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SUSTAINABLE ARCHITECTURE & BUILDING MAGAZINE

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## LIVING ROOF CASE STUDY

Vancouver Convention Centre

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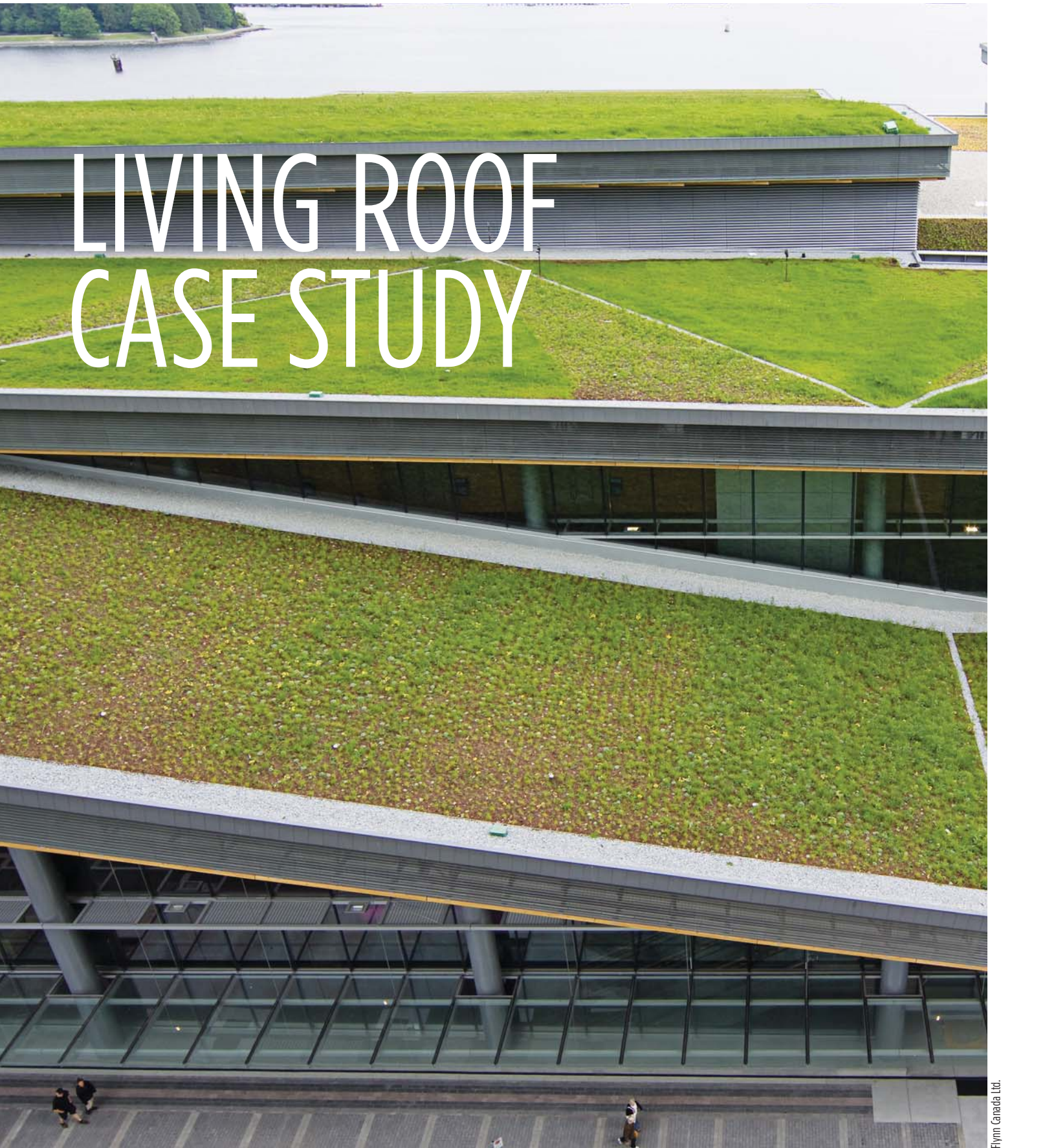
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Photo cover: Vancouver Convention Centre green roof, courtesy Flynn Canada Ltd.  
Photos above: Selective Insulation, Vancouver Convention Centre, Mountain Equipment Co-op Store



# LIVING ROOF CASE STUDY

Flynn Canada Ltd.

