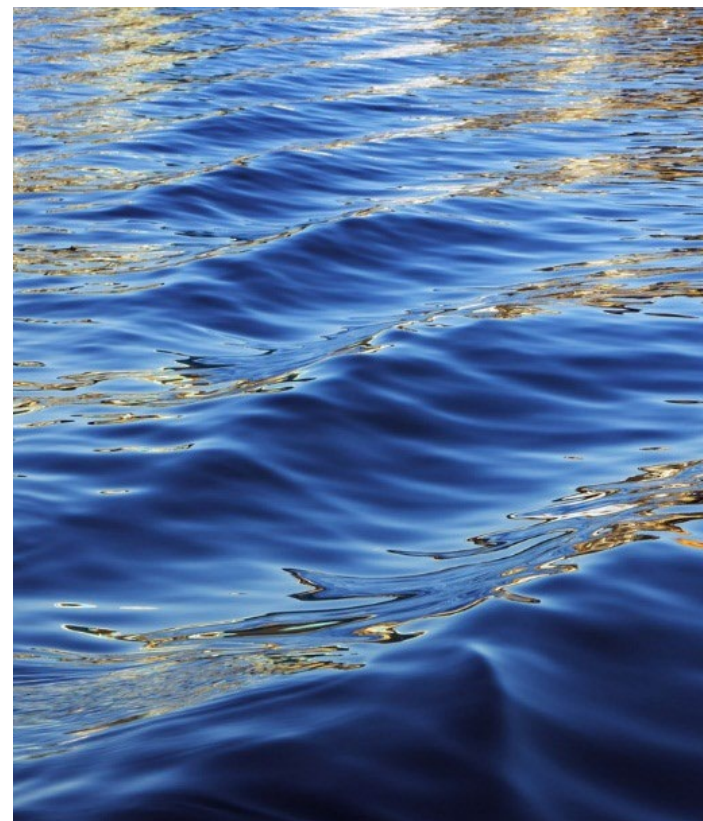
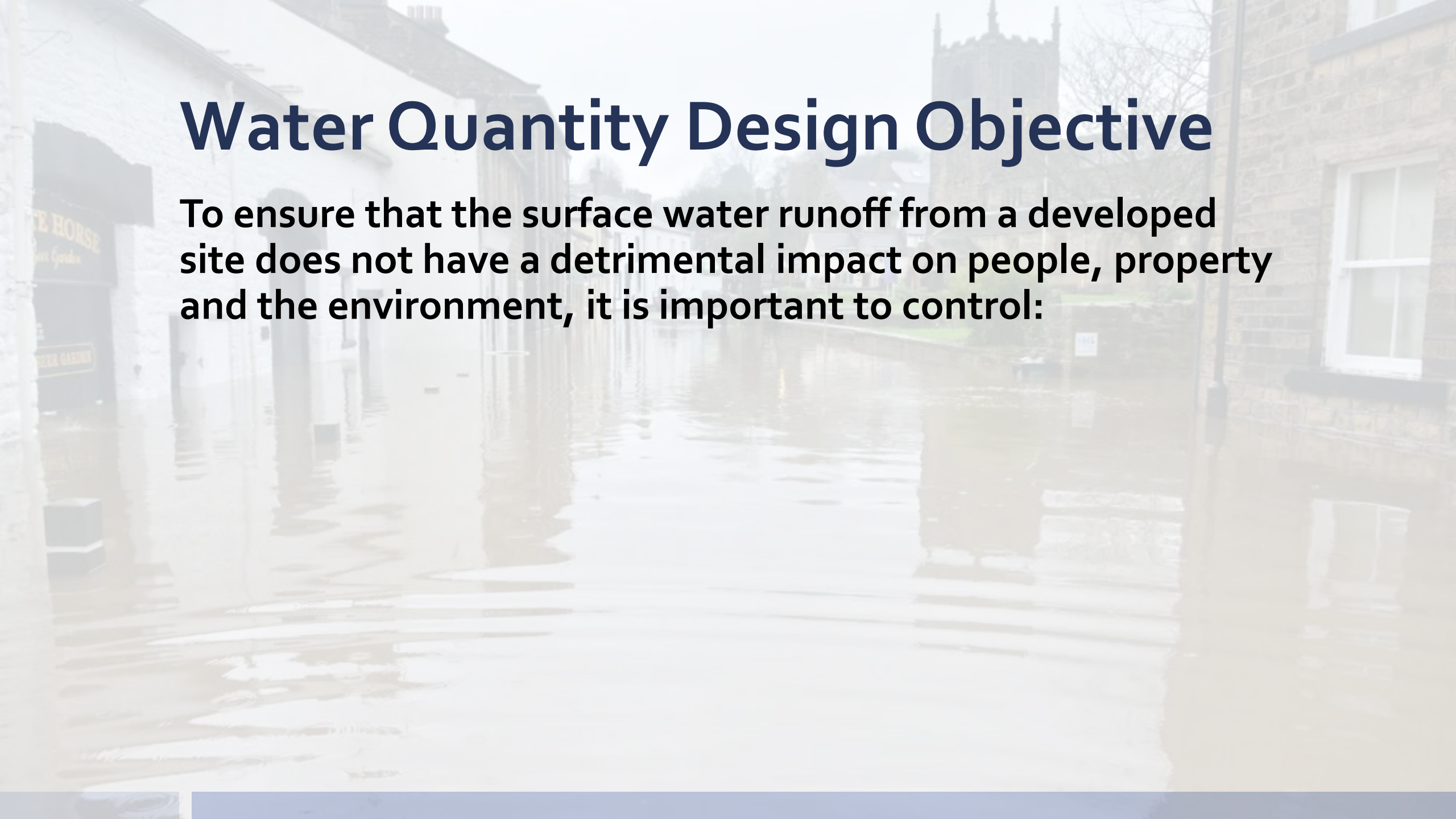


SuDS Design



Water Quantity Design Objective

To ensure that the surface water runoff from a developed site does not have a detrimental impact on people, property and the environment, it is important to control:

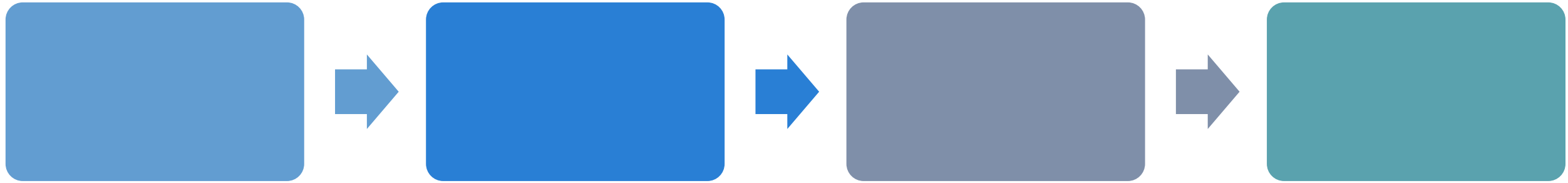


Water Quantity Design Objective

To ensure that the surface water runoff from a developed site does not have a detrimental impact on people, property and the environment, it is important to control:

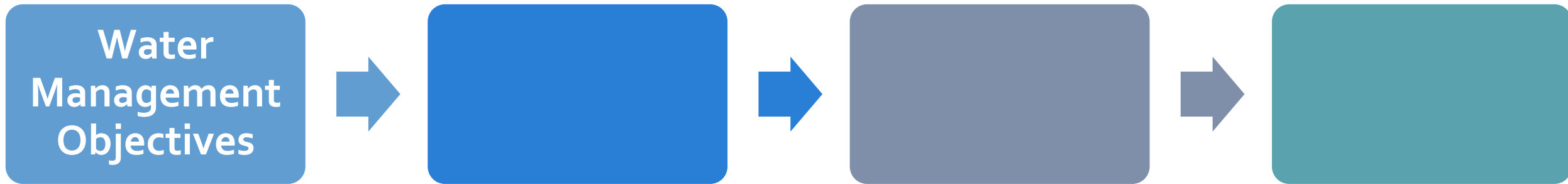
- how fast the runoff is discharged from the site (i.e. the peak runoff rate) and
- how much runoff is discharged from the site (i.e. the runoff volume)

SuDS Design Process



SuDS Design Process

The SuDS design process broadly follows four stages:



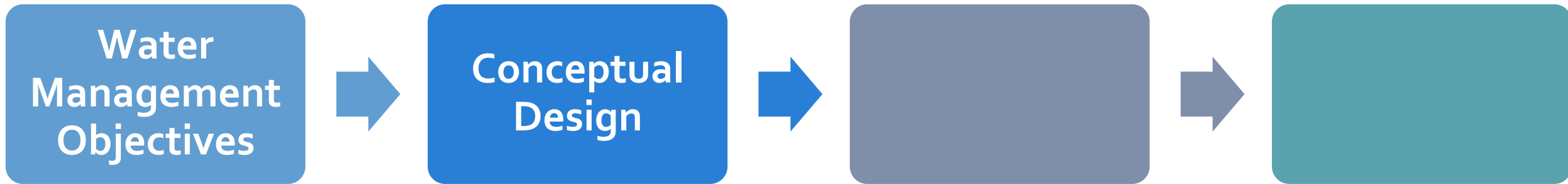
Water Management Objectives

Through consultation with relevant stakeholders, and with reference to adopted local planning and regulatory guidance, policy, the site Environmental Impact Assessment, and flood risk/consequence assessment, clear local or site-specific strategic objectives should be established, including:

- Flood risk management
- Water quality management
- Community, social and amenity provision
- Habitat and biodiversity requirements
- Long-term maintenance and adoption arrangements for proposed SuDS (including applicable standards and criteria)
- Climate change adaptation and resilience
- Water supply objectives and constraints.

