Designing Green Roofs for Stormwater Management

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Product Manager

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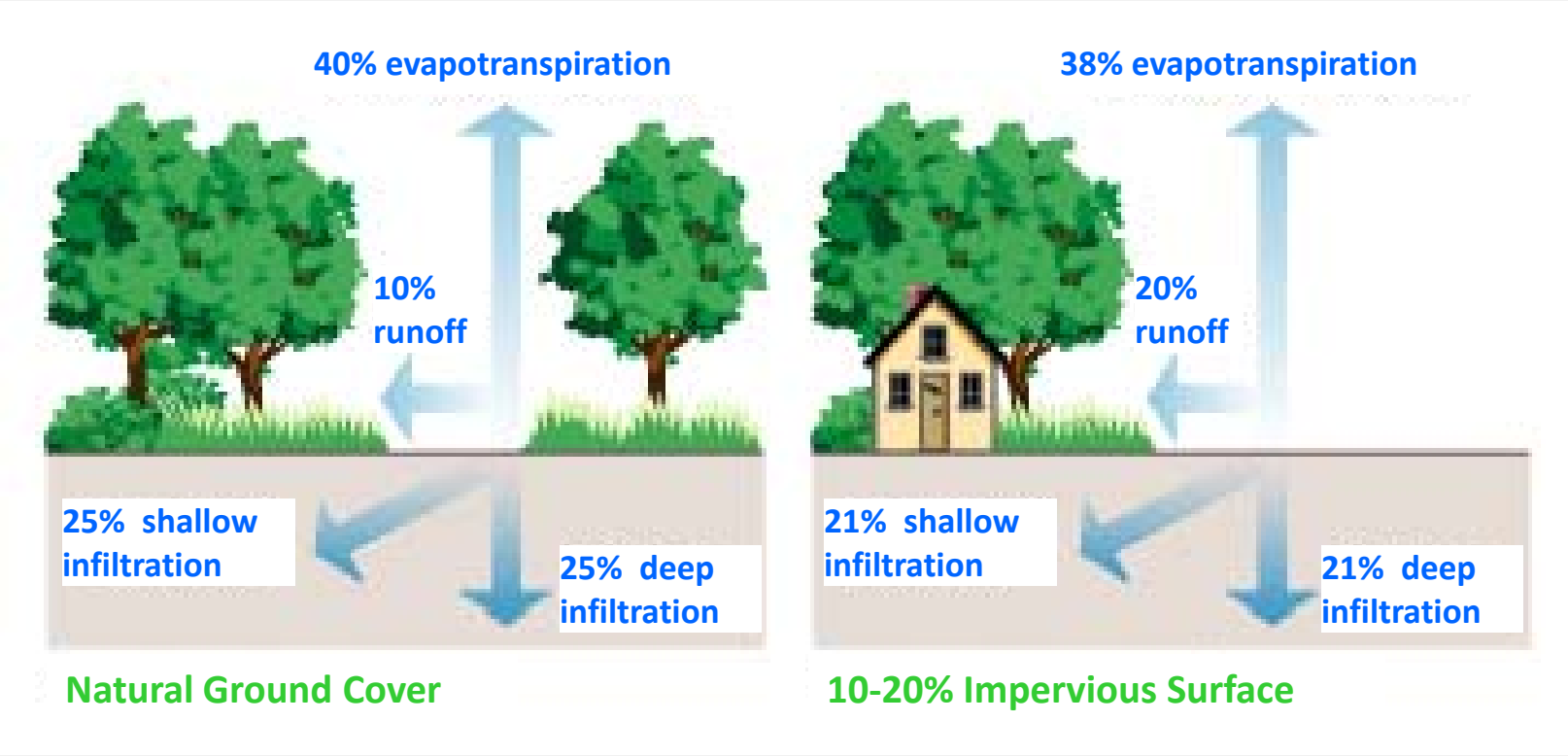
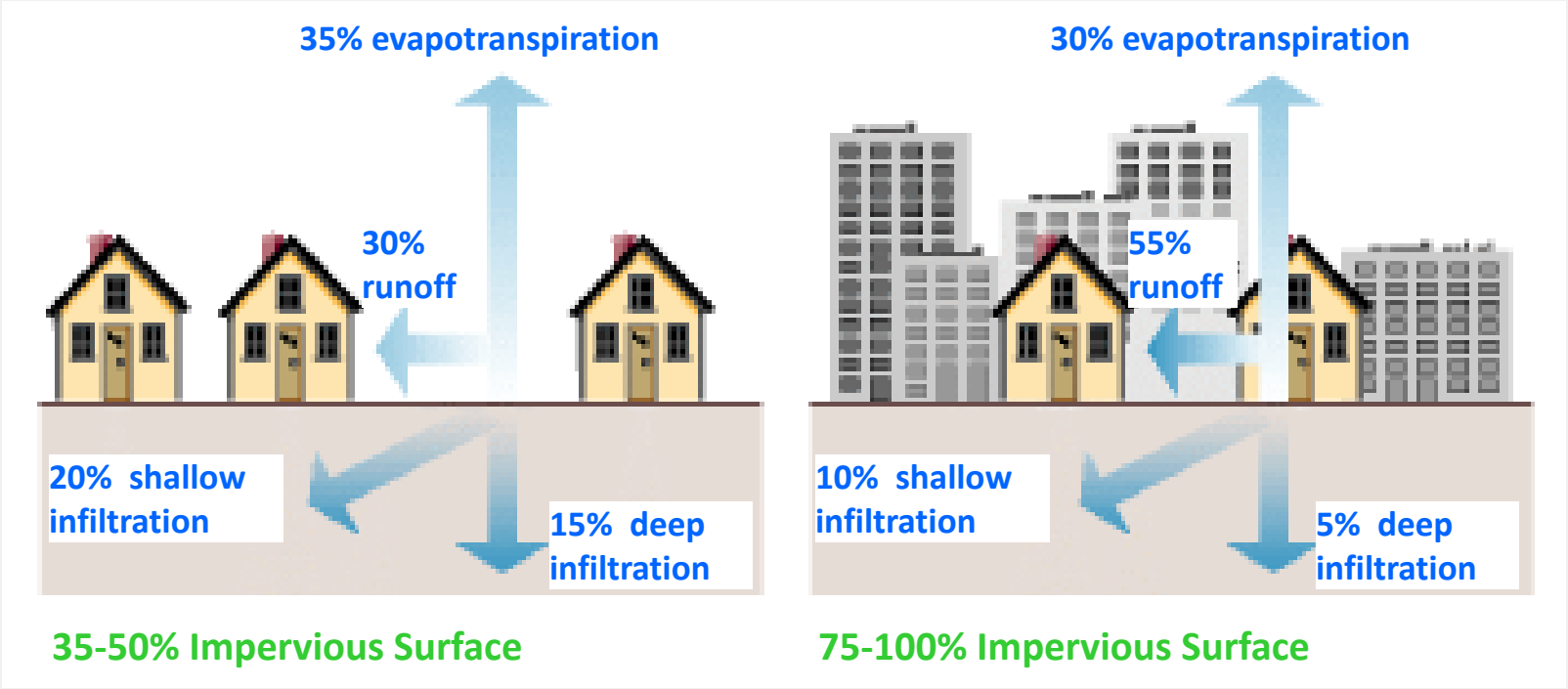
RCABC 2018-11-14