**CLIENT** Vancouver Convention Centre Expansion Project **LANDSCAPE ARCHITECTS** PWL Partnership Landscape Architects Inc.; Don Wuori Design Consultants **ARCHITECTS** LMN Architects; Musson Cattel Mackey Partnership; DA Architects & Planners **STRUCTURAL ENGINEERS** Glotman Simpson Consulting Engineers **MECHANICAL ENGINEER** Stantec **ELECTRICAL ENGINEERS** Schenke/ Bawol Engineering **ENVIRONMENTAL ENGINEER** EBA Engineering Consultants Ltd. **LANDSCAPE CONTRACTORS** Holland Landscapers **GENERAL CONTRACTOR** PCL Constructors West Coast Inc. **PROPAGATION CONTRACTOR** NATS Nursery **ROOF CONTRACTOR AND GREEN ROOF CONTRACTOR** Flynn Canada Ltd. **PHOTOS** As noted

# Vancouver Convention Centre Expansion Project

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[www.sabmagazine.com](http://www.sabmagazine.com)

**A I B C CONTINUING  
 E EDUCATION  
 S SYSTEM**

## Simple outward appearance belies underlying complexity of Canada's largest green roof

The Vancouver Convention Centre Expansion Project [VCCEP] which opened in April 2009 occupies a prominent site on the city's Coal Harbour waterfront, with sweeping views west to Stanley Park and north and east to the Coast Mountains. Designed by Seattle-based LMN Architects, in conjunction with Vancouver's Musson Cattel Mackey Partnership and DA Architects & Planners, the 100 000sq.m [1.1 million sf] facility was conceived as a model of sustainable design for large-scale civic buildings.

BY BRUCE HEMSTOCK

### Site plan



The project was the focus of international attention from both design professionals and the public as the broadcast centre for the 2010 Winter Olympic and Para Olympic Games in February and March 2010. While the project employs a wide range of green strategies, including on-site water treatment, deep seawater cooling and heating, and a giant skirt designed to help restore the local fish habitat, the single most visible component of the environmental strategy is the building's living roof.

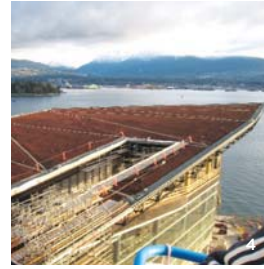
The desire to maintain view corridors from the downtown core limited the overall height of the building, and has given the project a horizontal emphasis. Sloping roof planes supporting an extensive green roof create an architectural landform that is connected both visually and ecologically to its natural context.

The living roof has been designed to imitate Pacific Northwest Coastal grassland and to provide a nesting ground for local birds. The roof has been landscaped with more than 400,000 indigenous plants and grasses from the region [from 25 different species] that provide natural habitat to birds, insects and small mammals. Locally established populations of honeybees pollinate the flowering plants. The Convention Centre's 2.4 hectare [6 acre] self-maintaining, regenerating, living roof is the largest green roof in Canada and presented some unique challenges both in design and construction. PWL Partnership Landscape Architects Inc. led the green roof team in developing the design, plant selection, growing medium design, detailing, nursery propagation coordination and installation field reviews.

### THE ROLE OF LIVING ROOFS

A key component of the overall building envelope design, a living roof is comprised of plants, growing medium, drainage medium, and irrigation system, all of which work together as part of the overall roof system. Living roofs provide benefits for both the building and the environment. The buildup of growing medium and the associated plant layer protect the roof membrane from ultraviolet light degradation and mechanical damage, plus extend the life of the membrane as much as two to three times.

Water evaporation from the growing medium and transpiration from the plants contribute to



the reduction of building heat gain. The growing medium and plant material also insulate the building against heat gain and loss. It is projected that VCCEP's green roof will reduce summer heat gain by as much as 26%. In addition to these building-related benefits, a living roof can provide significant improvements to storm water management by detaining runoff and reducing peak flows. In a building of this scale, storm water detention can translate into significant cost savings by reducing the size of the municipal storm water infrastructure. This became a strong argument in support of the green roof for the VCCEP project.

Urban air quality is also improved as the living roof traps airborne particles and the plants absorb carbon dioxide and release oxygen. Adding ecological habitat in the urban environment and improving overlook conditions from adjacent buildings can also be a significant benefit.

