NATURE-BASED DESIGN / BIODIVERSITY SENSITIVE DESIGN FOR URBAN DEVELOPMENT

- GLOBAL TRENDS, BUILT PROJECTS AND DESIGN CONCEPTS -

12 MAY 2021

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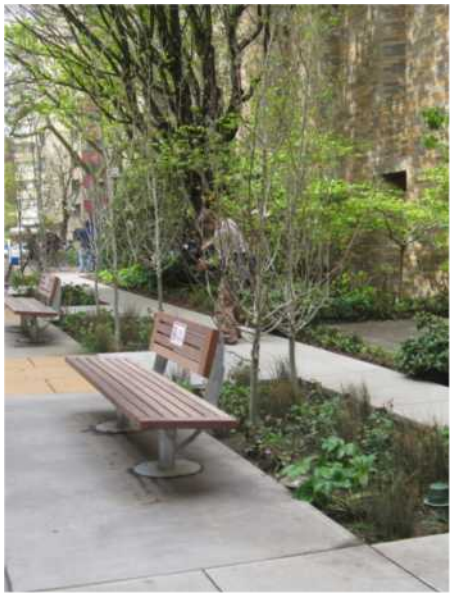
AGENDA

1. Global Trends in Nature-based Design Solutions (NBD) / Biodiversity Sensitive Design (BSUD)
2. Company Profile Enviro Pro
3. Built Projects by Enviro Pro
4. Nature-based Design Solutions (NBD) Concepts
5. Ecological Enhancement



Global Trends in Nature-Based Design (NBD)

- Cities are increasingly considered to be important for wildlife conservation
- Urbanisation would eventually lead to biodiversity loss
- Biodiversity loss can be mitigated by urban design and development improvements
    - However, the implementation has been slow
- Urgent need to incorporate ecological knowledge into decisions made by planners and developers

Global Trends in Nature-Based Design (NBD)

Nature-based Solutions principles

1. Embrace nature conservation norms (and principles);

2. Can be implemented in an integrated manner with other solutions to societal challenges (e.g. technological and engineering solutions);

3. Are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge;

4. Maintain biological and cultural diversity and the ability of ecosystems to evolve over time;

5. Are an integral part of the overall design of policies, and measures or actions, to address a specific challenge.

Global Trends in Biodiversity Urban Sensitive Design (BSUD)

Document Biodiversity Values
Native plants & animals, incl threatened.
Landscape context, including geological & hydrological features, spatial arrangement, and connectivity.
Potential threats to biodiversity.

Identify Biodiversity Objectives
Maintain or improve viability of threatened species & ecosystems.
Opportunities for rewilding.

Identify Development Objectives
Building & infrastructure requirements.
Population & dwelling targets.
Liveability targets.

Identify BSUD Actions
Considering 5 principles for BSUD.
Seek solutions that address biodiversity & development objectives.
Address key threats to biodiversity

Assess BSUD
Assess the contribution of BSUD using appropriate metrics: Population viability, occupancy, abundance.
Use tools such as PVA & expert elicitation.

Decide
Determine BSUD that best meets biodiversity & development objectives.
Manage trade-offs between objectives using tools such as: Project Prioritisation Protocol and participatory approaches



Source: Conversation Letters – A Journal of the Society for Conservation Biology (2017)

Global Trends in Nature-Based Design (NBD)

Neutral wet grassland rain garden

Vegetated wet swale with sloping sides

- London Plan policies: Urban Greening and Biodiversity And Access to Nature:
  - Requires developments to make urban greening a fundamental element of design and deliver net gains for biodiversity.
- Design opportunities
  - Sites of Importance for Nature Conservation (SINCs).
  - Sustainable Drainage Systems.
  - Roofs and Podiums.
  - Facades.

Source: Urban Greening for Biodiversity Net Gain: A Design Guide - Mayor of London (2021)

Experiences in Nature-Based Design (NBD)

- **Enviro Pro Green Innovations (S) Pte Ltd works on NBD in Singapore since 2009.**

- Core Competency and proven track record in:

  - Biodiversity Assessments (e.g. Sentosa Biodiversity Assessment, 2018).
  - Environmental Safeguards (e.g. SEA for Coastal Protection Study Sentosa, 2021).
  - Sustainable Drainage / ABC Waters design and build projects.
  - Water-based green infrastructure and ecological restoration/landscape designs.
  - Soil-Bio engineering and plant-based solutions provider.

  - Science-driven, innovation in water and soil engineering, biodiversity focused.
  - Recipient of the President's Design Award Singapore 2018- Design of the Year.

Sungai Satu, Penang Island, Malaysia
An ecological river restoration with integrated constructed wetland treatment system to filter river water pollutants (design and build, 2013-2016).

Windsor Park, Singapore
Rainwater fed wetland ecosystem design as part of park development (design 2014-2016).

Teluk Bahang, Penang Island, Malaysia
A porous Bio-drain that conveys and filters stormwater and effluent, coastal habitat restoration (design and build 2018-2021).

Sungai Satu River Rehabilitation Project

Project: Sungai Satu River Rehabilitation Project, Penang, Malaysia, 2013 - 2016.

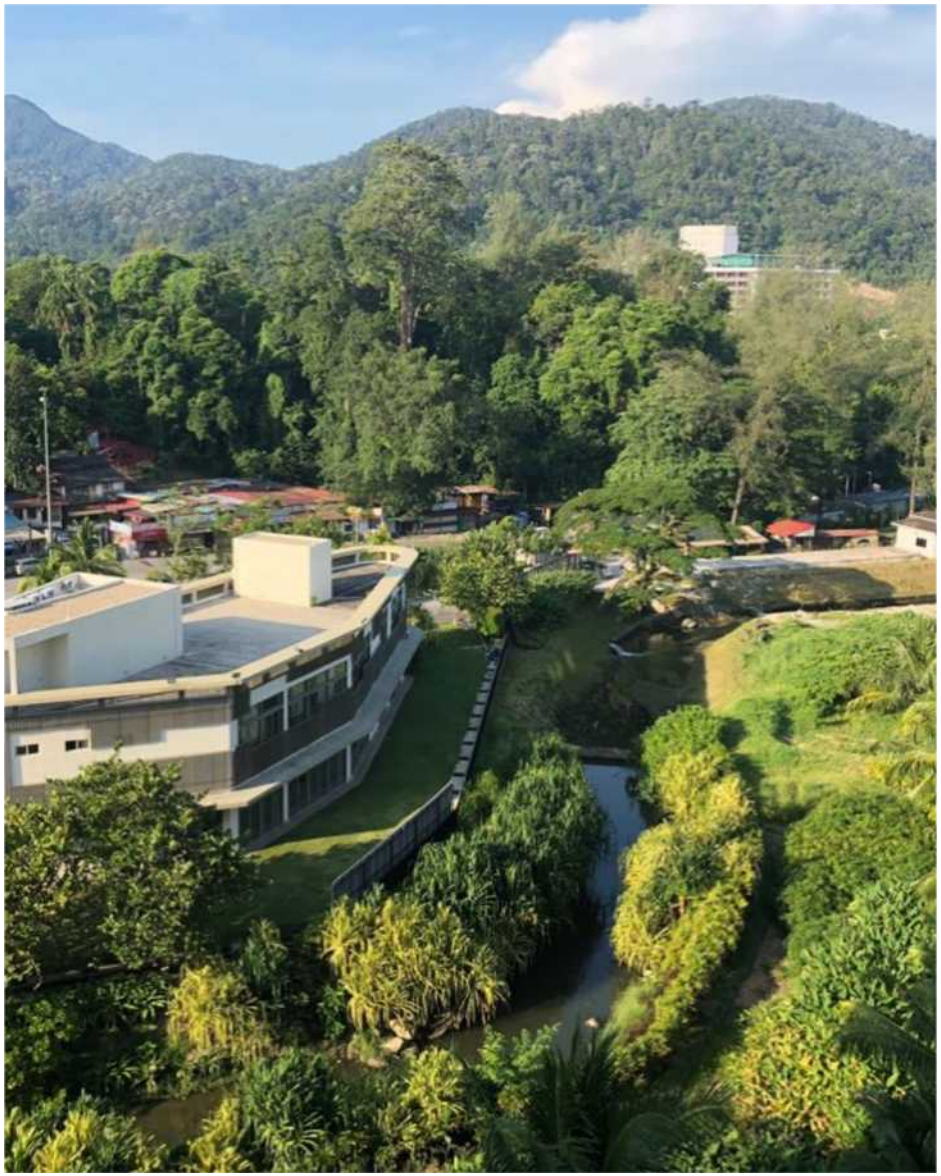
Key Design Concepts

• Bio-engineered slope – Rock chamber mattresses were placed on the river embankments as a slope stabilisation method. The bio-engineered slopes were re-greened and provide a coastal ecological habitat.

• Constructed Wetlands – Provides water treatment which improves water quality by means of filtration and phyto-remediation.