Rural Hydrology



Source: Stream Corridor Restoration: Principles, Processes, and Practices

Urban Hydrology



Source: Stream Corridor Restoration: Principles, Processes, and Practices

Stormwater Problems in Urban Areas

- Flash flooding causes damage to buildings, infrastructure and erosion to waterways
- Urban runoff carries pollutants to river/ocean
- Combined sewage overflow (CSO) is serious environmental concern

Sponge City Concept – Manage Stormwater by Working with Nature

Source: Drainage Services Department, Hong Kong

Stormwater Management – Low Impact Development (LID)

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Why Green Roof?

- Reduce stormwater runoff
- Lower energy demand
- Mitigate urban heat island
- Extend roof membrane life
- Improve air quality
- Enhance biodiversity
- Add green amenity space

Project: Coquitlam Water Treatment Plant
Partner: Next Level Stormwater Management

Green Roof Policies/Programs in Canada

- **Port Coquitlam Green Roof Bylaw**
  - All new commercial & industrial buildings >5,000 m^2 must install a green roof covering at least 75% of roof area
- **Richmond Green Roof Bylaw**
  - All new industrial or office buildings outside the city centre >2,000 m^2 must install a green roof covering at least 75% of the roof area
- **City of Toronto Green Roof Bylaw & Eco-Roof Incentive Program**
  - All new buildings with gross floor area over 2,000 m^2 must install a green roof covering 20-60% of the roof area depending on GFA
  - Industrial Buildings: the lesser of 2,000 m^2 or 10% of available roof space
  - Penalty of non-compliance: \$200/m^2
  - All buildings not subjected to the Green Roof Bylaw can receive \$100/m^2 for green roof installed up to \$100,000

How does a Green Roof Reduce Runoff?

Vegetation – takes up water for photosynthesis & evapotranspiration

Growing Medium – stores rain water, taken up by vegetation or evaporation

Water Retention Layer – absorbs and stores excess water for later

Drainage /Filter Layer – stores rain water and drains off excess

Root Barrier

Roof System

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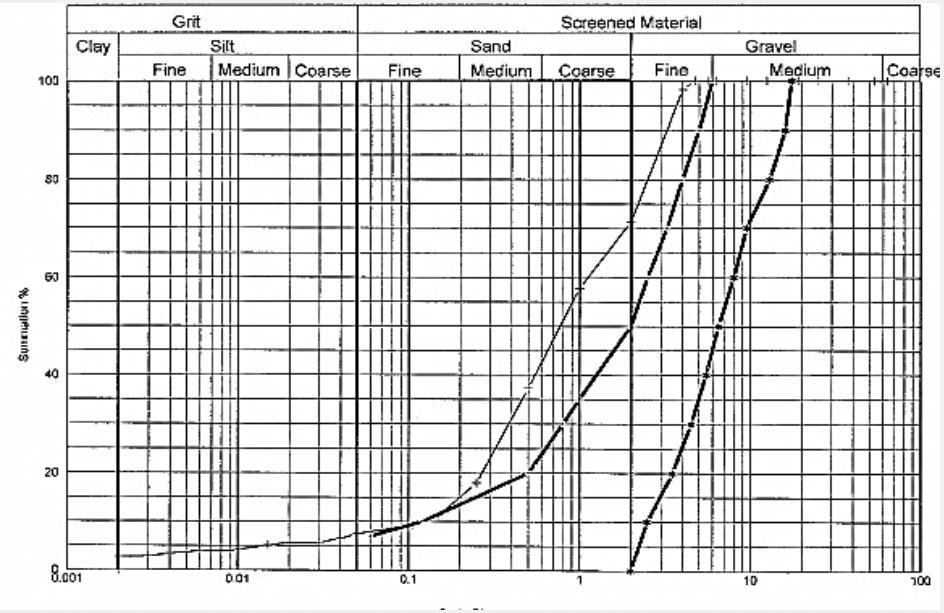
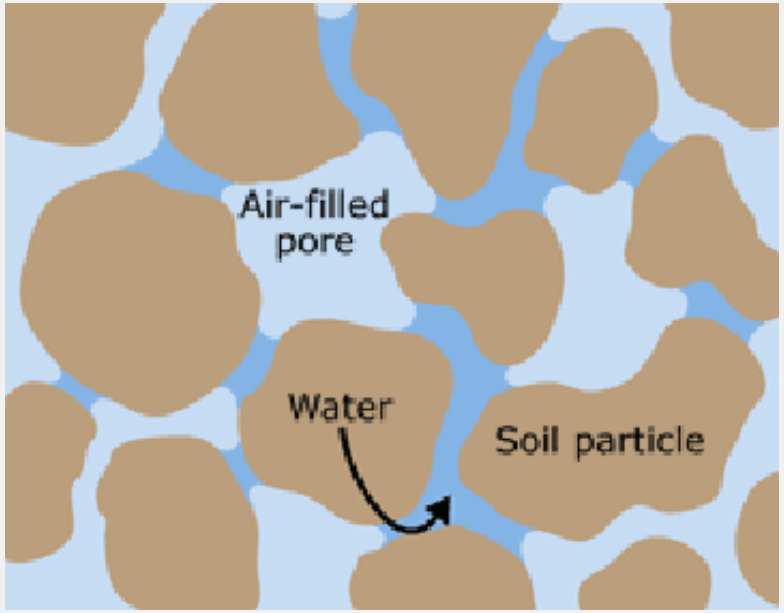
Growing Medium