SuDS Design Process

The SuDS design process broadly follows four stages:



SITE CHARACTERISATION

Natural Land & Water Flow



Ground Potential & Risk



Existing Infrastructure & Use



Evaluate existing topography, flow routes, and ground conditions to understand natural water movement and inherent risks.

DEVELOPMENT CHARACTERISATION

Proposed Landscape & Form



Strategic Risk Management



Long-term Adoption & Maintenance



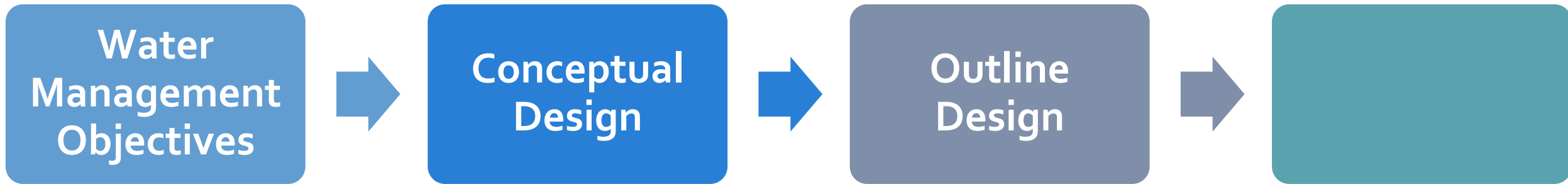
Analyze proposed land use, topography, and alignment with long-term strategies for future ownership.

SuDS Conceptual Design: Identifying Components and Linkages



SuDS Design Process

The SuDS design process broadly follows four stages:





Runoff Control & Future-Proofing

Establishing the baseline natural runoff rate to define site control limits.

Greenfield Runoff Rates

Establishing the baseline natural runoff rate to define site control limits.



Climate & Urban Provisions

Accounting for climate change and urban creep in sub-catchment runoff estimates.



=



Large Event Volume Gap

Calculating the runoff volume difference between developed and greenfield sites for major storms.



Component-Specific Capacities

Infiltration Capacities

Measuring site capacity when infiltration-based drainage components are proposed.

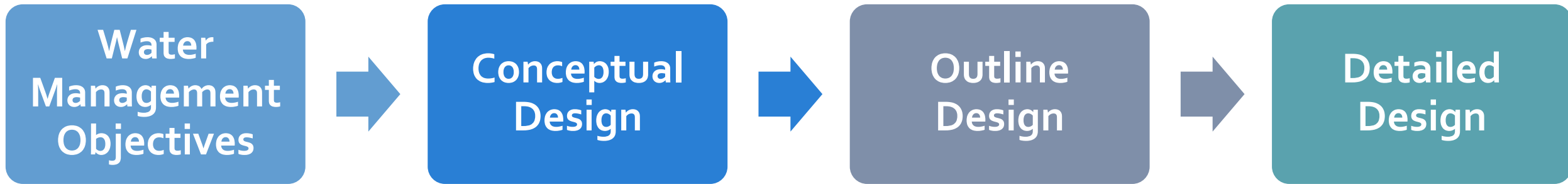
Non-Potable Water Demand

Estimating water usage needs to size rainwater harvesting components effectively.



SuDS Design Process

The SuDS design process broadly follows four stages:



Conceptual Design

How much rain falls?

How much runoff is created?

How much water must be stored?

How slowly must it be released?

What physical systems will achieve this?

Site / Development Characterisation

Site Area and Layout

- **Total area (hectares)**
- **Proposed buildings**
- **Roads and parking**
- **Green spaces**

This determines how much impermeable surface will generate runoff.



Site / Development Characterisation

Surface Types

Each surface produces different runoff.

Surface	Run Off
Roof	Very High
Asphalt	High
Block Paving	Medium
Grass	Low



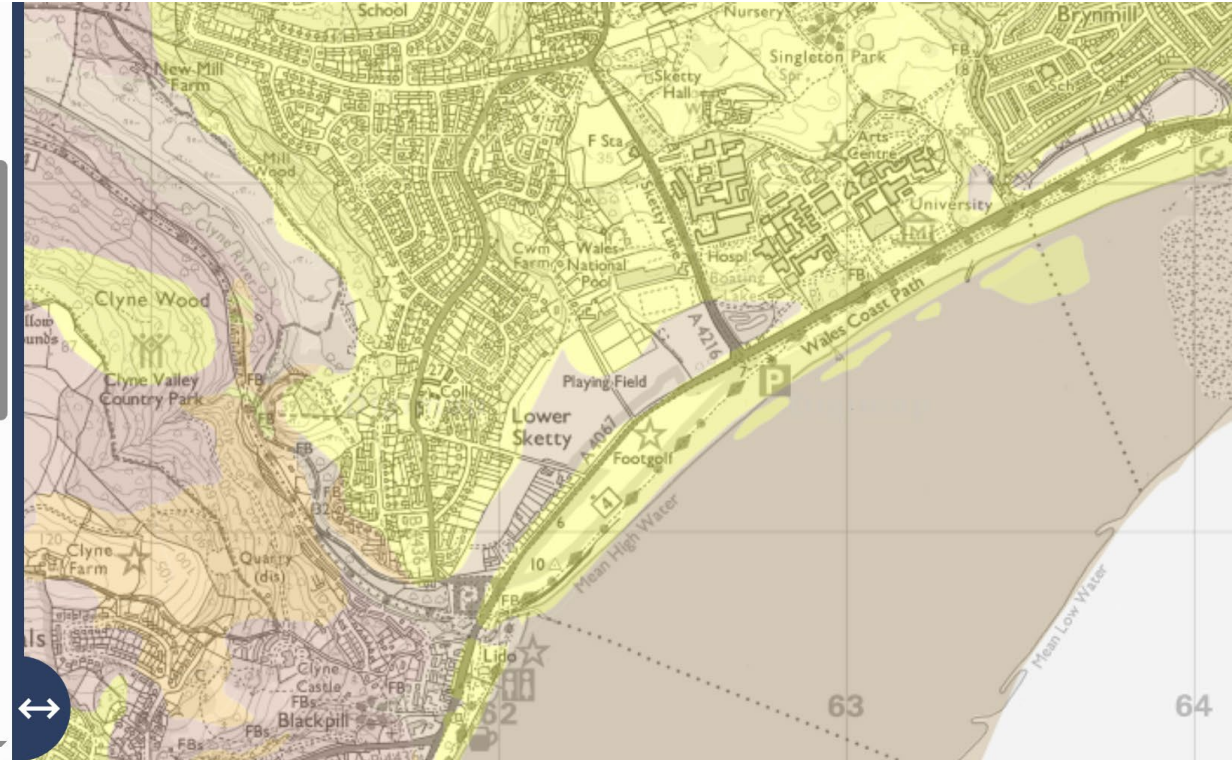
Site / Development Characterisation

Soil Type

This determines if water can soak into the ground.