ENVIRO PRO

Sungai Satu River Rehabilitation Project



Nature-Based Design evolves (left: after completion, right: three years later).

Windsor Park Wetland Project

Project: Wetland at Windsor Nature Park, 2014 - 2016.

Key Design Concepts

• Construction of Wetlands - Rainwater is detained within the wetlands, lowering peak runoff and prevents flooding of the surrounding area.

• Bio-engineered slope – Rock chamber mattress were used to stabilise the wetland slopes. All bio-engineered slopes were re-greened.

• Ecological Enrichment– Snags are placed in the wetland as bird perching. The wetland provides suitable habitat for various dragonflies and butterflies.

ENVIRO PRO

Teluk Bahang Bio-Drain Project

Project: Sustainable Drainage Design and Construction for "The Angsana" Hotel, Teluk Bahang, Penang, Malaysia, 2018 – 2021.

Key design concepts

• Re-naturalization of the main drain - Drainage reserve will be able to cleanse the main drain water and act as a velocity-reducing feature to protect beach areas.

• Bio-engineered slope - Provides conveyance and retention function, as well as a vertical filtration system as water percolates via porous drain base.

ENVIRO PRO

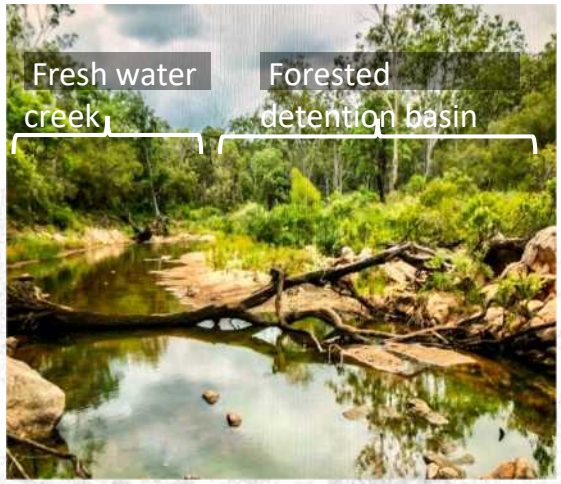
Nature-based Design Concepts

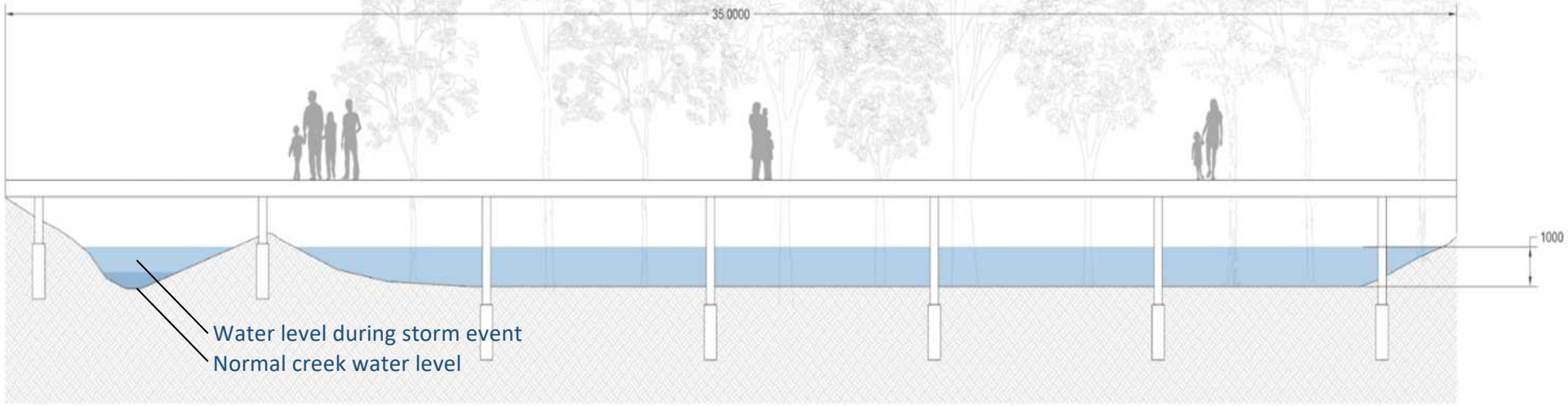
Flood Management with Nature-Based Design

Nature-based Design Concepts

Flood Management with Nature-Based Design

Sketch of natural creek with an overflow detention basin

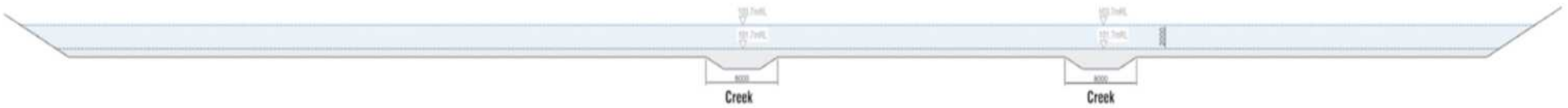




Typical section showing forest walk and retention spillover basin

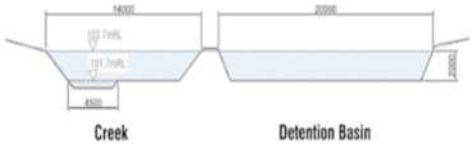
Nature-based Design Concepts

Typical section CC of Mangrove Basin



Typical section AA of Freshwater creek

Typical section BB of Saline tolerant creek



Freshwater creek length - 352m

Saline tolerant creek length - 266m

Creek detention basin average sectional area - 36.4m^2
Total creek detention basin surface area - 6335m^2
Total detention basin volume - 12670m^3

Mangrove creek length- 194m/240m
Mangrove flooding surface area - 36644m^2
Area of cross section above 101.7mRL - 329m^2
Total mangrove basin volume - 65959m^3

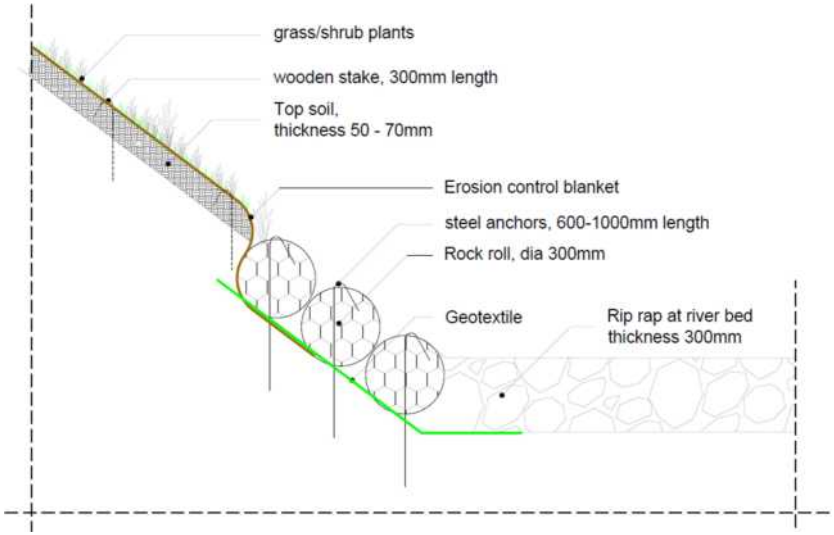
Total storage volume - 78629m^3

- The mangrove basin functions like a natural intertidal mangrove, allowing tidal flooding in normal operation.
- During expected major storm events the sluice gate will be shut at a tidal level of 101mRL, turning the entire mangrove into a temporary retention basin to handle stormwater.
- There are also a series of smaller retention basins alongside the creek, adding to the total retention capacity.
- These areas do not only function as stormwater retention areas but can have considerable value as natural amenities for people to enjoy.