- Depth
- Composition
- Particle size distribution





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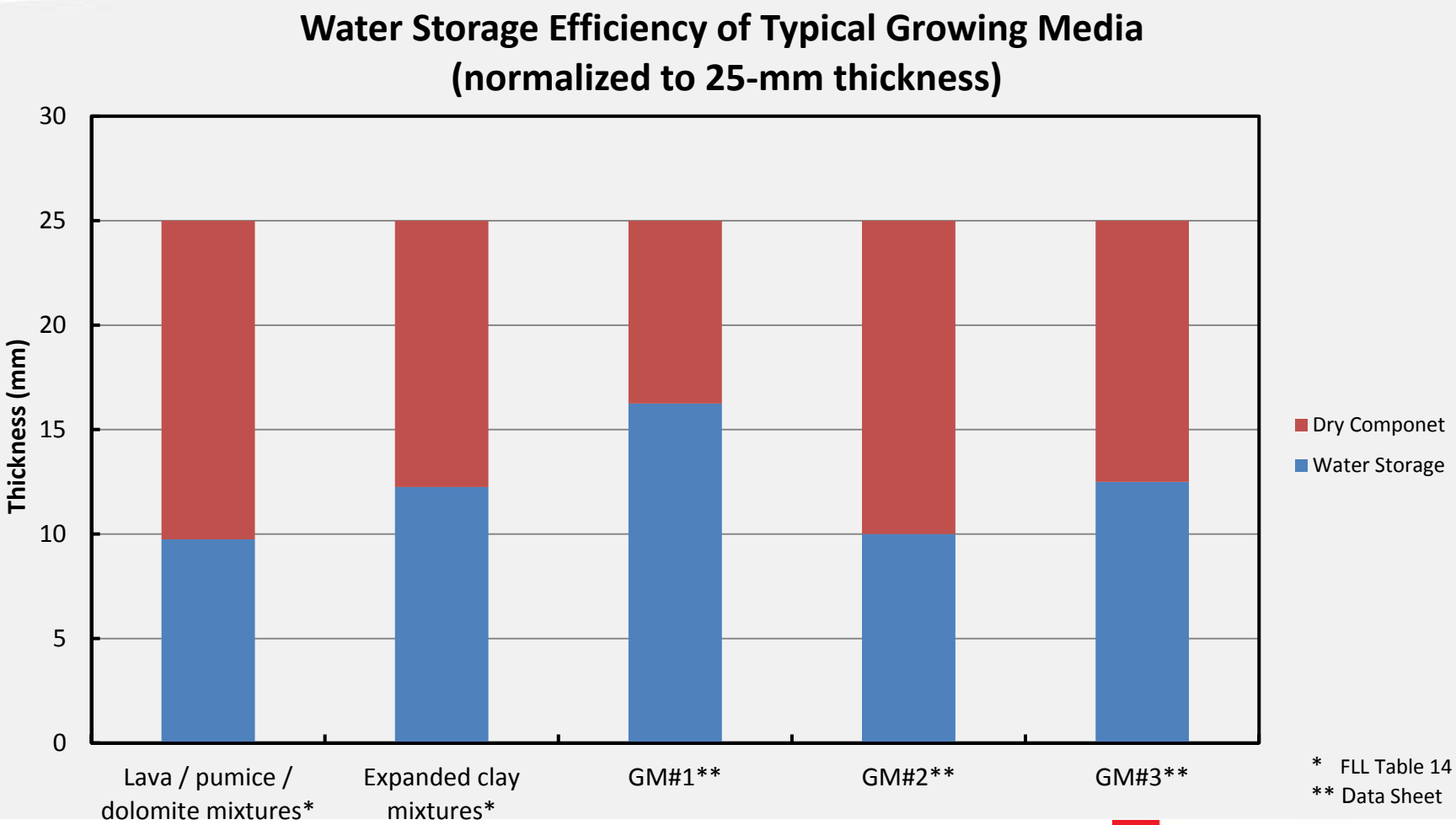
Water Storage Efficiency Comparison



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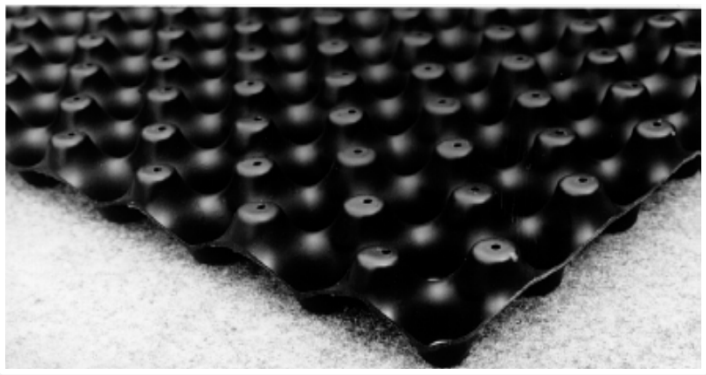
Drainage Layer