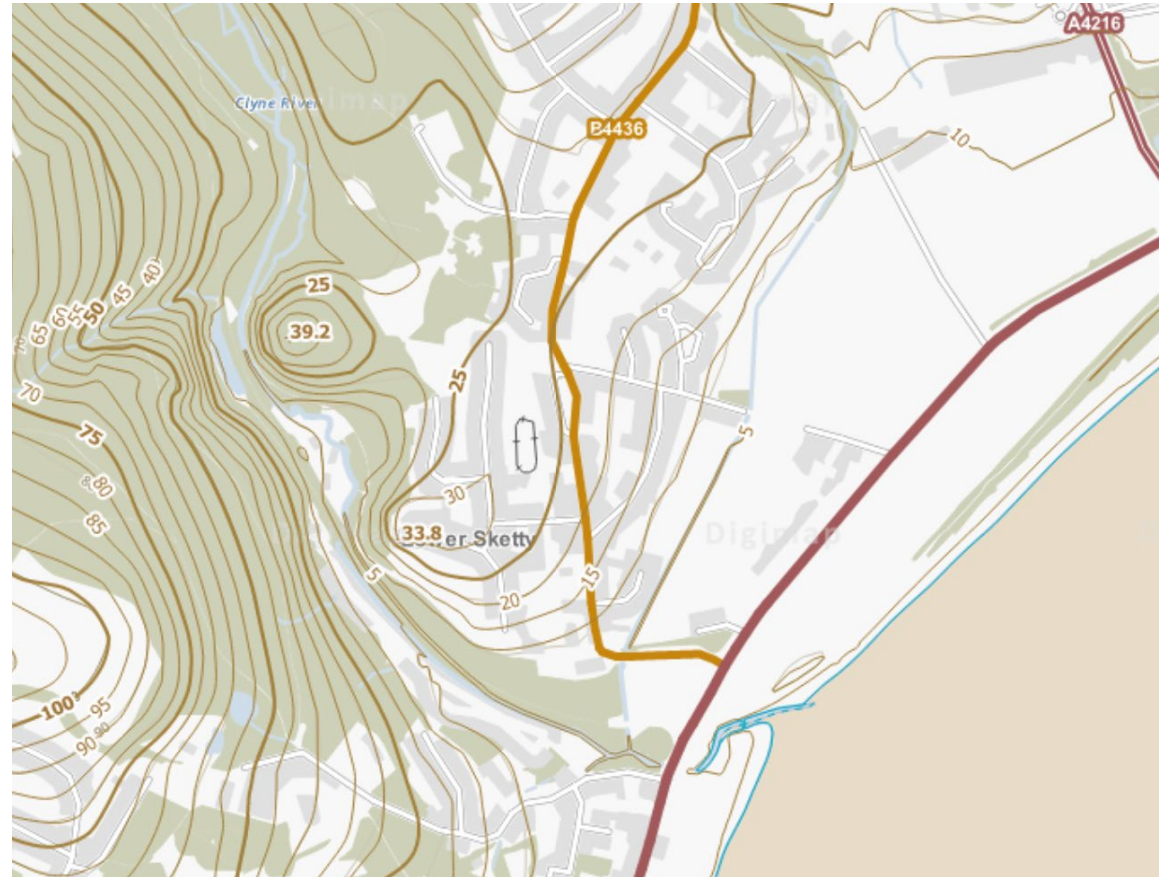
If infiltration is being considered, testing is carried out using BRE 365 methodology.

If soil is impermeable
→ must store and discharge.



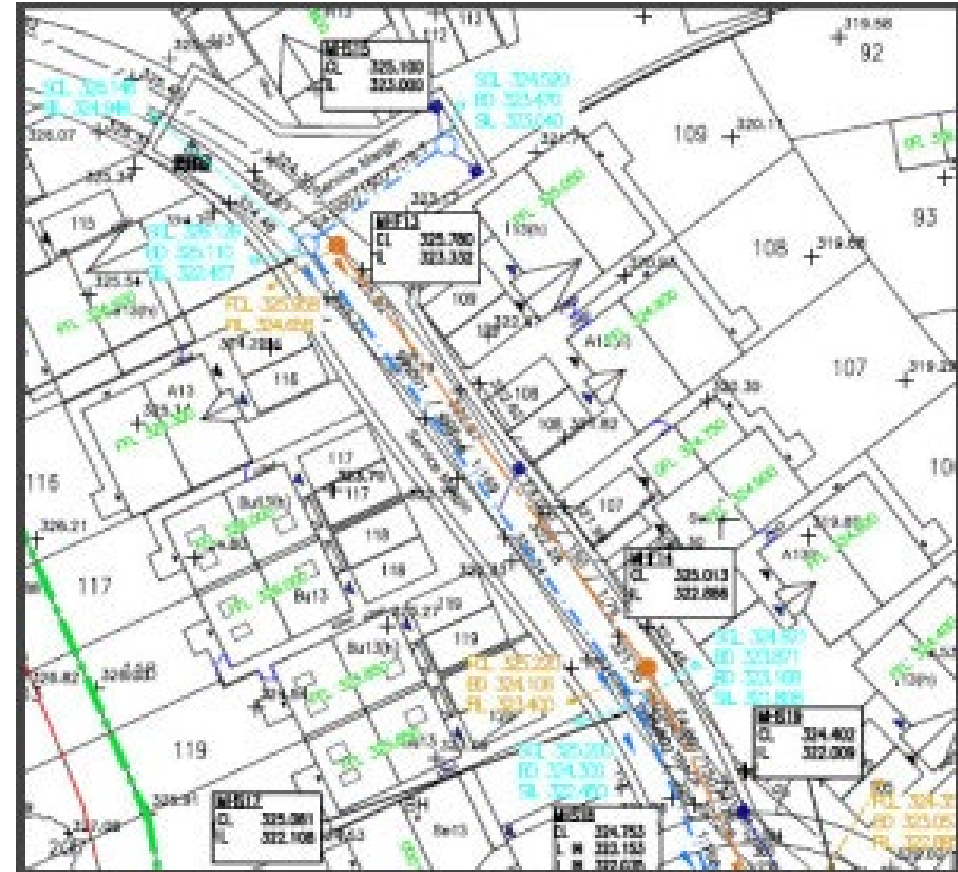
Site / Development Characterisation

Site Slope



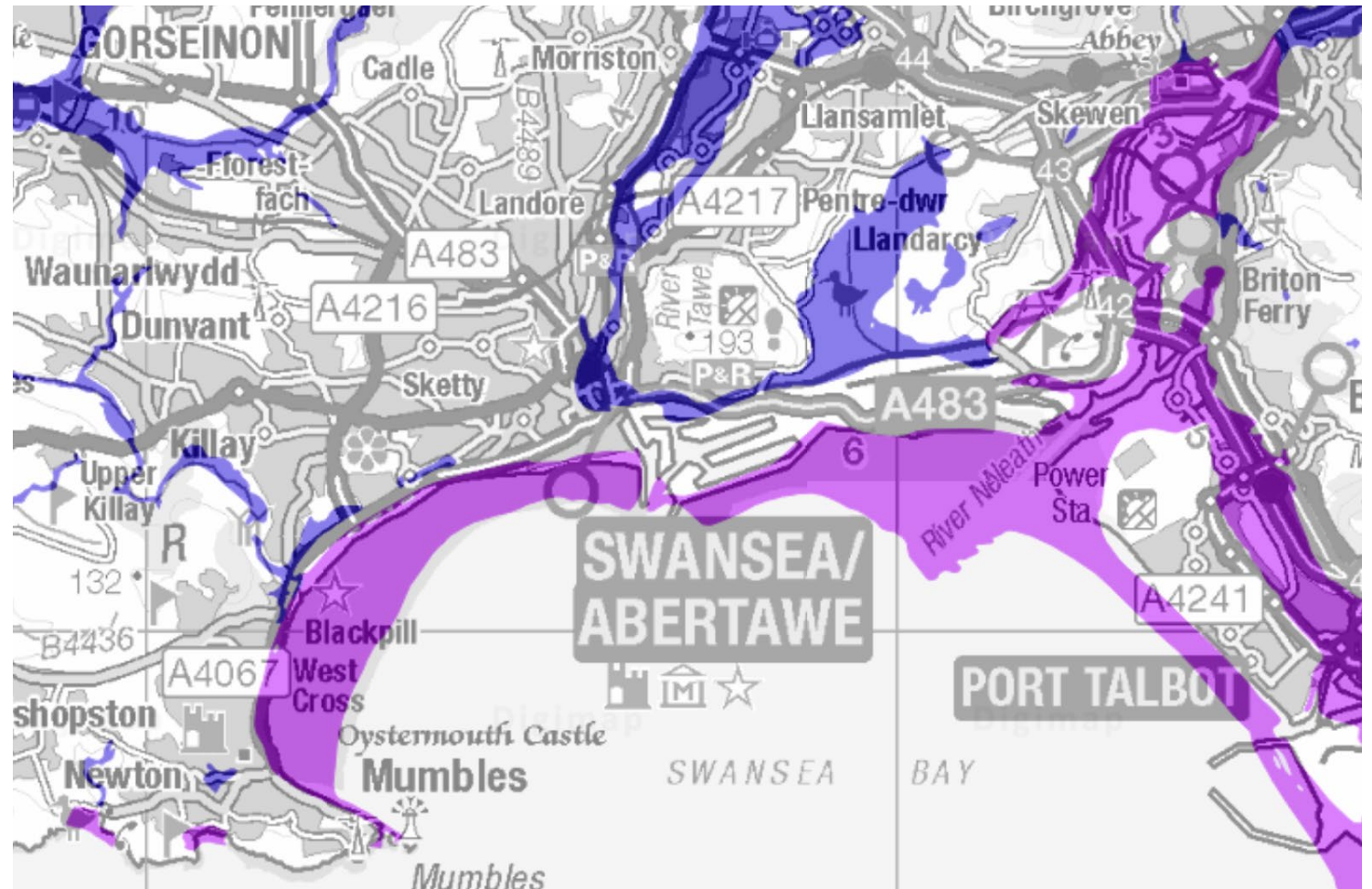
Site / Development Characterisation

Existing Drainage



Site / Development Characterisation

Flood Risk



Rainfall Data



- The next step in designing any Sustainable Drainage System (SuDS) is to understand the rainfall characteristics for the location of interest.
- This helps determine the intensity and volume of water the system needs to manage.