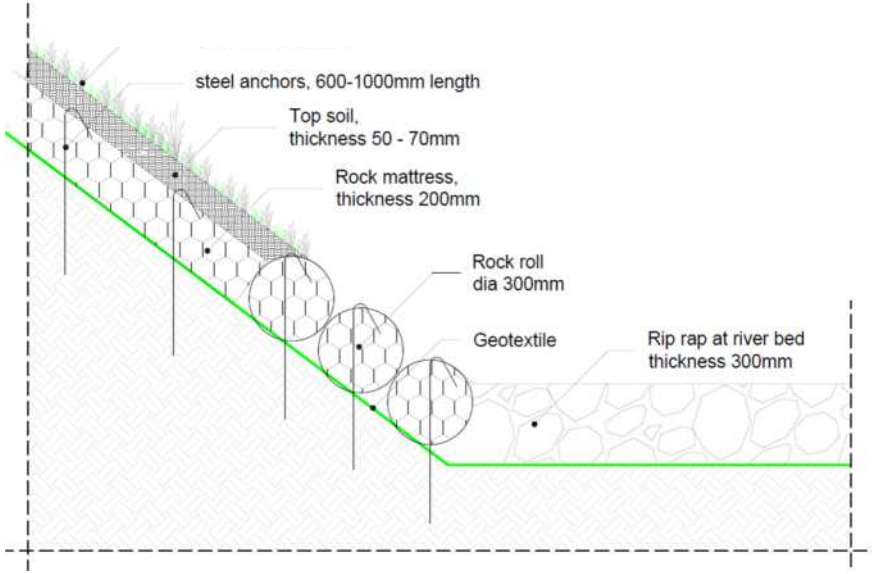
Nature-based Design Concepts

Nature-based Design Concepts

Sungai Satu river rehabilitation project - Penang



Typical detail of a vegetated soil slope



Typical detail of a reinforced vegetated soil slope

Nature-based Design Concepts


Jurong Lake


Jurong Lake

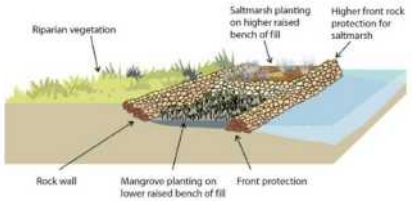

Fresh water forest - Indonesia


Penang

Nature-based Design Concepts

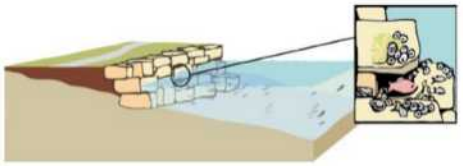
Coastal Revetments –with Nature-Based Design

Mangrove buffer revetment

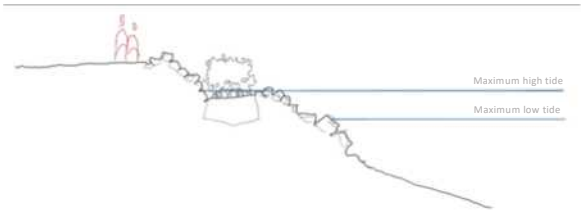


Revetment with a vegetated buffer

Rock revetment



Terraced gabion basket revetment



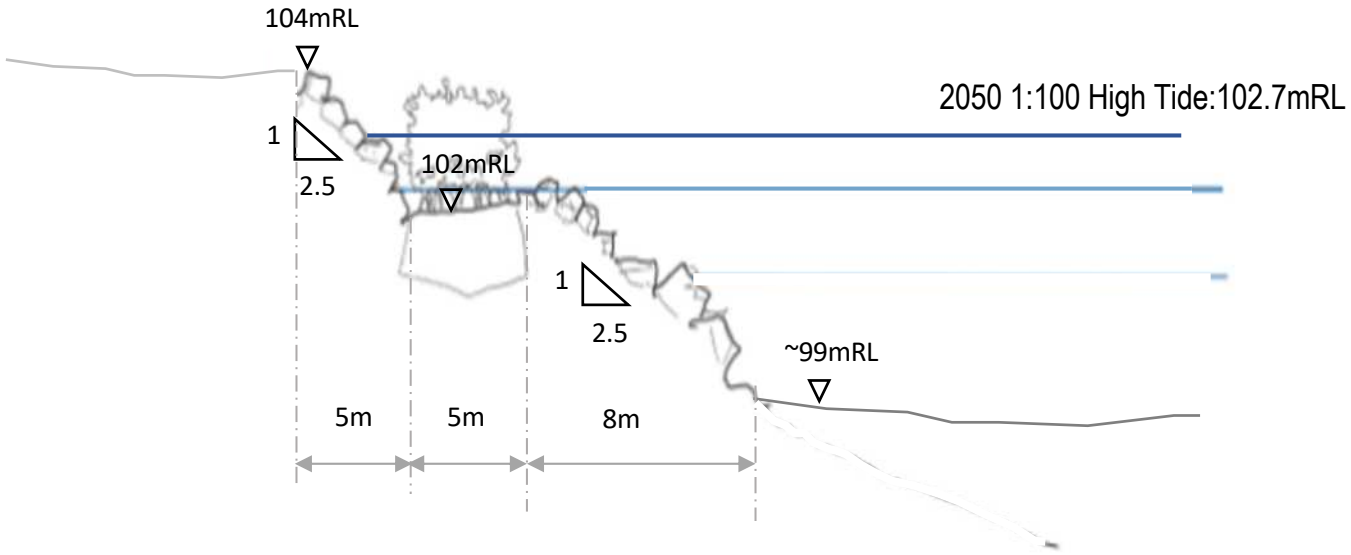
Eco revetments can be used to create more greenery and increase biodiversity of coastal habitats.

Nature-based Design Concepts

A rock revetment with a planted mangrove strip in the middle. The mangrove buffer can get inundated during a high tide. Including the protection this revetment provides, it also provides aesthetic and biodiversity benefits.

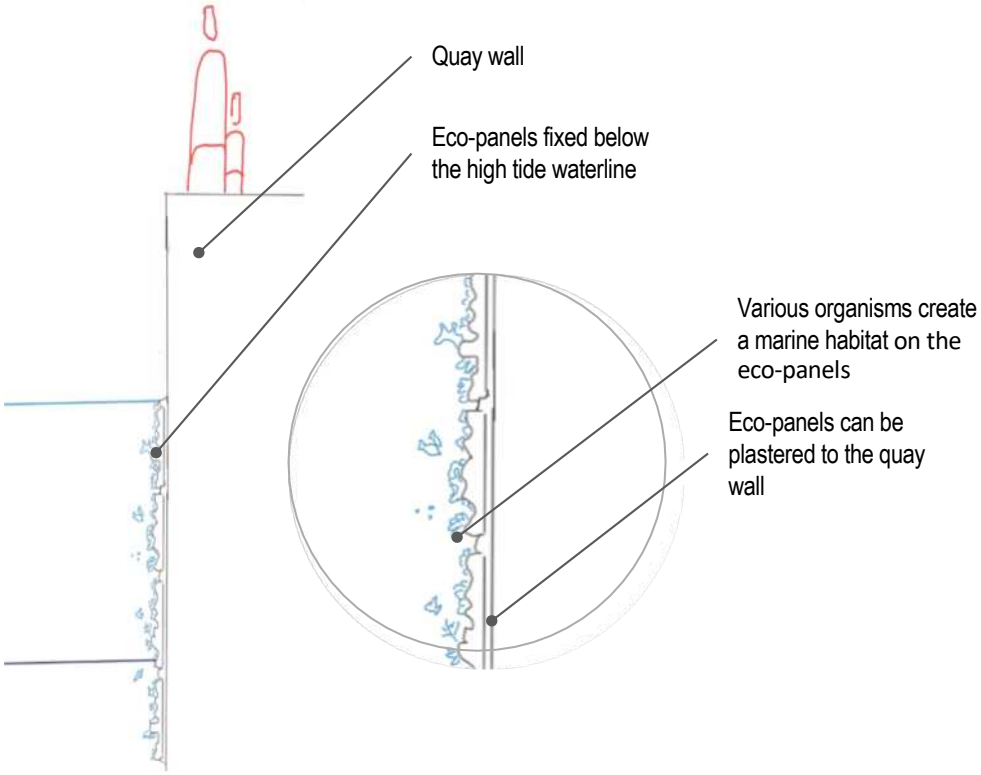
- Slope to be roughly graded to 1:2.5 and a marine grade geotextile installed to hold soil in place.
- Large boulders packed on top that function as energy dissipation and intertidal habitats.
- Planted mangrove buffer to be created at high tide waterline between the two boulder revetments.
- Geotextile to be installed on top of mangrove buffer planting area to prevent soil erosion.
- Suitable mangrove and mangrove associated species to be planted to create a biodiverse mangrove habitat.

Vegetated revetment buffer



Nature-based Design Concepts

Eco-Panels are concrete panels designed to increase the surface area for marine coral and other organisms to develop on. This creates a more biodiverse habitat attracting other animals to the area further increasing marine biodiversity. They can be installed on vertical quay walls.