Entangled net geocomposite



Drainage board with reservoirs

Dimpled drains

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Water Retention Layers

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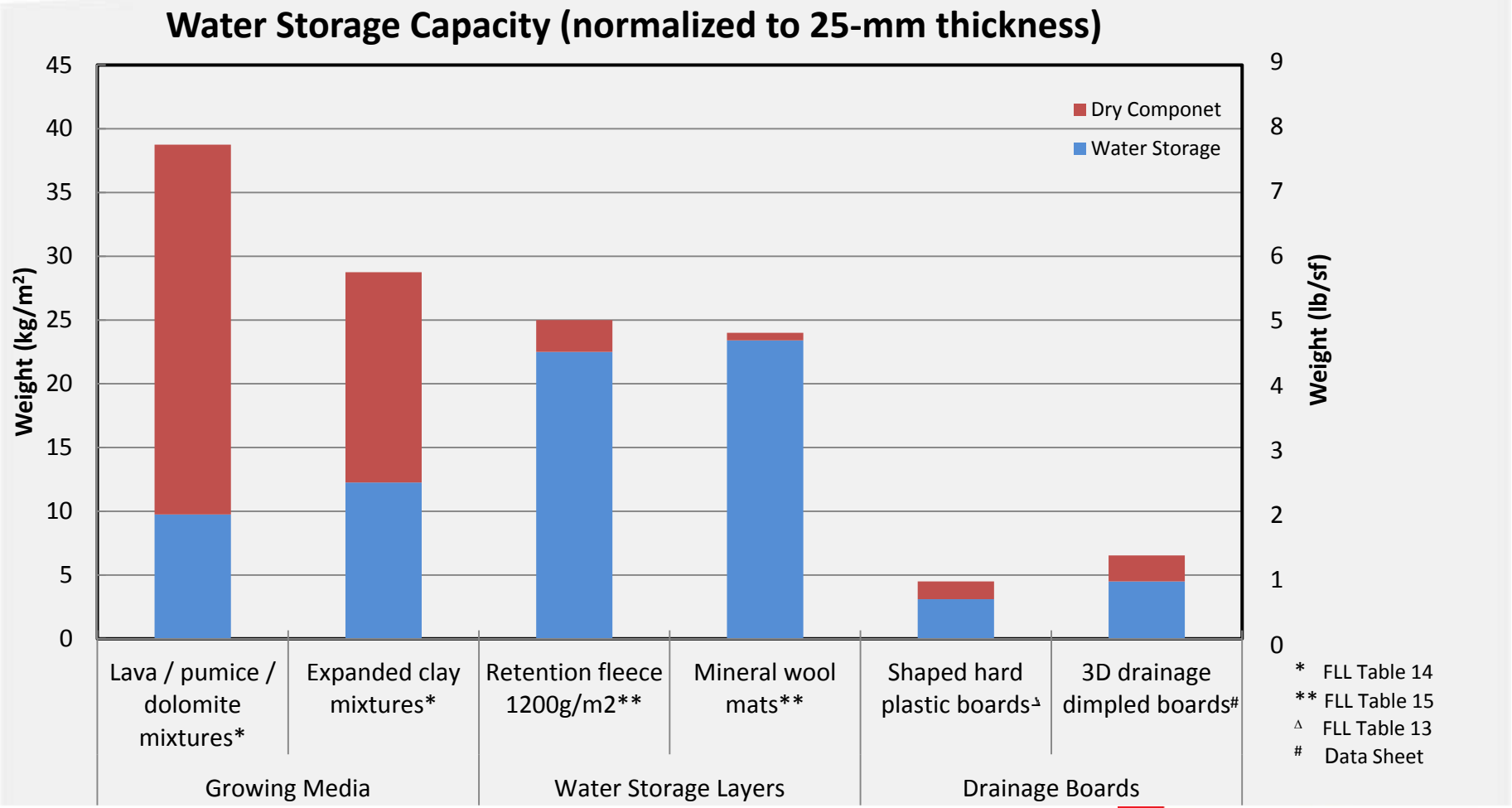
Water Retention Comparison

Components	Thickness	Dry Weight	Saturated Weight	Water Retention
Growing Medium	10 mm	6.2 kg/m²	9.9 kg/m²	3.7 l/m²
Growing Medium	30 mm	18.6 kg/m²	29.7 kg/m²	11.1 l/m²
Retention Fleece	9 mm	1.2 kg/m²	8.7 kg/m²	7.4 l/m²
Mineral Wool	30 mm	2.2 kg/m²	27.5 kg/m²	25.3 l/m²

Water Storage Capacity Comparison



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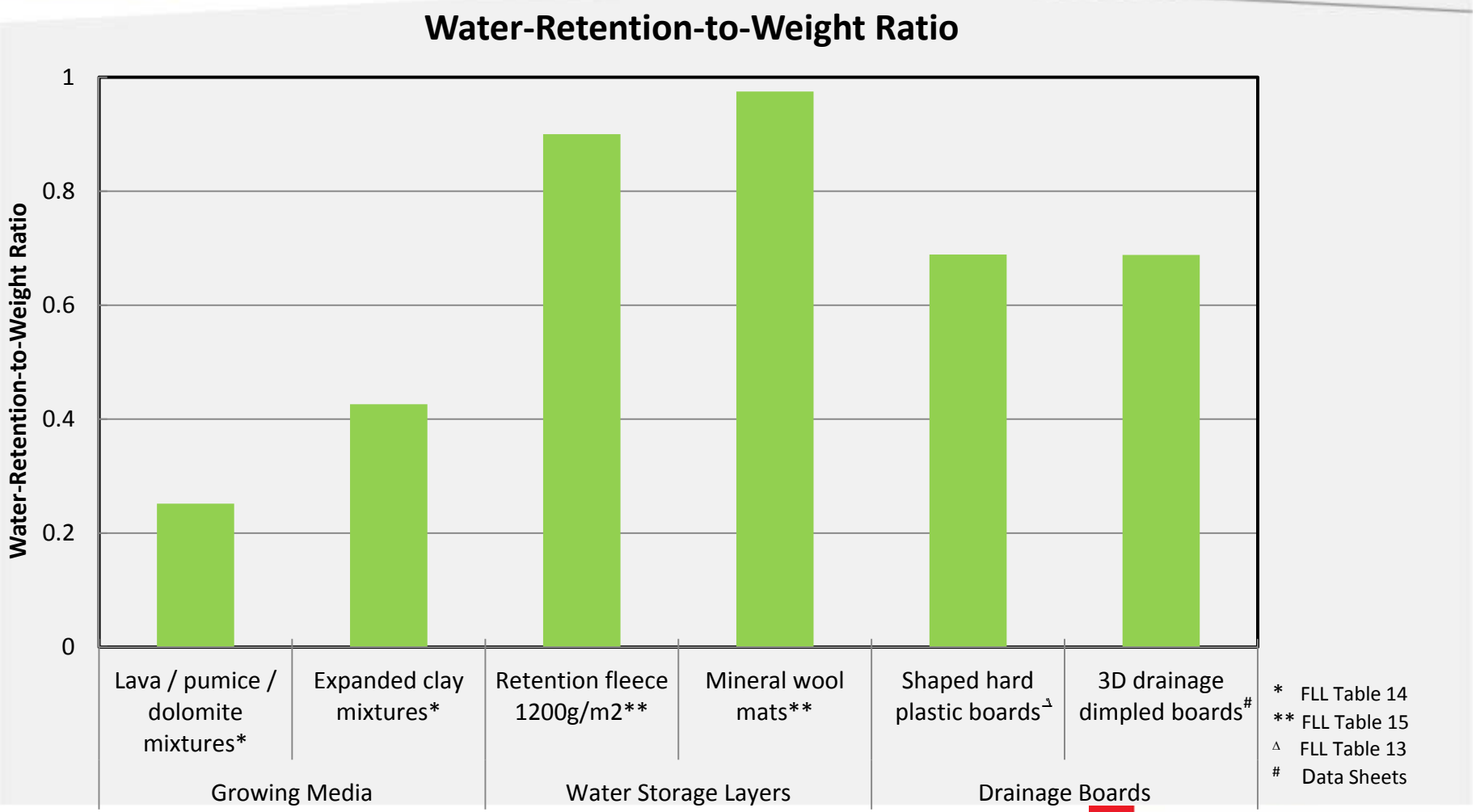
Water Retention to Weight Comparison