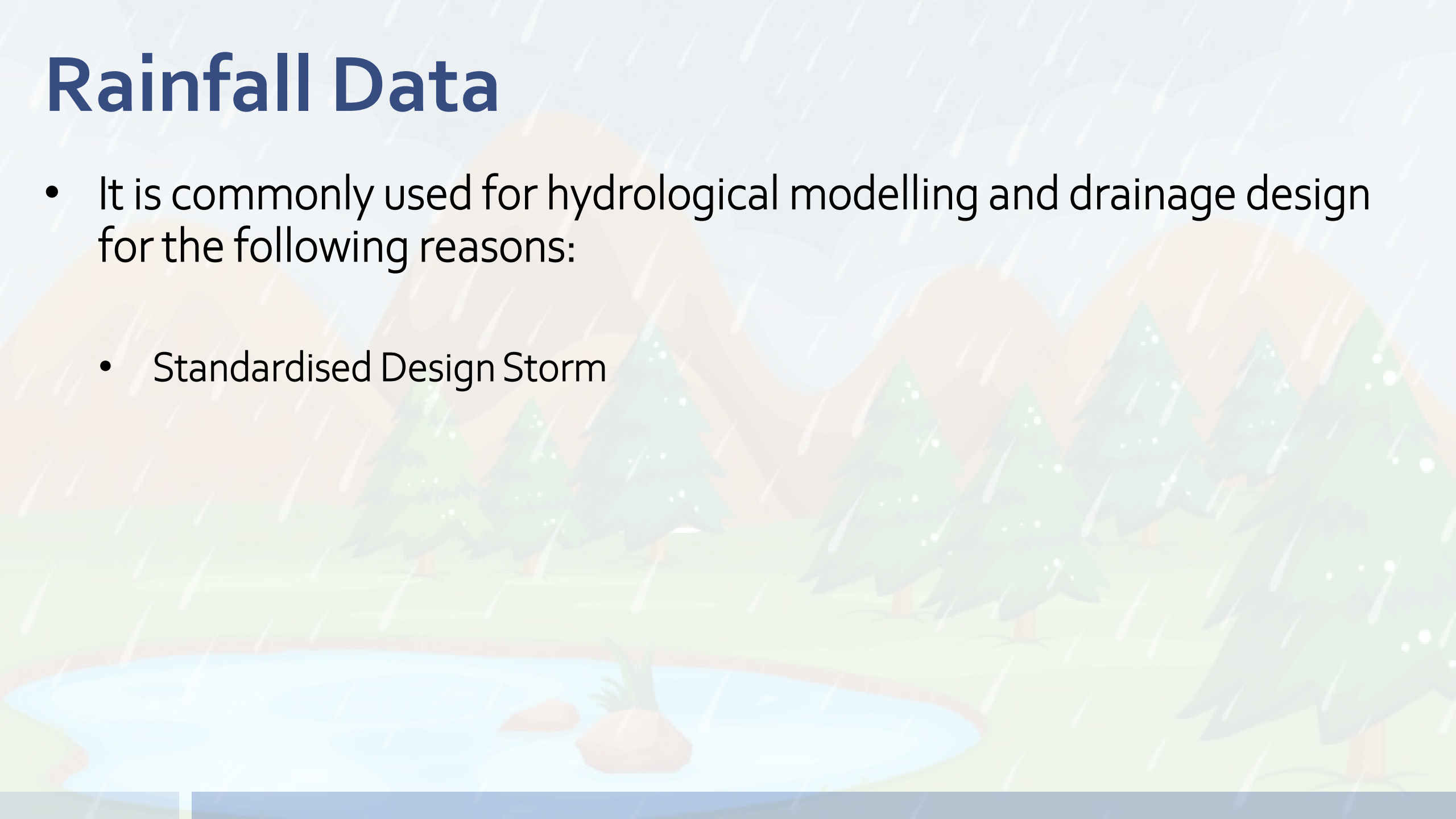
Rainfall Data



- In Sustainable Urban Drainage Systems (SUDS) design, M5-60 refers to the 60-minute rainfall depth with a return period of 5 years, based on historical rainfall records.

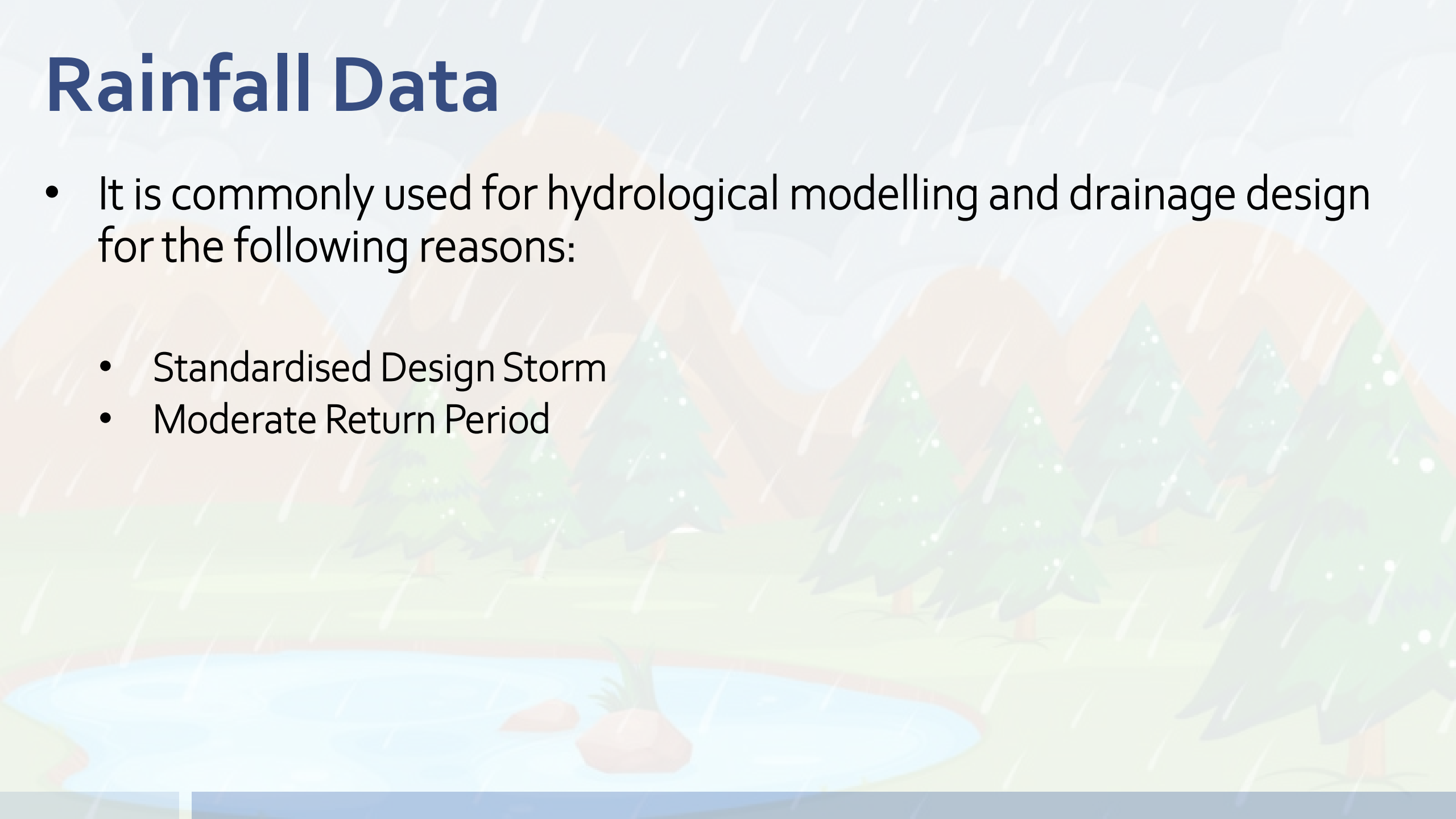
Rainfall Data

- It is commonly used for hydrological modelling and drainage design for the following reasons:
 - Standardised Design Storm