Concrete Eco Panel designs

Nature-based Design Concepts

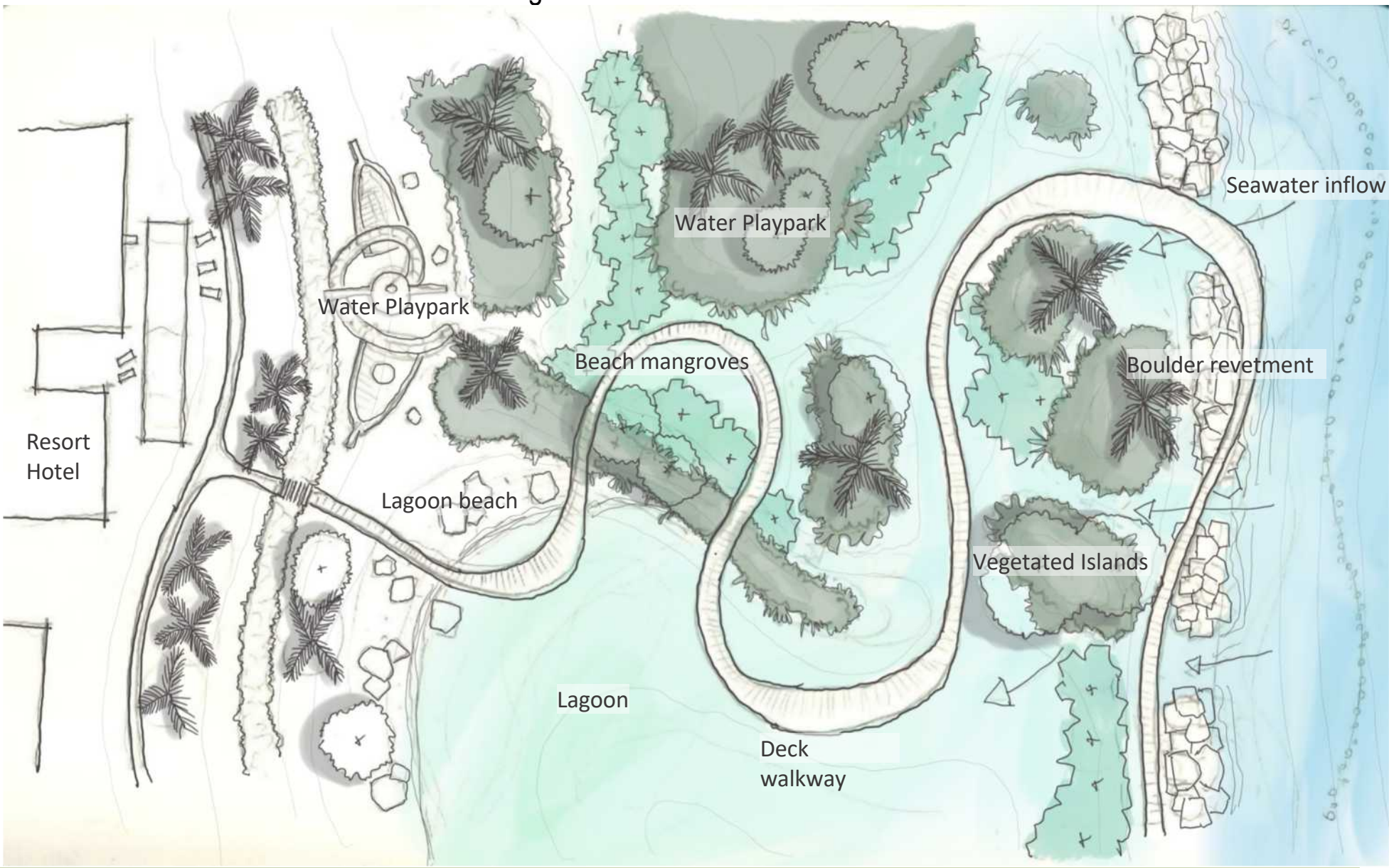
Examples of textured panels and other structures that can be used to increase surface area for marine habitats to develop.

Concrete textured panels used to increase the surface area for marine habitats.

Sculptural revetment forming tidal pools for marine habitats which can be viewed up close by guests as an educational element.