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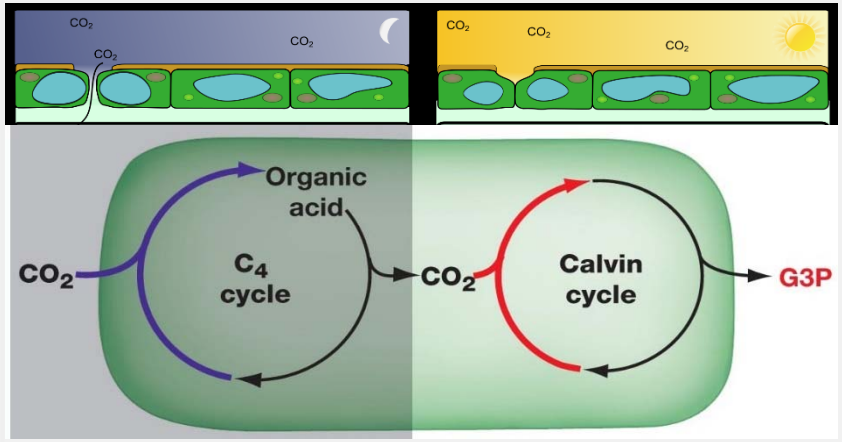
Vegetation – Regular Plants (C3)

- Plants take up water from the roots and release it to the atmosphere from their leaves
- During photosynthesis, plants can lose 97% of the water they uptake to transpiration
- Depletes a green roof's water storage and creates capacity for the next rainfall
- Plants can become dry and wilted between rainfalls

Plants – Succulents (CAM)

(CAM) Crassulacean Acid Metabolism



- an adaptation for increased water use efficiency typically found in plants living in arid conditions
- Stomata in the leaves remain shut during the day to reduce evapotranspiration, but open at night to collect CO_2
- CAM plants such as sedums are more heat and drought tolerant for rooftop survival

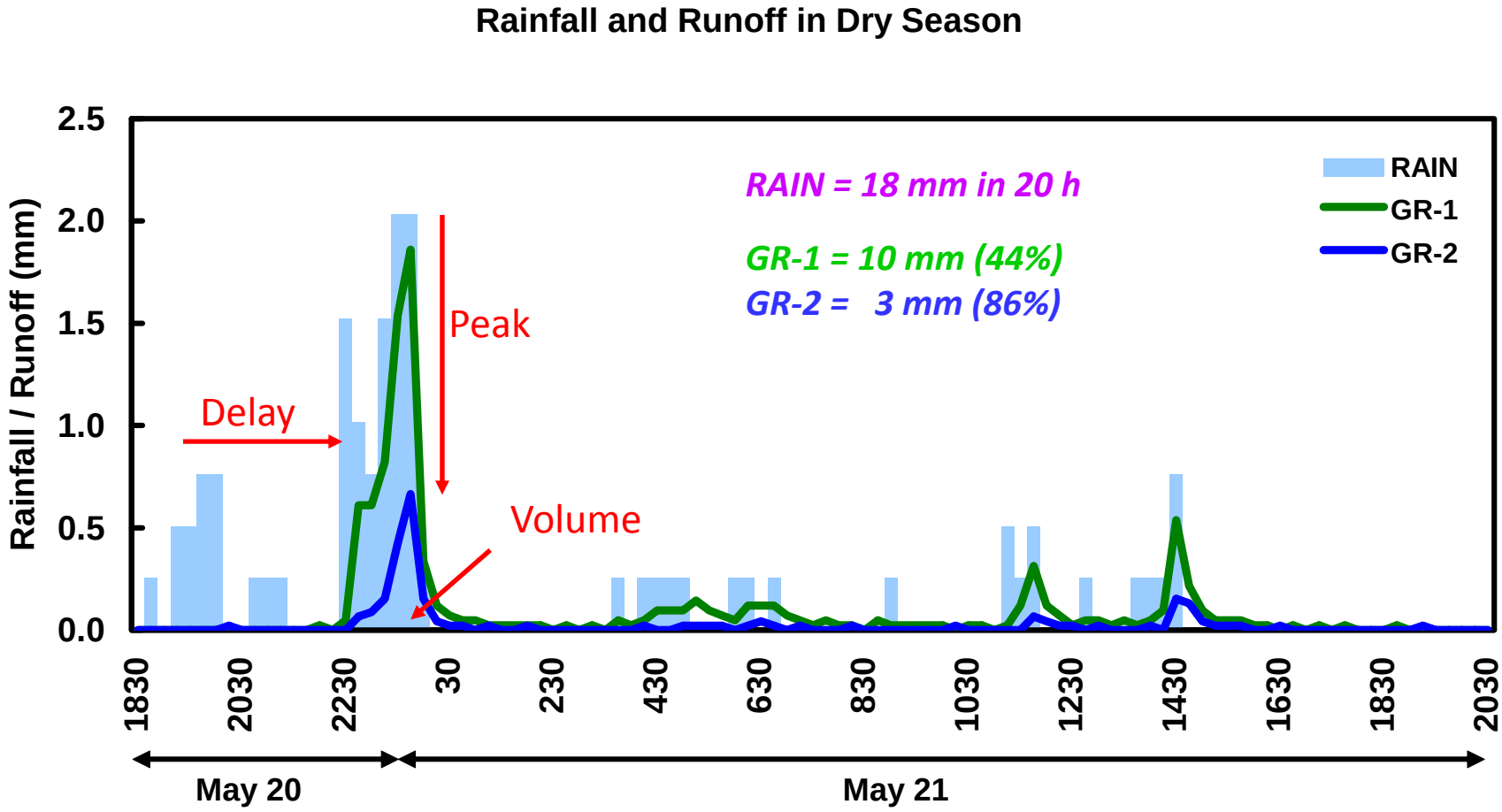
British Columbia Institute of Technology