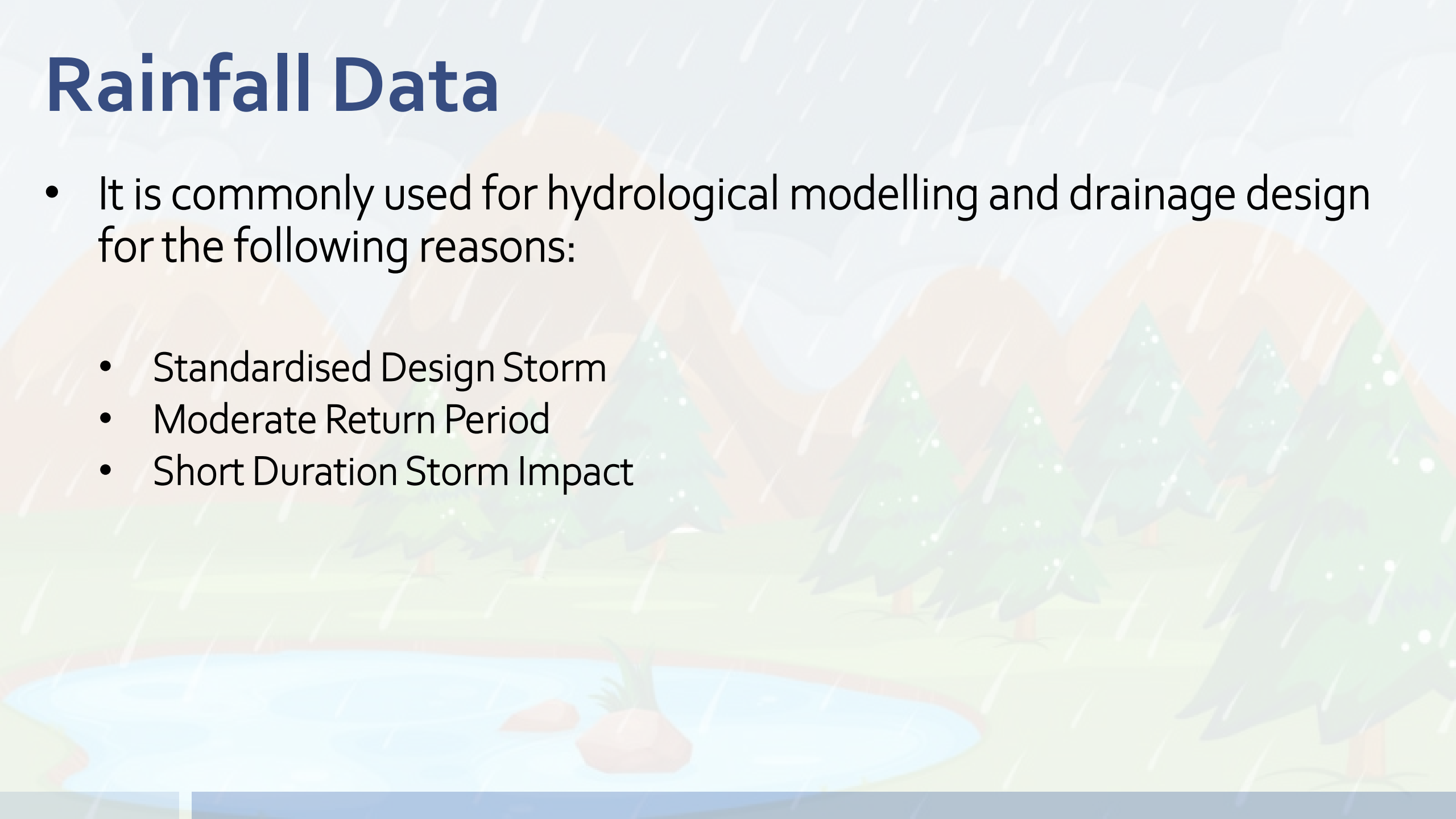


Rainfall Data

- It is commonly used for hydrological modelling and drainage design for the following reasons:
 - Standardised Design Storm
 - Moderate Return Period



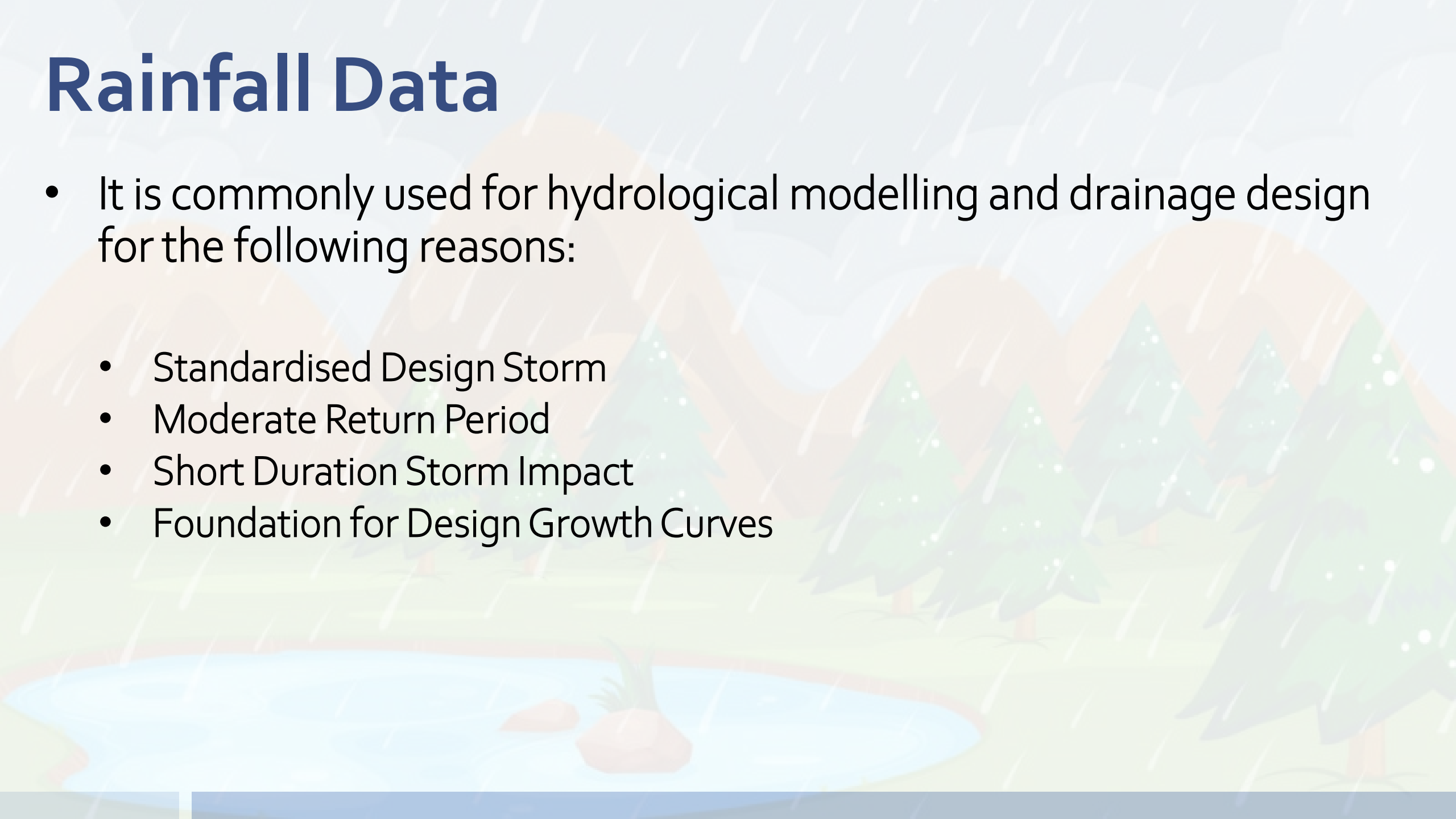
Rainfall Data

A stylized illustration of a rainy landscape. In the foreground, there is a small blue pond with two reddish-brown rocks. Behind the pond, several green coniferous trees are scattered across a light green field. In the background, there are rolling hills or mountains in shades of orange and brown. The entire scene is overlaid with numerous white diagonal lines representing falling rain.