## VCCEP'S LIVING ROOF

From the beginning, the VCCEP design team saw an opportunity to improve the functional and aesthetic properties of the Convention Centre's new roof by incorporating plants. The character of the building with its sloping roof planes ranging from 3 % to 54 %, rising seamlessly from Harbour Green Park and the Coal harbour escarpment, is that of a metaphoric land-form, and within this metaphor, the living roof that covers it is analogous to the plant layer that covers the earth.

With a roof area of 2.5 hectares [six acres], the issues of weight, envelop design, storm water management, growing medium retention on sloping surfaces, irrigation water volumes, and plant types were among the initial technical problems the team singled out to be resolved. In addition, clear spans able to accommodate rooms in the range of 7,400sq.m [80,000 sf] with the minimum possible roof structure needed to be carefully considered.

In order to address these issues, a living roof system similar in nature to Coastal grassland was proposed. Grassland plants are able to grow in shallow depths of soil, plus endure long peri-

ods of drought in the summer and heavy rain in the winter. This plant palate can grow in 15cm of growing medium and enabled us to meet the structural limit for dead load on the roof.

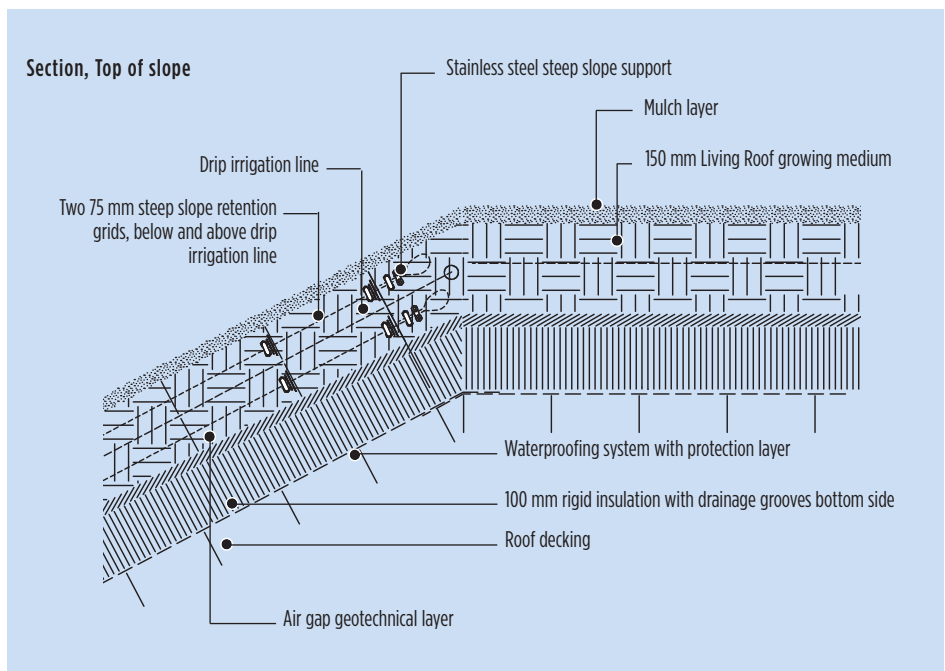
The roof deck is primarily Densdeck sheathing over metal Q-deck, an economical, and durable system that meets the stringent acoustic requirements of the project's meeting rooms and ballrooms. Above this, the waterproof membrane incorporates a Permaquick® reinforced hot-applied rubberized asphalt buildup roofing system with root barrier cap sheet. Rigid building insulation has been laid on top of this cap sheet, and then the entire roof area has been overlain with a leak detection grid. The last system, covering the entire roof area, is the living roof overlay itself.

The living roof overlay was put together by PWL Partnership and is comprised of a drain mat/filter cloth drainage layer over the roof insulation, 15cm of growing medium, drainage runnels and a drip irrigation system. To ensure that the project could be competitively tendered, and built as economically as possible, PWL

needed to ensure the complete drainage system was designed from standard components, so it could be ordered from any manufacturer in Canada and installed without modification or customization.

The growing medium is a combination of lava rock, sand, and organic matter. The mix is well drained, with a saturated weight of 1.29 tonne per cubic metre [80.5 lbs per cu.ft. or 40.25 lbs per sf]. With the exception of the lava rock, the component parts are derived from byproducts from other operations. Sand is from the dredging operations on the Fraser River needed to keep the shipping channels open. Organic matter is from the waste products of the timber industry, food waste and yard waste. Peat moss was not used in the growing medium mix to ensure that the valuable resource of the peat bogs was not damaged.