Source: BCIT

Experimental Roof Sections

Source: BCIT

Dry Season Event



Dry Season: Apr – Sep, total rainfall = 231 mm

Source: BCIT

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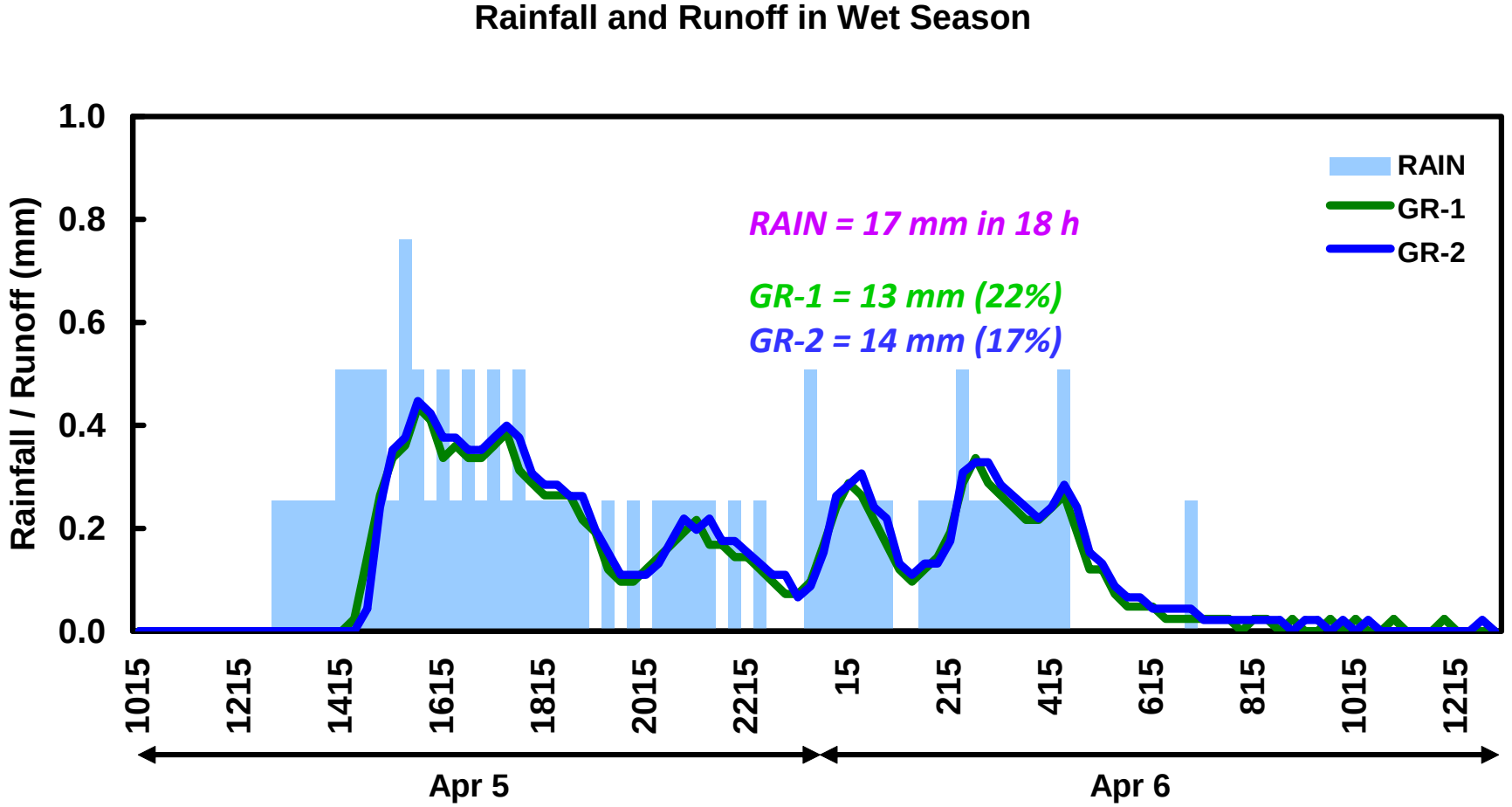
Wet Season Event