- It is commonly used for hydrological modelling and drainage design for the following reasons:
 - Standardised Design Storm
 - Moderate Return Period
 - Short Duration Storm Impact

Rainfall Data

- It is commonly used for hydrological modelling and drainage design for the following reasons:
 - Standardised Design Storm
 - Moderate Return Period
 - Short Duration Storm Impact
 - Foundation for Design Growth Curves



Rainfall Data

The background of the slide is a stylized illustration of a rainy landscape. It features rolling hills in shades of orange and yellow, several green coniferous trees, and a light blue body of water in the foreground. White diagonal lines represent falling rain across the entire scene.

- It is commonly used for hydrological modelling and drainage design for the following reasons:
 - Standardised Design Storm
 - Moderate Return Period
 - Short Duration Storm Impact
 - Foundation for Design Growth Curves
 - Alignment with Industry Standards

Rainfall Data



Using the FEH web services, the estimated rainfall depths for Swansea are:

$$M_{5-60}=17\text{mm}$$

This means that if a storm with a return period of 5 year occurs and lasts an hour, the total depth of rainfall is 17mm over that period.

Peak Runoff - Example

$$Q = 2.78 \times C \times i \times A$$

Where:

Q= Peak Runoff Rate (m³/s)

C= Runoff Co-efficient (depends on land use)

i = Rainfall intensity (mm/h)

A= Catchment area in hectares

Peak Runoff - Example

Calculate the peak runoff for a 1.01 hectare site using the following values:

$C = 0.75$

$i = 17\text{mm/h}$

See Separate Calculation Sheet



Greenfield Runoff Rate Estimation



Greenfield runoff rate (Q_{bar}) is the natural runoff from an undeveloped site and is used as a benchmark for limiting discharge in new developments.

Greenfield Runoff Rate Estimation

$$Q_{\text{bar}} = 0.00108 \times \text{Area}^{0.89} \times \text{SAAR}^{1.17} \times \text{SOIL}^{2.17}$$

Where:

Q_{bar} = Mean Annual Flood (m^3/s)

AREA = Area of catchment in km^2

SAAR = Standard Average Annual Rainfall for the period 1941-1970 in mm

SOIL = Soil Index

Greenfield Runoff - Example

Calculate the peak runoff for our 1.01 hectare site using the following values:

AREA = 0.5

SAAR = 1136

SOIL = 0.37

See Separate Calculation Sheet



Estimating Storage Volume

$$\text{Volume} = (\text{Inflow Rate} - \text{Outflow Rate}) \times \text{Duration}$$

Where:

Inflow Rate = Peak Runoff (Q)

Outflow Rate = Greenfield Runoff (Q_{bar})

Duration = Length of Storm

Storage Volume- Example

Calculate the peak runoff for our 1.01 hectare site based on a M5-60 storm.

See Separate Calculation Sheet



Estimating Storage Volume

Media Type	SVP	VFC	SVP(1-VFC)
Sand	0.30	0.25	0.225
Soil	0.40	0.35	0.260
Gravel	0.30	0.15	0.255
Green Roof Mix	0.23	0.35	0.150
Geocellular Module	0.95	0	0.950
Sub-base	0.30	0.35	0.195
Geocomposite Layer	0.50	0.0	0.500
Void	1.00	0	1.000