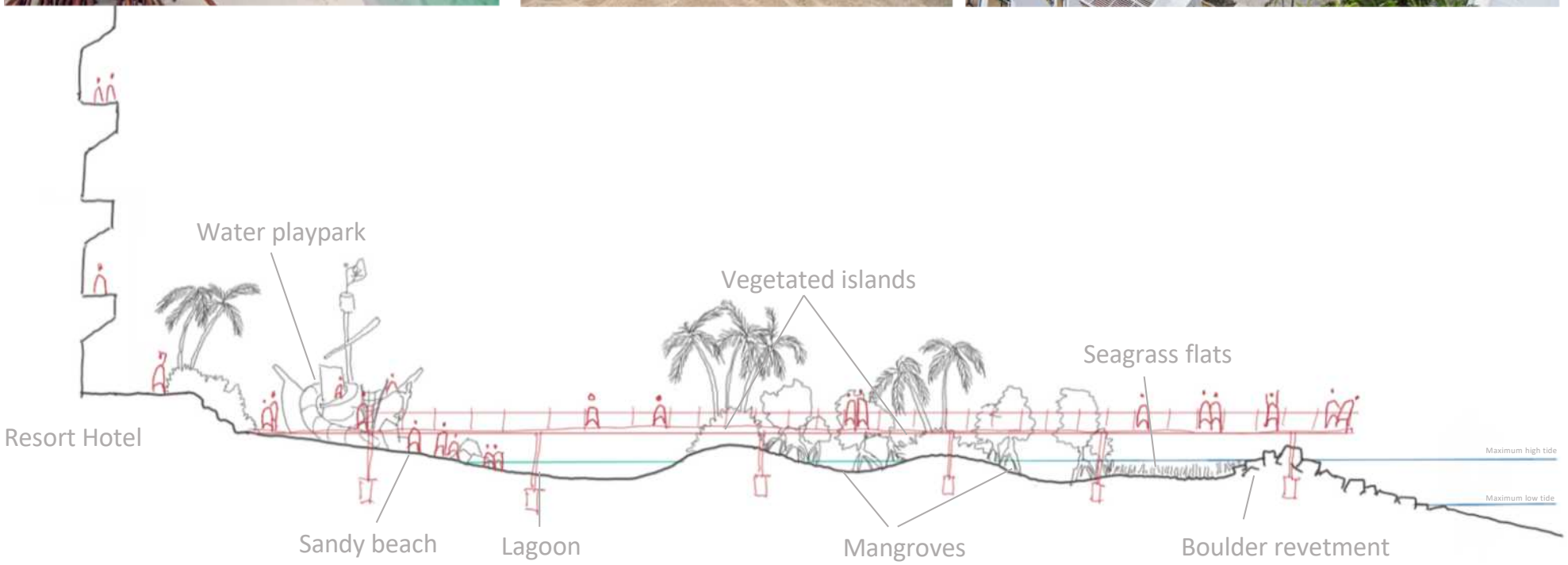
Nature-based Design Concepts

Intertidal Habitats –with Nature-Based Design



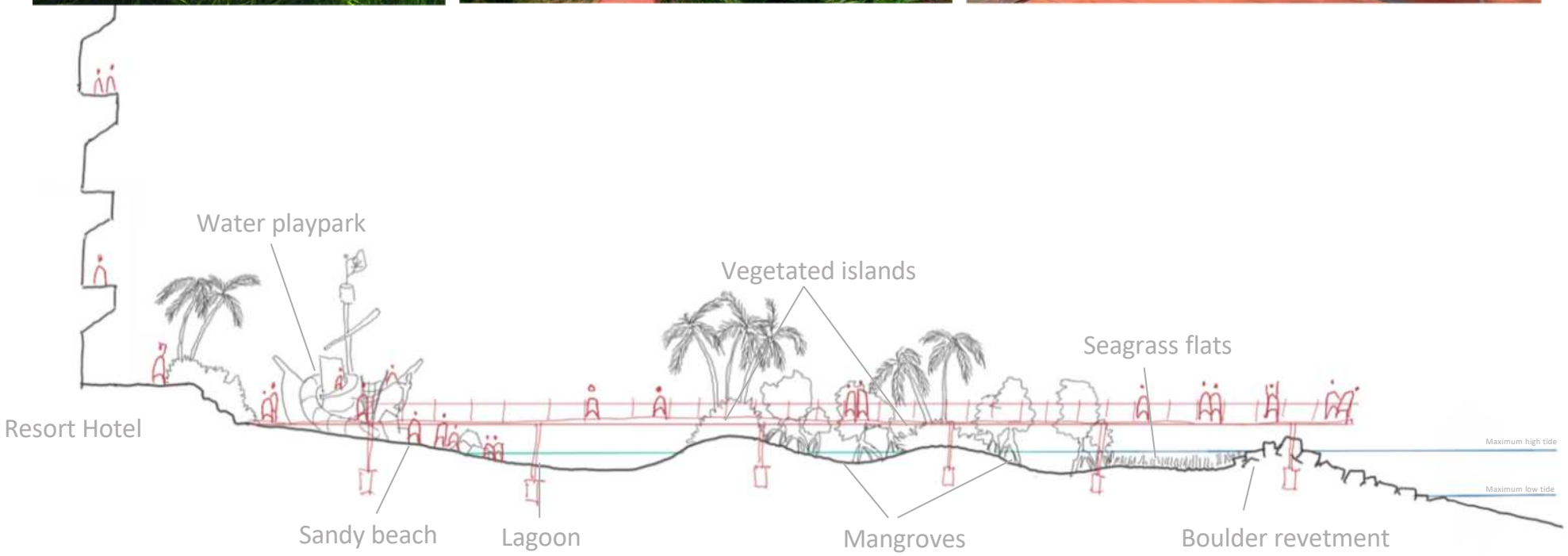
Nature-based Design Concepts

Intertidal Habitats –with Nature-Based Design



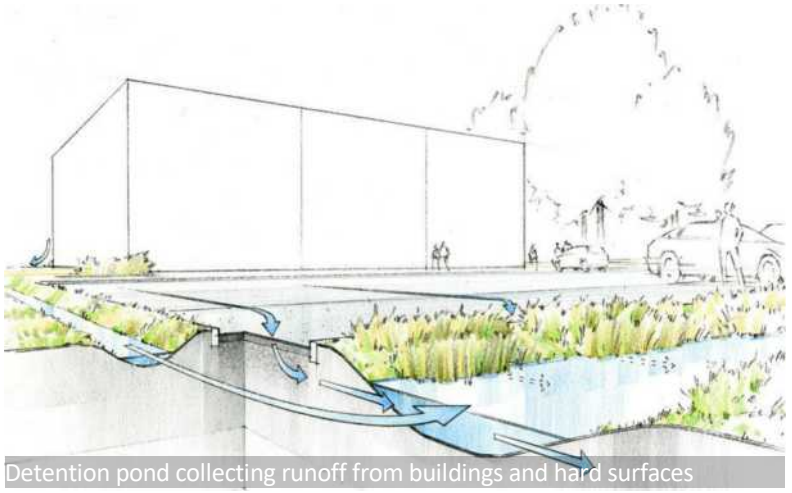
Nature-based Design Concepts

Intertidal Habitats –with Nature-Based Design



Nature-based Design Concepts

Rainwater detention ponds are designed to collect rainwater during a storm in a low-lying area and then hold the water for a time releasing the water back slowly through infiltration or remain a permanent aquatic ecological feature.



Detention pond collecting runoff from buildings and hard surfaces

Bio detention pond can become an amenity

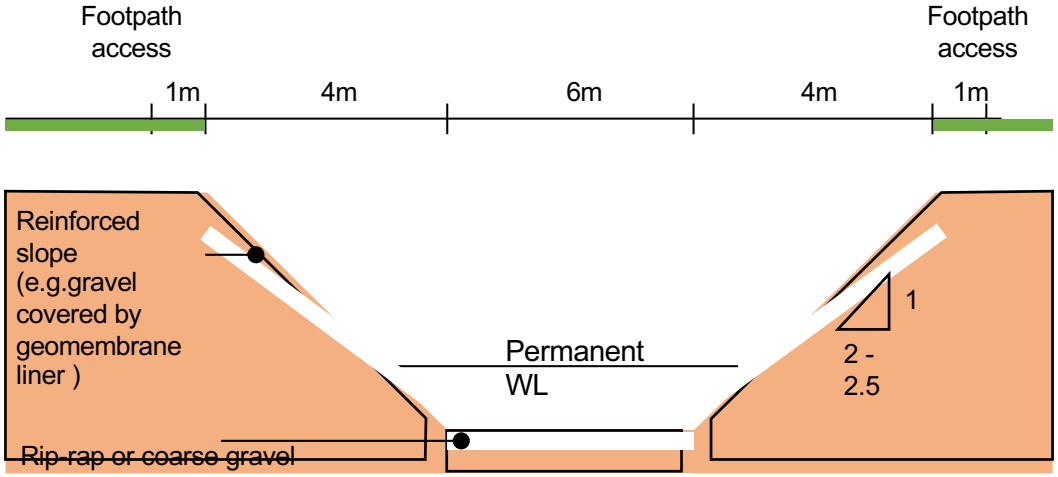
Bio detention pond next to a road

Nature-based Design Concepts

Detention ponds are permanent natural ponds with the capability of storing more rainwater runoff water during a storm event. The runoff is then slowly released over a longer period reducing the risk of flooding.

- Excavation of the area with a 1:2 average slope gradient.
- Laying of HDPE or geo-synthetic clay liners to about 200mm above the intended permanent waterline.
- Coir logs to be installed at waterline level and vegetated with appropriate macrophytic plants, coir logs can also be pre-grown and placed with vegetation in place (see photo).
- The rest of the slope to be covered in coir or similar biodegradable geotextile and vegetated with plants that can handle occasional inundation.