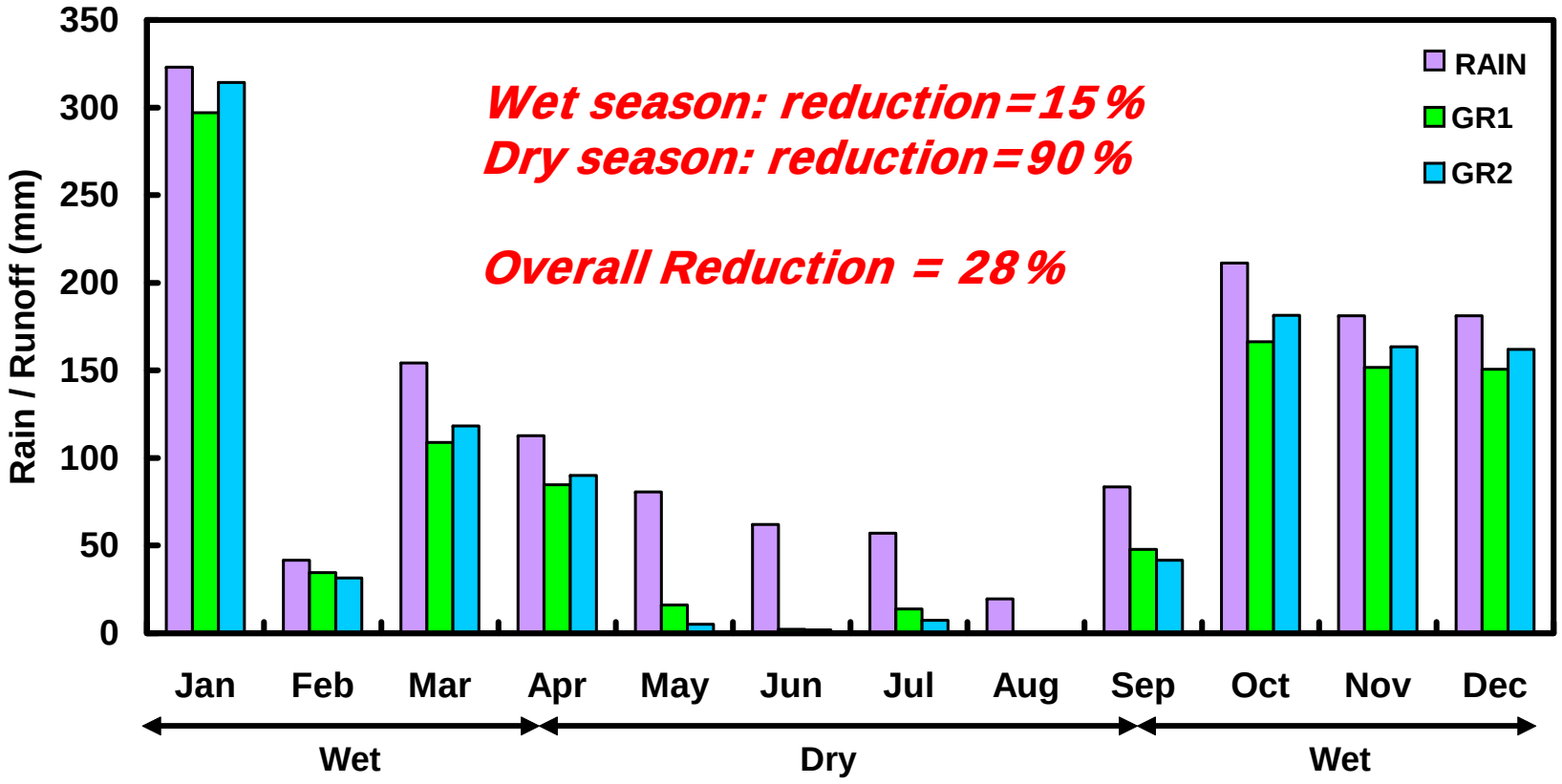


Wet Season: Oct – Mar, total rainfall = 1277 mm

Source: BCIT

Stormwater Runoff Retention

Rainfall and Runoff Statistics



=> More growing medium does not necessarily retain more water

Source: BCIT

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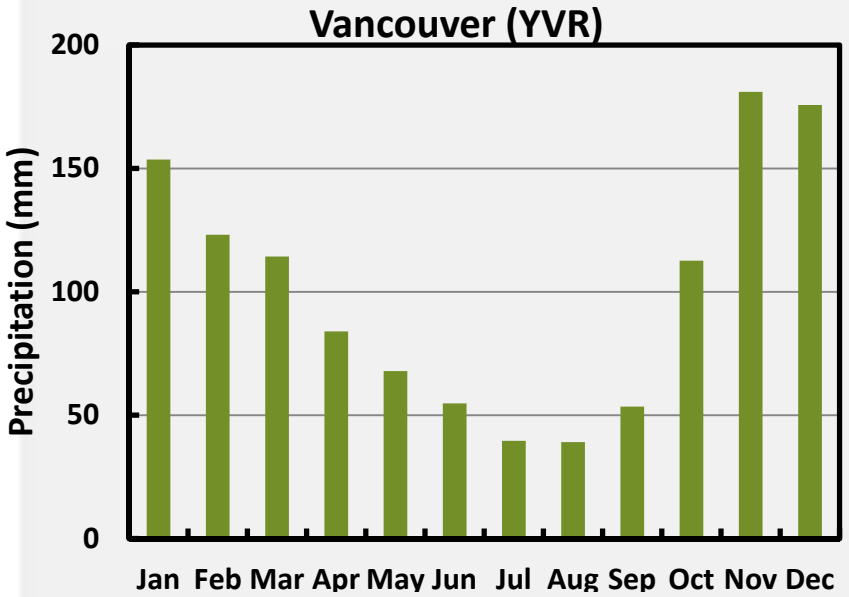
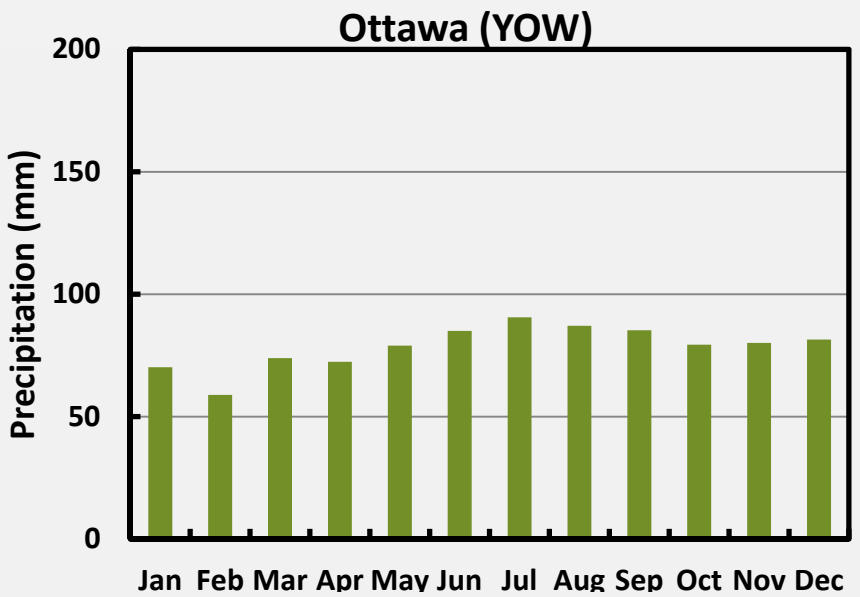
Climate Affects Annual Water Retention

- Annual water retention of a green roof with 150 mm(6”) GM
  - 26% (1117mm or 44”) in Vancouver
  - 54% (245mm or 9.6”) in Ottawa





=> Annual water retention is climate dependent

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Case Study –
Coquitlam Water Treatment Facilities

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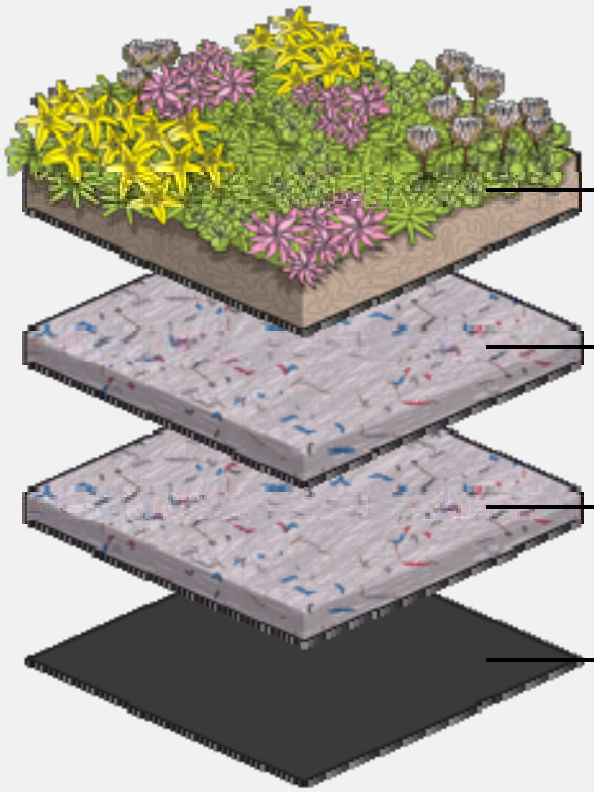
Green Roof System Buildup