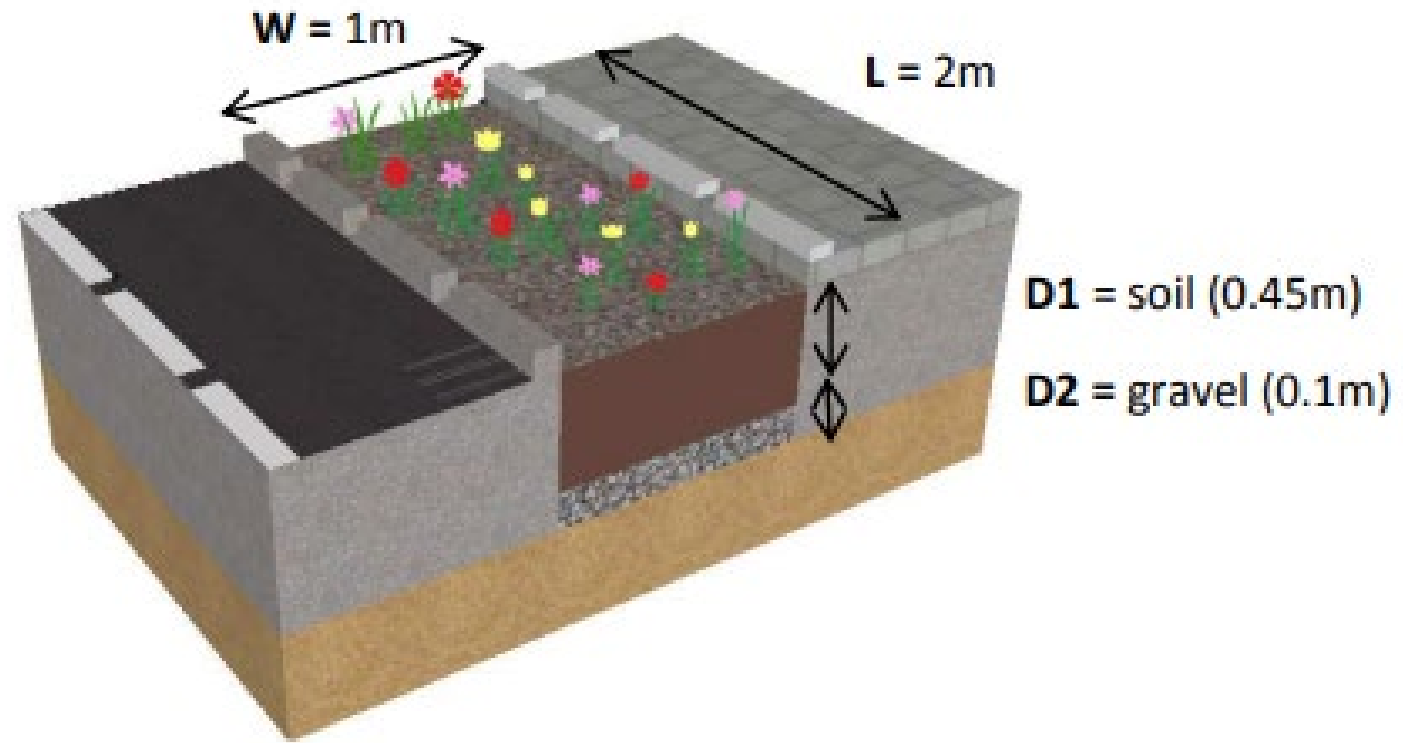
Rain Garden – Example

Calculation for estimating
volume of soil

$$V = L \times W \times D_1$$

$$V = 2.0 \times 1.0 \times 0.45$$

$$V = 0.9\text{m}^3$$



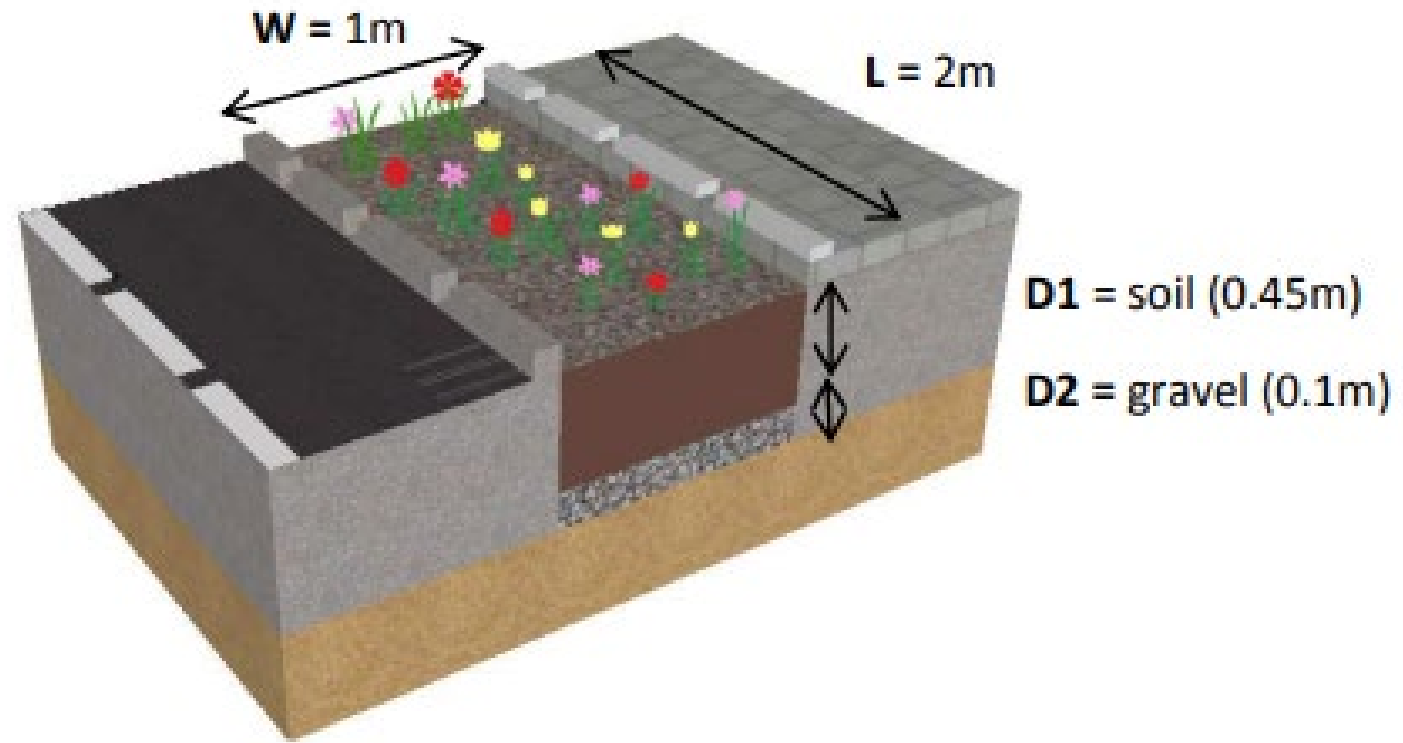
Rain Garden – Example

Calculation for estimating storage volume of soil

$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 0.9 \times 0.26$$

$$V_s = 0.234 \text{ m}^3$$



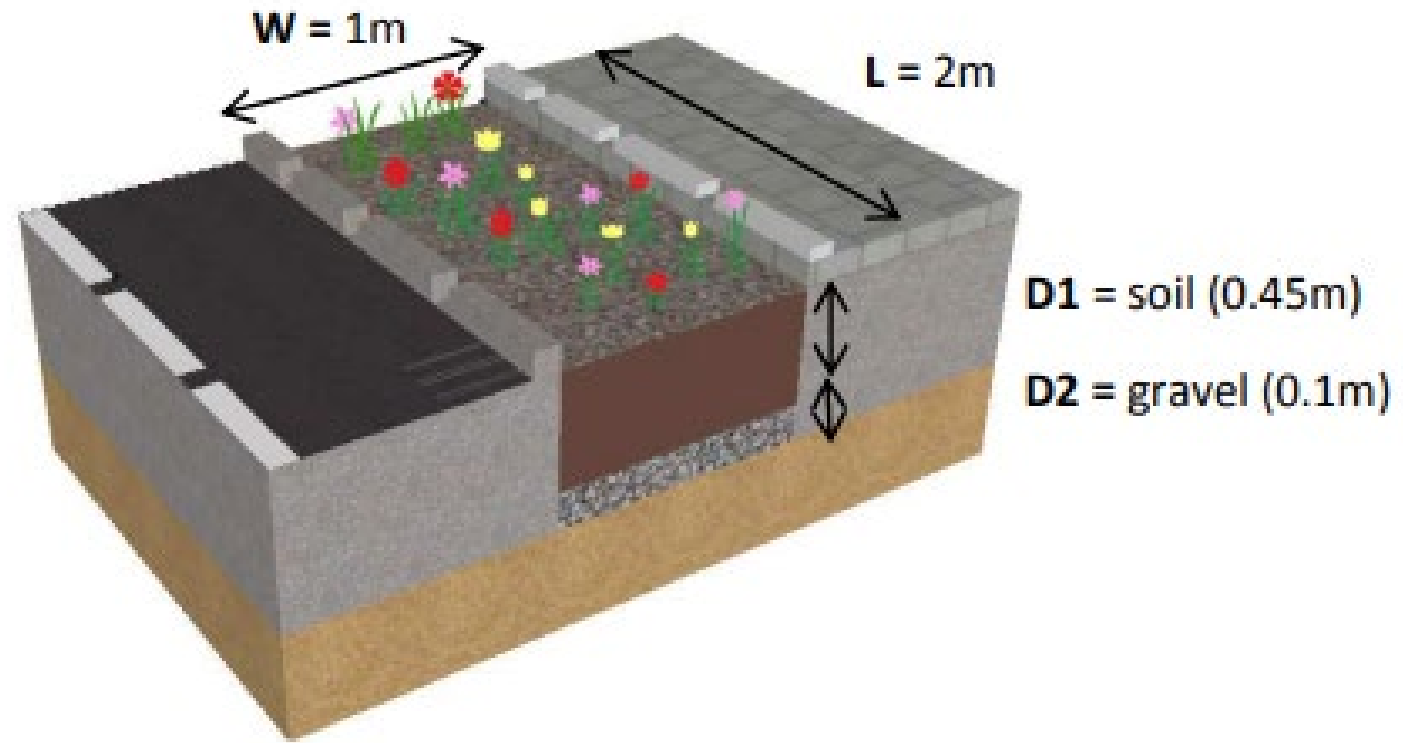
Rain Garden – Example

Calculation for estimating
volume of gravel

$$V = L \times W \times D_2$$

$$V = 2.0 \times 1.0 \times 0.1$$

$$V = 0.2 \text{ m}^3$$



Rain Garden – Example

Calculation for estimating storage volume of gravel

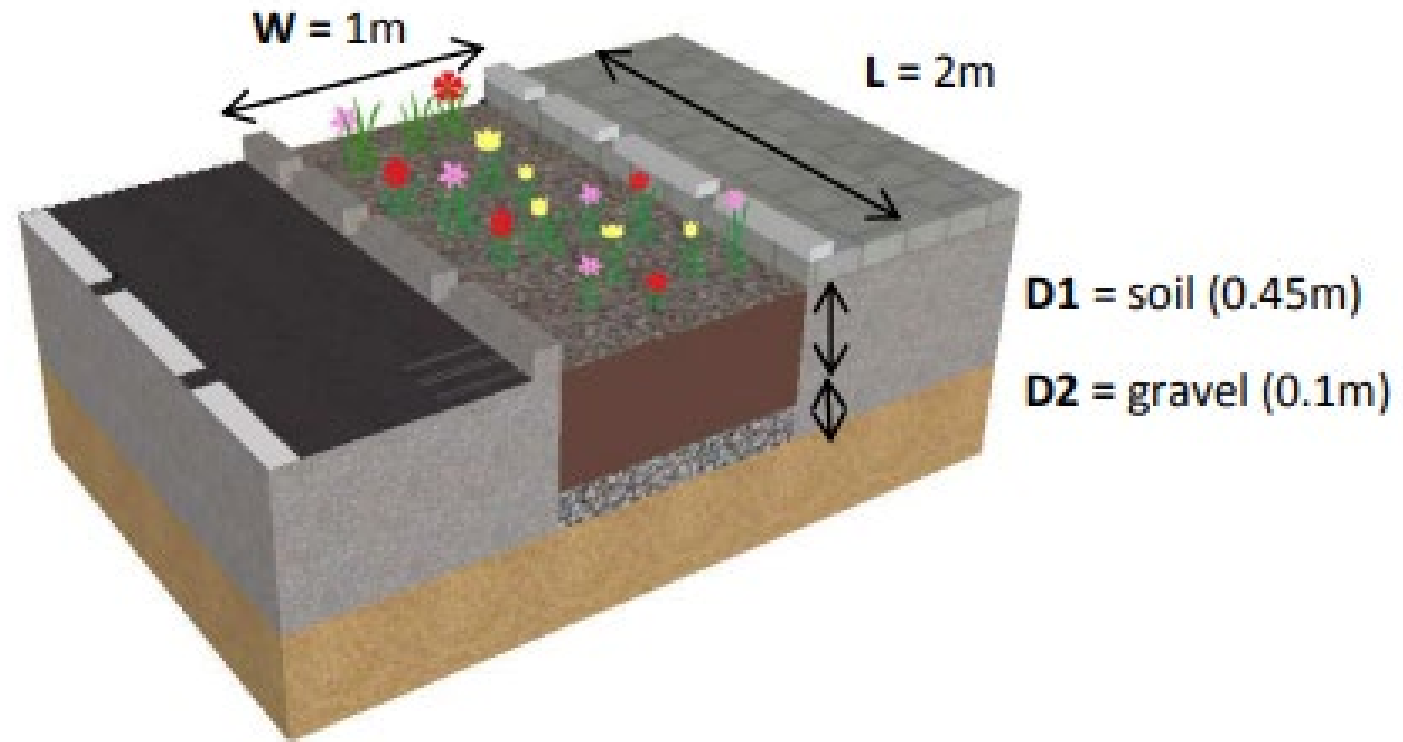
$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 0.2 \times 0.255$$