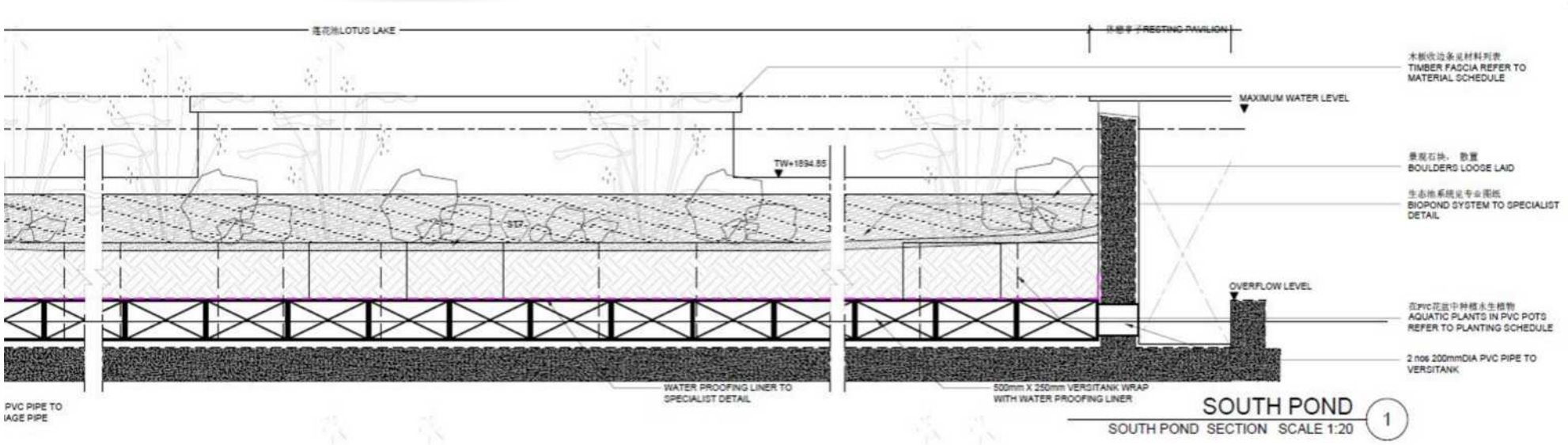
Vegetated coir logs © BGS



Nature-based Design Concepts

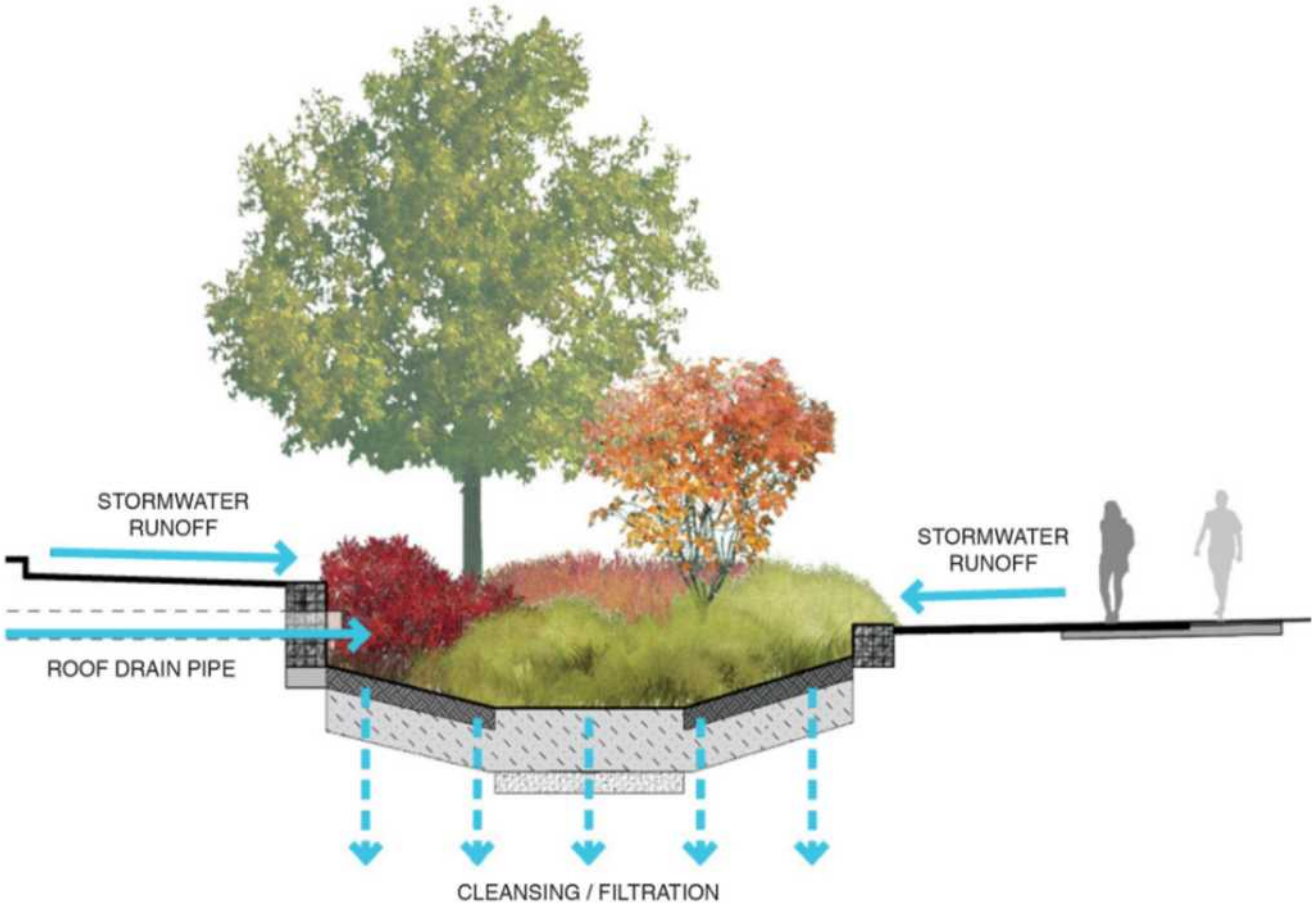
Subterranean detention

Subterranean detention area constructed using pipe halves



Nature-based Design Concepts

Naturalised Drainage



Bioswale cross-section

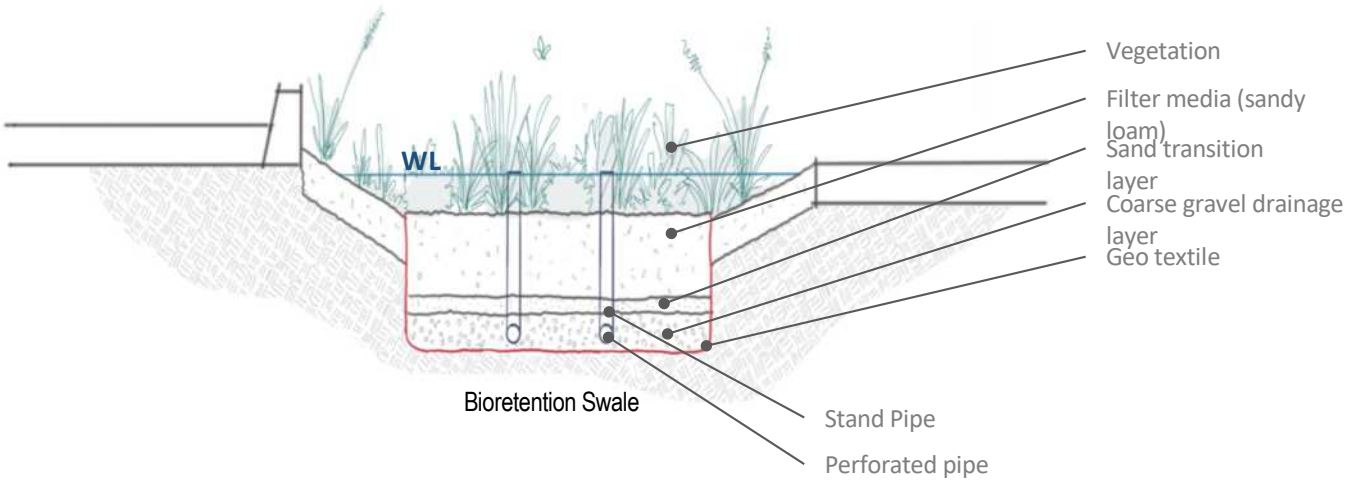
Naturalized Drains help to:

- Intercept stormwater and retain stormwater.
- Increase infiltration rates in urbanised areas.
- Filtering of pollutants in stormwater through vertical filtration.
- Slow release of stormwater into drainage system or ground below.
- Greener and aesthetically pleasing landscapes.
- Creates an urban ecology.

Nature-based Design Concepts

Naturalized Drains or Bio-Retention Systems convey, store and filter stormwater for slow release into drainage system.

"The Tembusu" Bioretention Swales by Enviro Pro



Bioretention Swale

Nature-based Design Concepts

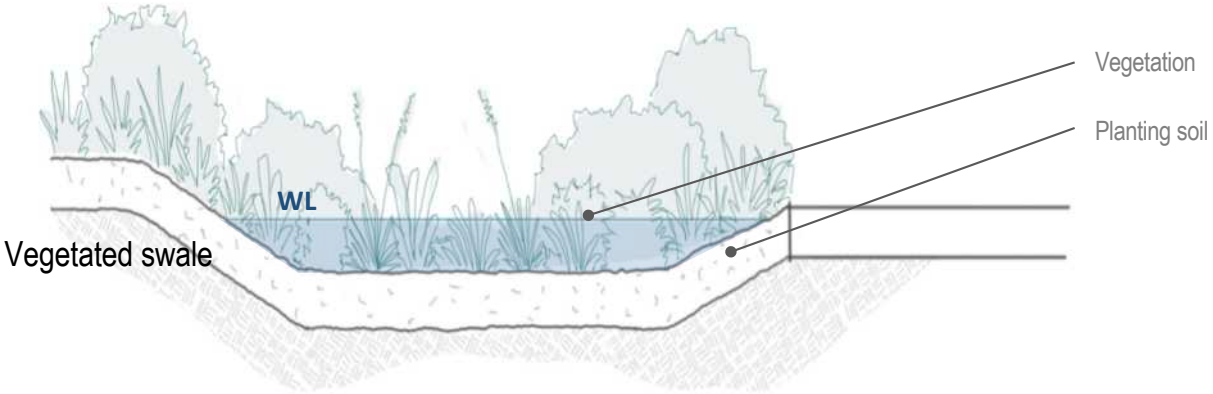
Vegetated Swales

Vegetated swales convey stormwater runoff to bioretention swales or other naturalized drainage systems. As they are vegetated channels the water flow rate is reduced allowing for some water to infiltrate into the soil. These swales also provides aesthetic and biodiversity benefits.

Primary functions

Water conveyance | Flow rate reduction | Sediment trap

Source: ABC Waters Design Guidelines



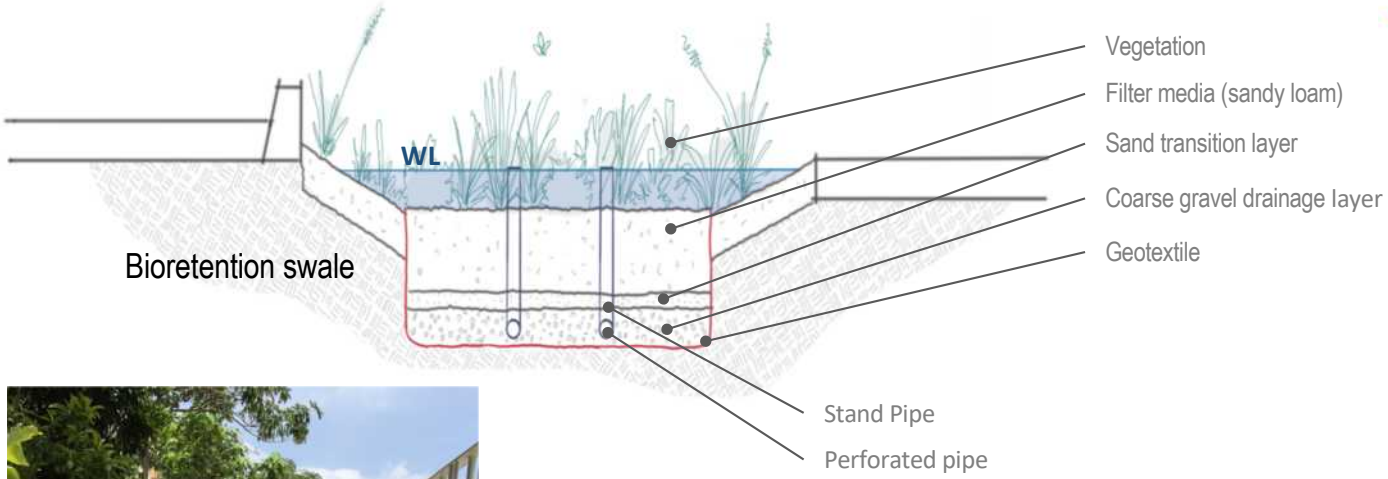
Vegetated swale

- Excavation of channel 1:100 average slope gradient.
- A layer of good quality planting soil (ASM) to be added.
- The channel to be vegetated with turf or low shrubs.