Even though the roof plants and growing medium will delay and hold a significant amount of storm water, the shear size of the roof required careful management of the storm water movement on the roof surface.





The largest and most challenging area of the roof's many sloping planes is 0.6 hectares [1.5 acres] in size. An arrangement of 45cm-wide [18"], drain rock-filled aluminum-edged runnels crisscrosses diagonally over the various roof planes directing storm water into a conventional building drainage system around the roof perimeter. The drainage system was modelled after a meandering stream in nature.

The building's piled foundations, and long structural spans meant that considerable attention had to be paid to avoid overloading of the roof. Growing medium, delivered by blower truck to a single point needed to be immediately moved by conveyor and lightweight buggy to prescribed safe storage locations above

structural supports.

In the steeply sloping areas, web style retention systems made of high strength polymer matting and stainless steel cables were used to hold growing medium and plant material in place.

Finally, the drip irrigation system designed to ensure that the living roof plants are able to withstand the long dry Vancouver summers utilizes a moisture sensor system that delivers water via 43,500 meters [27 miles] of drip irrigation to the roof only when the growing medium reaches a predetermined minimum moisture content. In keeping with the goal of sustainability the primary source of irrigation water is from the building's black water treat-

### MATERIALS

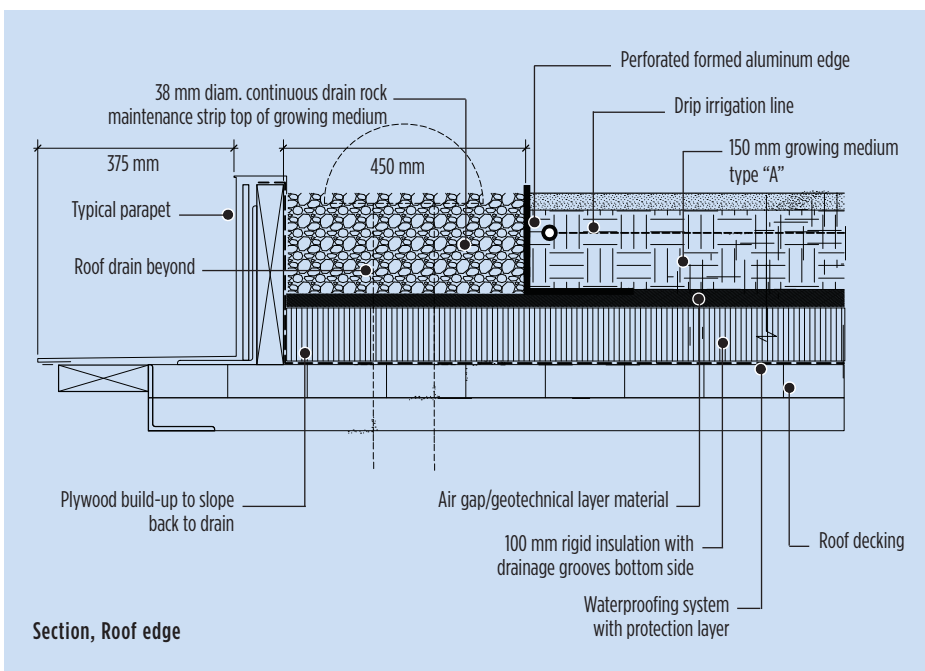
- Moisture-sensing irrigation system; leak detection by **International Leak Detection** using EFVM™ [Electric Field Vector Mapping]
- Spray polyurethane foam, four layers of Densdeck, 4-inch extruded polystyrene roof insulation grooved in two directions on back side for water flow
- **Tremco** TP-6100 Permaquik® hot fluid-applied polymer-modified asphalt membrane with polymer-modified bitumen sheet
- Living Roof overlay designed by PWL, including the drain mat and growing medium; plants supplied by Holland Landscapers - Nats Nursery [joint venture]

### LEAK DETECTION

The leak detection system consists of a low-voltage leak test, known as EFVM™ [Electric Field Vector Mapping]. The process uses permanently placed conductor wires in rectangular loop patterns around the areas to be tested. In detecting breaches, current in the wire loop moves across the roof membrane surface and down through the breach to the earthed structural deck. Technicians triangulate reading probes to identify the direction of the current and, thus, pinpoint the location of the breach.

