	x	x	x	x
	x							
Herptiles (Reptiles/Amphibians)	x	x	x	x		x	x	x
Fish	x	x	x	x			x	x
Invertebrates	x	x		x	x	x		x
Aquatic Invertebrates	x	x		x				x
Terrestrial Invertebrates	x	x	x	x	x	x	x	x
Plants	x		x	x	x	x	x	x
Aquatic Plants	x		x	x		x	x	
Coastal Plants (e.g., estuary, beach)	x	x		x			x	x
Terrestrial Plants	x	x	x	x	x	x	x	x

SPECIES GROUPINGS AND HABITAT TYPES

Species Groupings	General Habitat Types	BCS Habitat Types
Birds		
Aerial Insectivores	Field (Open); Forest; Riparian	Herb and Shrub; Young deciduous forest; Young mixed forest; Young evergreen forest; Mature forest; Old growth forest;
Raptors	Field (Open); Forest: Riparian	Herb and Shrub; Young mixed forest; Young evergreen forest; Mature forest; Old growth forest; Riparian
Wetland Birds(e.g., bitterns, rails)	Wetland	Wetland marsh; wetland bog; Riparian
Seabirds (e.g., cormorants, gulls, terns)	Marine – Estuarine	Marine intertidal/estuarine marsh
Shorebirds (e.g., sandpipers, plovers, oystercatcher, yellowlegs, killdeer)	Marine – Estuarine	Marine intertidal/estuarine marsh
Songbirds	Field (Open); Forest; Riparian	Young deciduous forest; Young mixed forest; Young evergreen forest; Mature forest; Old growth forest; Wetland marsh; wetland bog
Wading Birds (e.g., herons, night-herons)	Wetland; Rivers and Lakes	Wetland marsh; Wetland bog; Lakes, ponds and ditch; River; Riparian
Waterfowl (e.g., coots, ducks, geese, grebes, loons, swans)	Wetland; Rivers and Lakes	Wetland marsh; Wetland bog; Lakes, ponds and ditch; River; Riparian
Woodpeckers/Sapsuckers	Forest (mature)	Mature forest; Old growth forest
Mammals		
Medium to Large Mammals	Field (Open); Forest; Wetland; Riparian	Herb and Shrub; Young deciduous forest; Young mixed forest; Young evergreen forest; Mature forest; Old growth forest; Wetland marsh; Wetland bog; Riparian
Semi-aquatic Mammals	Wetland; Rivers and Lakes; Riparian	Wetland marsh; wetland bog; Lakes, ponds and ditch; River; Riparian
Small Mammals	Field (Open); Forest; Wetland	Herb and Shrub; Young deciduous forest; Young mixed forest; Young evergreen forest; Mature forest; Old growth forest; Wetland marsh; wetland bog
Bats	Field (Open); Forest; Wetland	Herb and Shrub; Wetland marsh; wetland bog; Mature forest; Old growth forest

Species Groupings	General Habitat Types	BCS Habitat Types
Herptiles (Reptiles/Amphibians)	Field (Open); Forest; Wetland; Rivers and Lakes	Herb and Shrub; Young deciduous forest; Young mixed forest; Young evergreen forest; Mature forest; Old growth forest; Wetland marsh; wetland bog; Lakes, ponds and ditch; River; Riparian
Fish	Wetland; Rivers and Lakes; Riparian	Wetland marsh; wetland bog; Lakes, ponds and ditch; River; Riparian
Invertebrates		
Aquatic Invertebrates	Wetland; Rivers and Lakes	Wetland marsh; wetland bog; Lakes, ponds and ditch; River
Terrestrial Invertebrates	Field (Open); Forest; Riparian	Herb and Shrub; Young deciduous forest; Young mixed forest; Young evergreen forest; Mature forest; Old growth forest
Plants		
Aquatic Plants	Wetland; Rivers and Lakes	Wetland marsh; wetland bog; Lakes, ponds and ditch; River
Coastal Plants (e.g., estuary, beach)	Marine – Estuarine	Marine intertidal/estuarine marsh
Terrestrial Plants	Field (Open); Forest	Herb and Shrub; Young deciduous forest; Young mixed forest; Young evergreen forest; Mature forest; Old growth forest

SPECIES GROUPINGS AND FOCAL SPECIES

Species Groups/Indicator Species/SCC Species/Additional Focal Species

Species Grouping	BCS Indicator Species	Species of Conservation Concern	Additional Focal Species
Birds			
Aerial Insectivores		Barn Swallow	Vaux's Swift
Raptors	Red-tailed Hawk	Barn Owl Short-eared Owl	Accipiter spp. (Cooper's Hawk) Bald Eagle Great Horned Owl Gyrfalcon Northern Harrier Peregrine Falcon
Wetland Birds		American Bittern	Sora
Seabirds		Double-crested Cormorant	Bonaparte's Gull California Gull
Shorebirds		American Avocet	Greater Yellowlegs
Songbirds	Common Yellowthroat Dark-eyed Junco Pacific-slope Flycatcher Song Sparrow Spotted Towhee Swainson's Thrush Warbling Vireo Willow Flycatcher Yellow Warbler		American Robin Black-capped Chickadee Brown Creeper House Finch Lincoln's Sparrow Pacific Wren Red-eyed Vireo Savannah Sparrow Warbling Vireo Western Meadowlark
Wading Birds		Great Blue *Heron faninni ssp.* Green Heron	
Waterfowl	Hooded Merganser		Canada Goose Common Goldeneye Mallard Trumpeter Swan
Woodpeckers/Sapsuckers	Downy Woodpecker Northern Flicker		Pileated Woodpecker Red-breasted Sapsucker
Other		Band-tailed Pigeon	Belted Kingfisher Northwestern Crow

Species Grouping	BCS Indicator Species	Species of Conservation Concern	Additional Focal Species
Mammals			
Medium to Large Mammals	Black-tailed Deer		Bobcat Raccoon Striped Skunk
Semi-aquatic Mammals	Muskrat	Pacific Water Shrew (SCC)	Mink River Otter
Small Mammals	Douglas Squirrel Townsend's Vole		Humboldt's Flying Squirrel Long-tailed weasel, altifrontalis subspecies Shrew Mole Trowbridge's Shrew Vagrant Shrew
Bats			
Herptiles (Reptiles/Amphibians)	Northern Red-legged Frog Long-toed Salamander Northwestern Salamander Northern Pacific Treefrog	Northern Red-legged Frog Painted Turtle Western Toad	Garter Snake spp.
Fish	Coastal Cutthroat Trout Coho Salmon		Salish Sucker Western brook Lamprey Redside Shiner
Invertebrates			
Aquatic Invertebrates	Dragonflies		Stoneflies/Caddisflies
Terrestrial Invertebrates	Butterflies & Moths	Oregon Forestsnail Pacific Sideband	Bees, wasps and allies Beetles (e.g., ground, lady, meshwing) Gastropods (e.g., Northwest Hesperian, , Banana Slug)
Plants			

Species Grouping	BCS Indicator Species	Species of Conservation Concern	Additional Focal Species
Aquatic Plants			Slender Spike-rush Wapato Yellow Pond-lily Skunk Cabbage
Coastal Plants (e.g., estuary, beach)			Lyngbye's Sedge Silver burweed
Terrestrial Plants			Cooley's Hedgenettle Douglas Aster Nodding Onion Pacific Yew Red Columbine Red Huckleberry Western Trillium