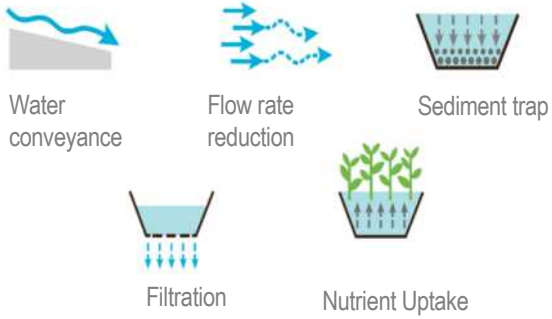
Nature-based Design Concepts

Bioretention Swales

Bioretention swales convey, filter and treat water runoff, while also providing aesthetic and biodiversity benefits. They are installed as an alternative to conventional concrete storm drains to convey stormwater runoff.

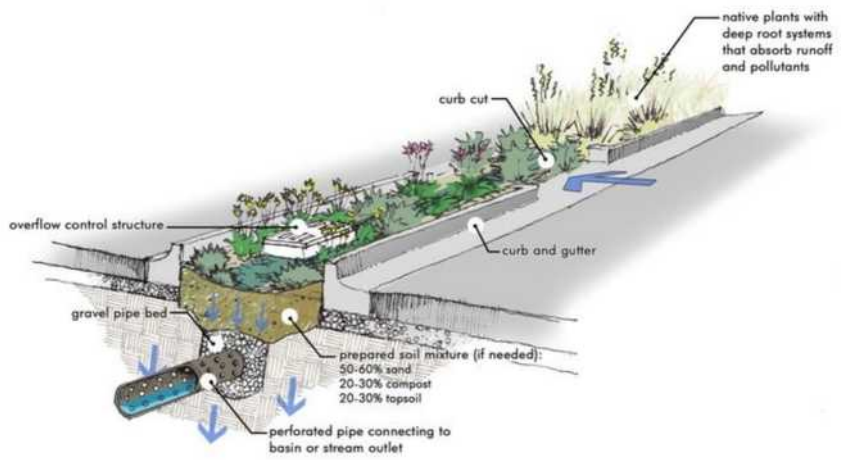


Primary functions



Source: ABC Waters Design Guidelines

"The Tembusu" Bioretention Swales © by Enviro Pro



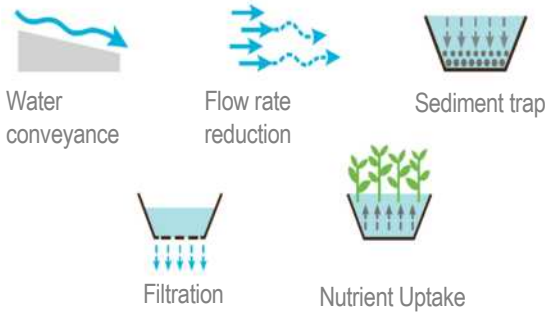
A typical Bioretention swale schematic

Nature-based Design Concepts

Bioretention Basins (Rain Gardens)

- Removes impurities in the influent water by fine infiltration, adsorption and biological uptake by plants and microbes attached to plant roots within the filter media layer.
- Temporarily stores stormwater before it is released to main public drainage system or re-charging the aquifer, controlling the volume and peak flow of water discharged.
- Careful selection of plants also helps to create many habitats for many butterflies and dragonflies.

Primary functions



Source: ABC Waters Design Guidelines


Bioretention Basin


Bioretention Basin

"The Tembusu" Bioretention Basins © by Enviro Pro

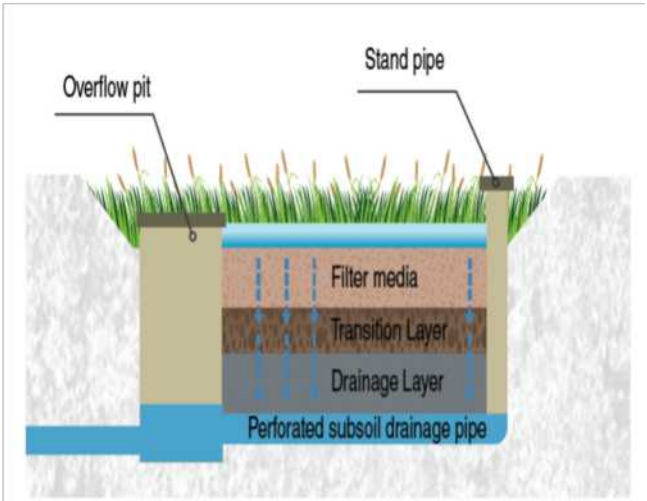
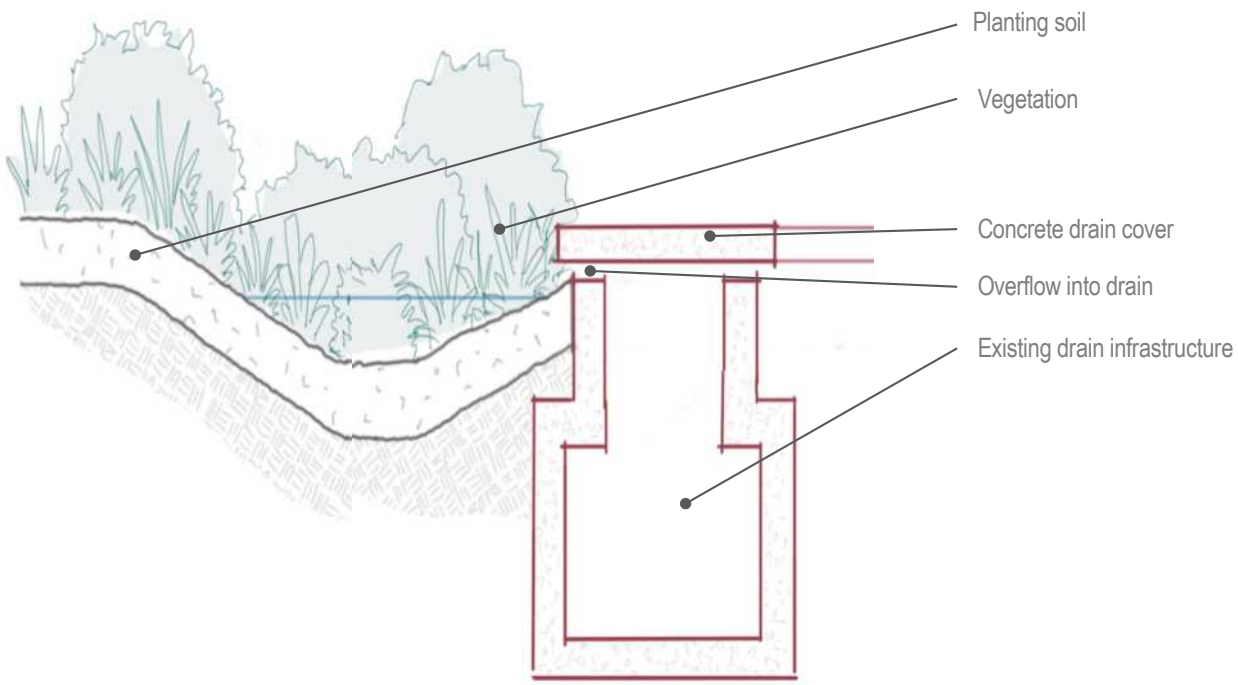


Fig. 4.30 Typical cross-section of a conventional rain garden

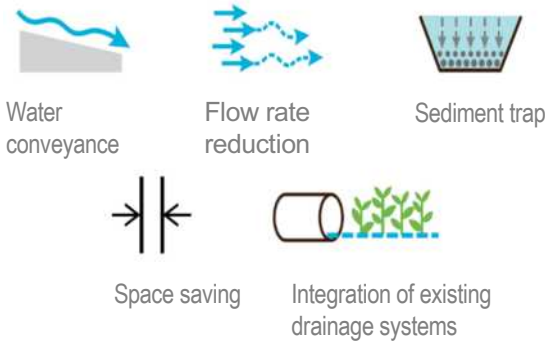
Nature-based Design Concepts

Integrated Swales

Integrated swales are a combination of vegetated or bio-retention swales with existing storm water drainage infrastructure. This provides the benefits of naturalized drainage while still utilizing existing drainage systems. When the vegetated swale gets inundated to a greater level than the swale can handle, the water overflows into the existing drainage.