Properties	
Roof Slope	10 - 15°
Thickness	48 mm
Saturated Weight	55 kg/m^2
Water Retention	32 l/m^2

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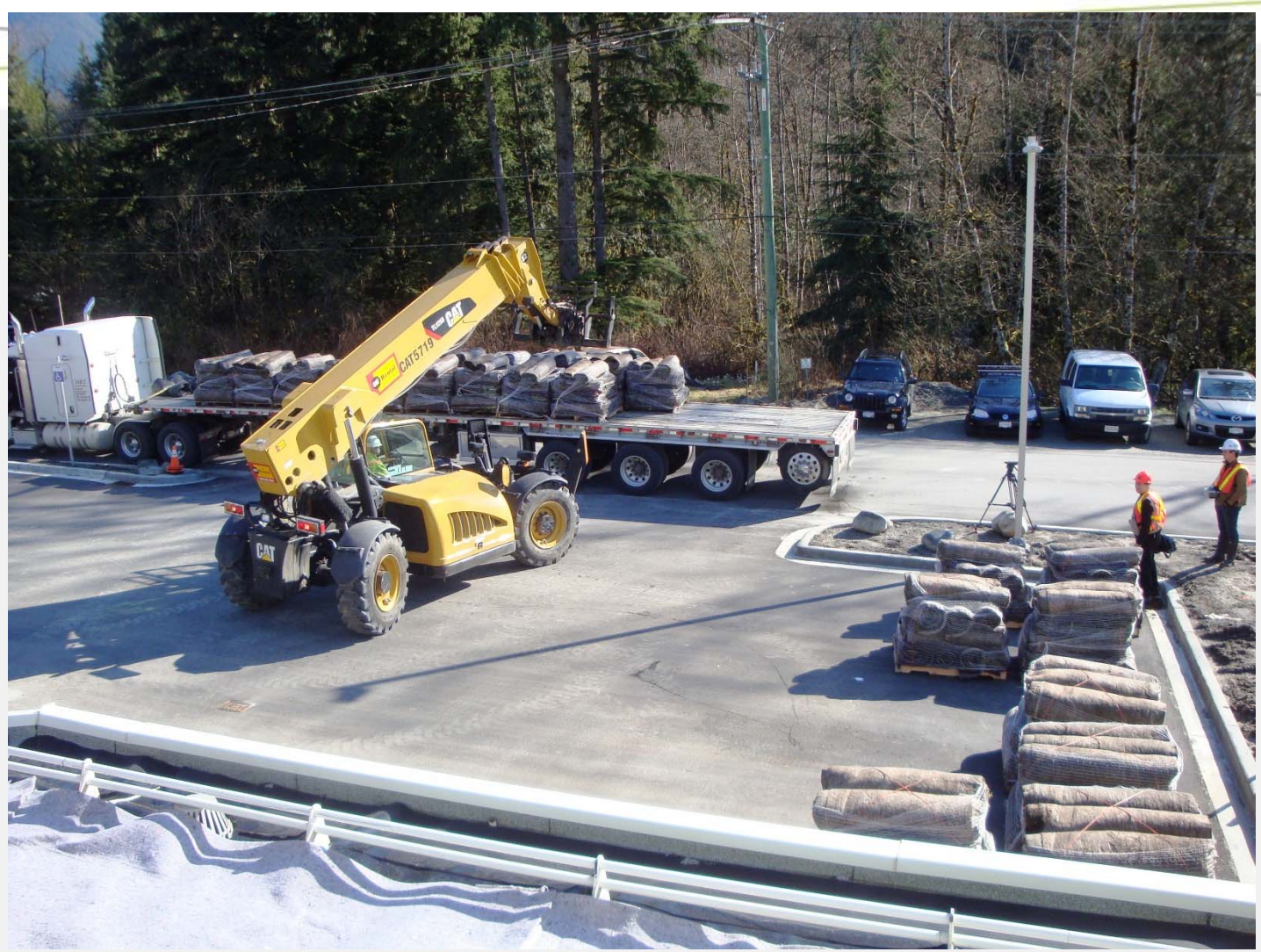
Materials Arrive on Site



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Install Water Retention Layers

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Install Water Retention Layers

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Vegetation Free Zone

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Covered Walkway Greening Completed

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Upper Roof Section

Partner: Next Level Stormwater Management

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Upper Roof Section

Partner: Next Level Stormwater Management

Progress through performance
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Upper Roof & Covered Walkway

Partner: Next Level Stormwater Management

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Lower Roof Section

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Progress through performance
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Lower Roof Section (3 hours later)

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Coquitlam Water Treatment Facilities - 2 Years Later

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Coquitlam Water Treatment Facilities - 2 Years Later

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Coquitlam Water Treatment Facilities - 2 Years Later

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Stormwater Management

- Green roofs delay and reduce peak flow, and reduce the total runoff volume; thus lowering the burden on the sewage system
- Many municipalities have policies or programs to promote LID's for stormwater management
- There are many options available to increase water storage capacity of green roofs while keeping system weight low
- Use water-retention-to-weight ratio to compare water storage capacity on a per unit weight basis when specifying products
- There is no one-size-fits-all solution; consider local climate when designing green roofs for stormwater management

Thank You!

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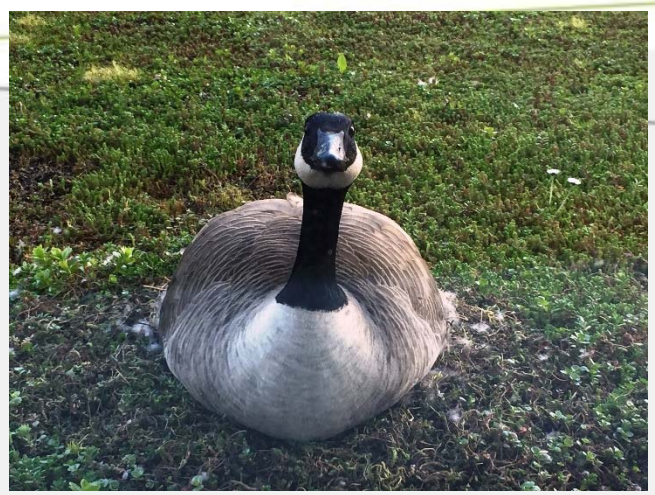

Project: Seaforth Armory, Vancouver BC
Partner: Next Level Stormwater Management

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