Waterproofing on steep slopes [1]. Completing application of waterproofing [2]. Retention webbing on sloping section prior to placement of growing medium. *Photo: Jonathan Taggart* [3]. Roof ready for planting [4]. Planting the living roof [5]. The multiple roof planes as viewed from Harbourside Park [6].

*Photos: courtesy of Flynn Canada Ltd.*



sustainability, the primary source of irrigation water is from the building's black water treatment facility.

A three-year off-site test plot program allowed the growing medium, runoff and drainage system to be thoroughly examined as well as confirming the suitability of the various native plant species proposed for the project. The test plots allowed for modifications to the living roof overlay design to respond to observations made during the test period.

Established for more than a year, VCCEP now has the largest non-industrial living roof in North America. The outwardly simple appearance of the roof, with its broad swathes of native grassland belies the complexity of the many hidden systems required to support it. ◀

**BRUCE HEMSTOCK BC SLA, CSLA, LEED AP IS A PARTNER IN PWL PARTNERSHIP LANDSCAPE ARCHITECTS INC, AND LED THE DESIGN TEAM FOR THE VCCEP'S LIVING ROOF.**

The convention centre roof is large enough to create a valuable habitat oasis between Stanley Park [middle distance] and the inland parks of metropolitan Vancouver [8].  
*Photo Courtesy of Flynn Canada Ltd.*



## GREEN ROOF CASE STUDY | THE VANCOUVER CONVENTION CENTRE EXPANSION PROJECT



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**PRINT AND RETAIN COMPLETED QUESTIONNAIRE**

*Non AIBC members should copy the questionnaire, fill it in and submit to their respective architectural association to receive a CLU*

- 1. What factor most influenced the horizontality of the building and roof design?**
  - a. Ground conditions and structural constraints
  - b. Programming and parking considerations
  - c. Adjacent buildings
  - d. Bylaws intended to maintain downtown view corridors
- 2. What are the ordered components of the green roof assembly?**
  - a. Plants, drainage medium, growing medium, irrigation system
  - b. Plants, growing medium, drainage medium, irrigation system
  - c. Plants, growing medium, irrigation system, drainage medium
  - d. Irrigation system, plants, growing medium, drainage medium
- 3. What factor most influenced the plant species selection?**
  - a. Reduced soil depth supported by the required free spanning structure
  - b. Aesthetic choice by landscape architect and client
  - c. Suitable habitat for local insects and mammals
  - d. Summer and winter growth cycles
- 4. Which regional ecosystem would it make the most sense to imitate in**

**creating a living roof in Vancouver?**

- a. Boreal wetland
  - b. Central Plains grassland
  - c. Pacific Northwest Coastal grassland
  - d. Pacific Northwest Coastal rain forest
- 5. Which challenge in design and construction likely had the least impact on the choices made by the design team?**
    - a. The structural spans of the building
    - b. The slope of the roof
    - c. The need for irrigation due to dryness of Vancouver summers
    - d. The need for adequate drainage during periods of heavy rainfall
    - e. The cost of the various components
  - 6. After what naturally occurring feature (or metaphoric landform) is the runnelled drainage pattern of the roof modeled in order to carefully manage the movement of storm water?**
    - a. Babbling brook
    - b. Meandering stream
    - c. Raging river
    - d. Burns Bog
  - 7. Which phrase best describes the relationship between the system of a living roof and the building envelope?**
    - a. To act as primary insulator between the indoor environment and outdoor environment

- b. To reduce degradation to the roofing membrane from ultraviolet light
  - c. To reduce the effects of hydrostatic pressure on the roofing membrane
  - d. To conduct thermal transfer through water evaporation and transpiration
- 8. What is not a component of an overall building envelope roofing system?**
    - a. Drainage medium
    - b. Plant layer
    - c. Root barrier cap sheet
    - d. Drainage mat filter cloth
    - e. Irrigation drip
  - 9. Which item is not a primary design consideration when integrating a living roof system on a project?**
    - a. Weight
    - b. Envelope design
    - c. Storm water management
    - d. Growing medium retention
    - e. Slope of the roofs
    - f. Plant types
    - g. Irrigation water volumes
    - h. Ceiling light spacing
    - i. Roof structure
  - 10. The Vancouver Convention Centre's green roof should be maintained on a quarterly basis**
    - a. True
    - b. False

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