Primary functions



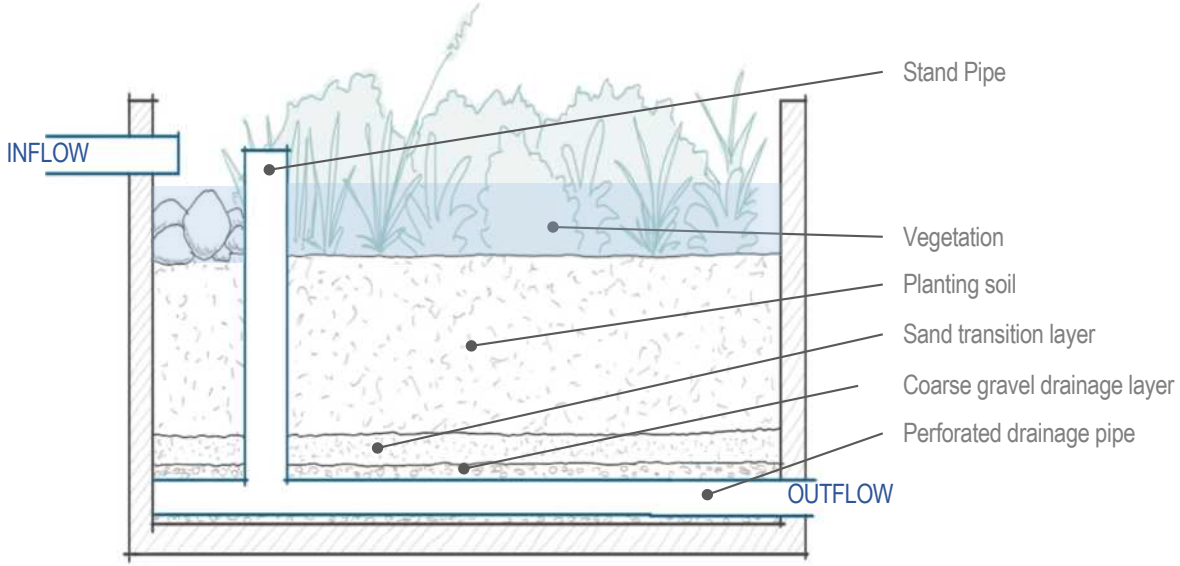
Source: ABC Waters Design Guidelines

"The Tembusu Integrated Swale © by Enviro Pro.

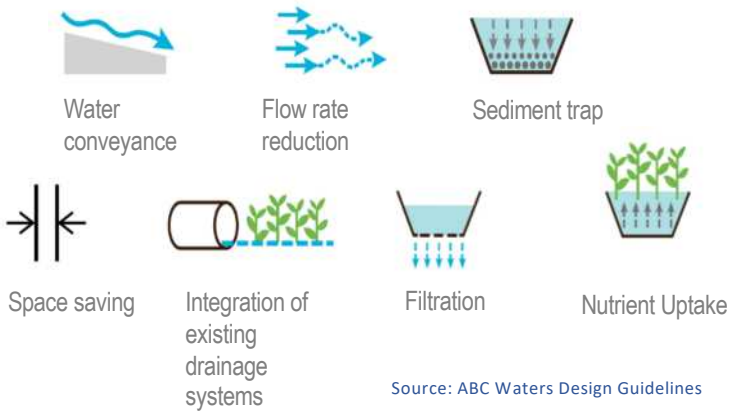
Nature-based Design Concepts

Modular Bioretention Swales

Modular bioretention swales can be utilized where space is limited. They are compact designed bioretention cells. These Bioretention cells are staggered along existing drainage infrastructure at certain intervals. They collect rainwater runoff and filter and treat it before sending the water down main drainage pipes.

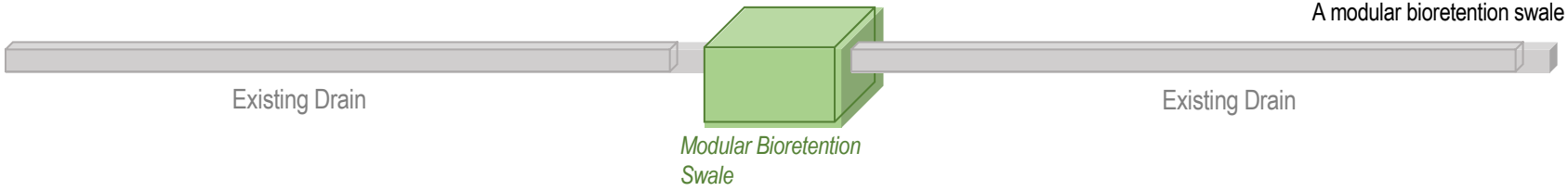


Primary functions



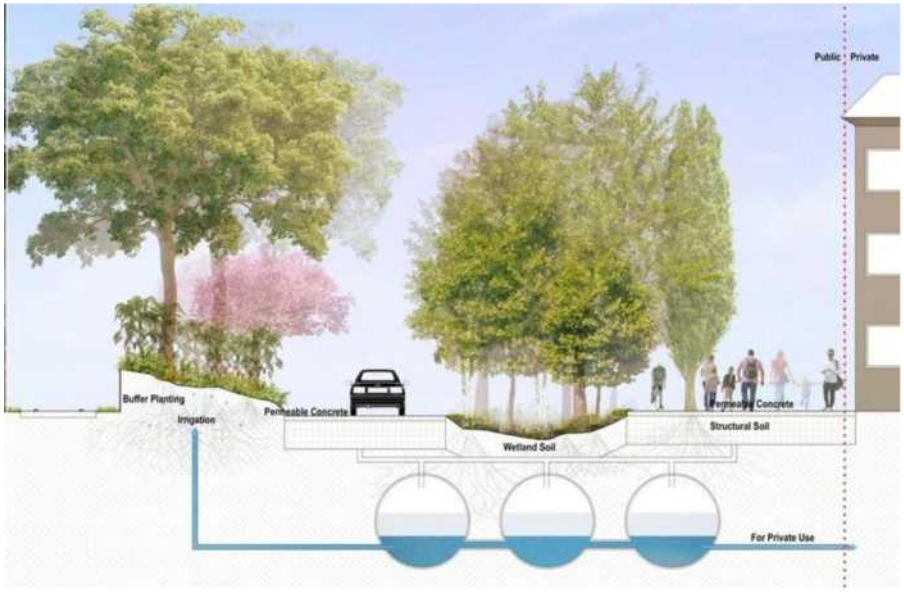
Source: ABC Waters Design Guidelines

A modular bioretention swale close to NUS High School

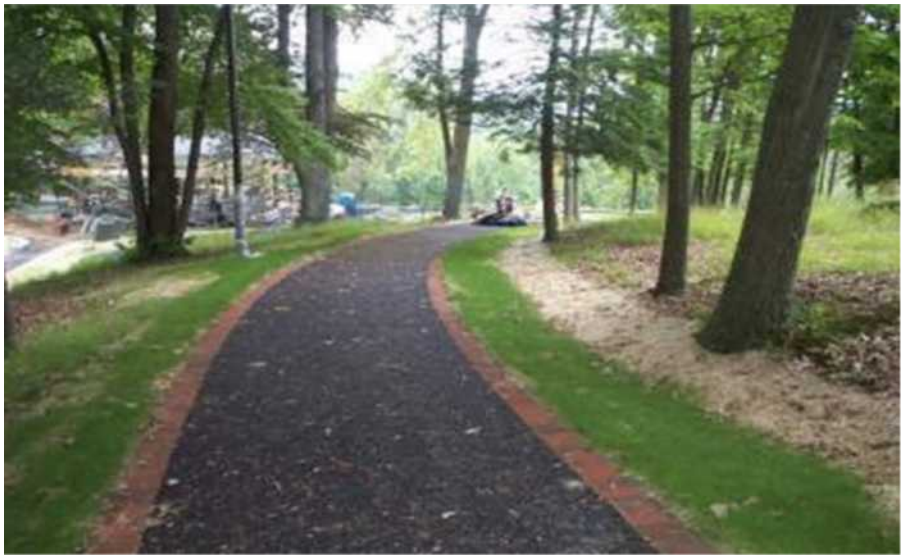


Nature-based Design Concepts

Permeable Pavement Structures with sub-pavement drainage



Permeable pavements create space for tree planting and urban ecology as drainage moves under the road surface.



Pervious concrete pavement is an effective means to meet growing demands for integrated sustainable drainage and mobility solutions. By capturing rainwater and allowing it to seep into the ground, pervious concrete is instrumental in recharging groundwater, or conveying storm water runoff into space-saving sub-road drainage systems.

Ecological Enhancement

Biodiversity Themed Landscapes – City Butterfly Trail

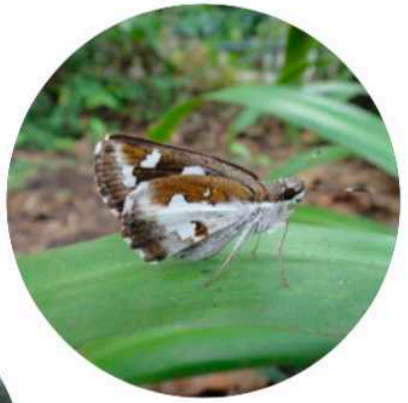
Creating butterfly gardens is both art & science…

Blood Flowers

Blue Pansy

Common Rose Caterpillar

Grass Demon



Thank you!

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