$$V_s = 0.051 \text{m}^3$$

$$\text{Total storage} = 0.235 + 0.051$$

$$\text{Total storage} = 0.285 \text{m}^3$$



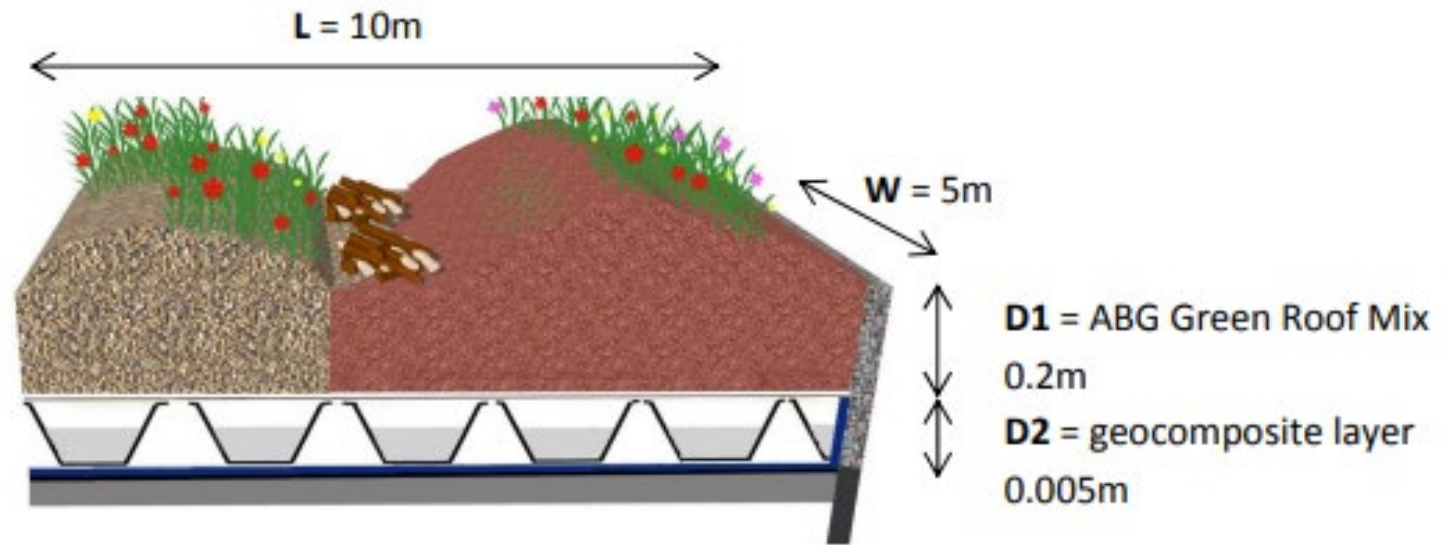
Green Roof – Example

Calculation for estimating
volume of Green Roof Mix

$$V = L \times W \times D_1$$

$$V = 10.0 \times 5 \times 0.2$$

$$V = 10.0 \text{ m}^3$$



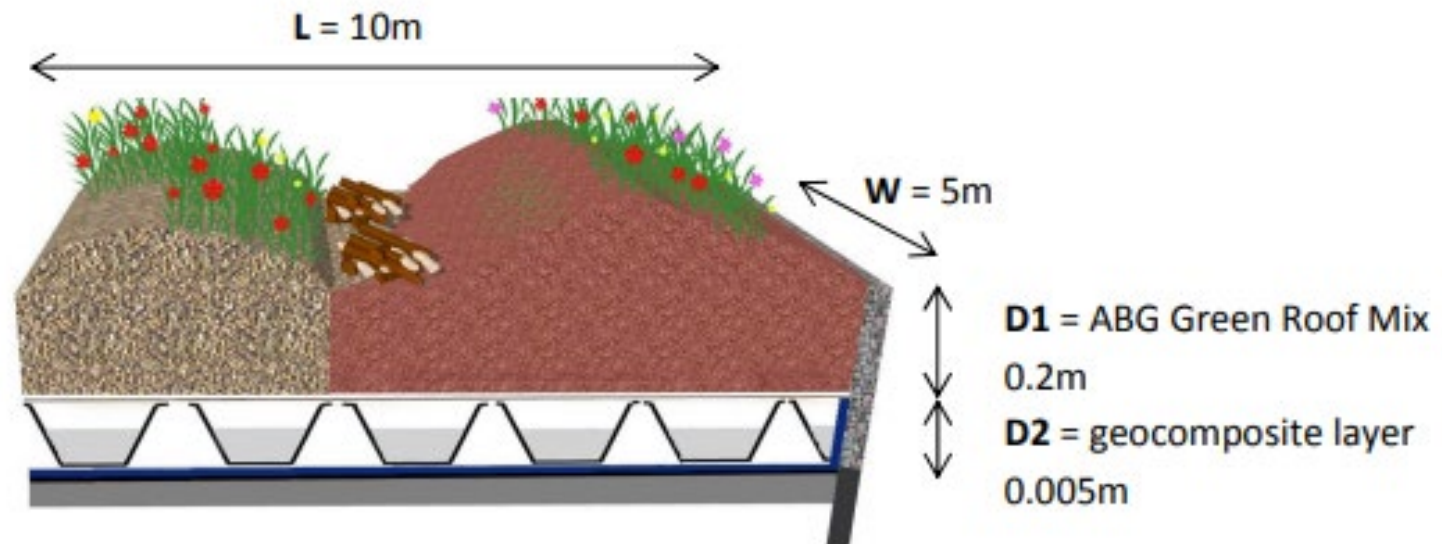
Green Roof – Example

Calculation for estimating
storage volume of Green
Roof Mix

$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 10 \times 0.15$$

$$V_s = 1.5 \text{m}^3$$



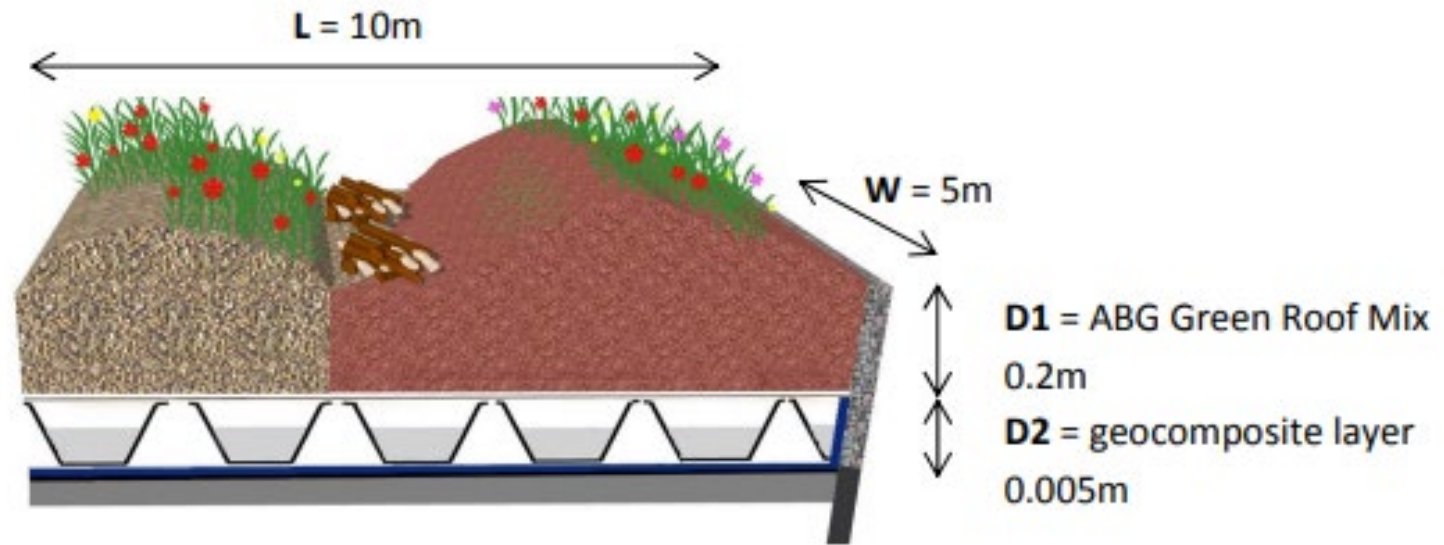
Green Roof – Example

Calculation for estimating
volume of Geocomposite
Layer

$$V = L \times W \times D_2$$

$$V = 10.0 \times 5 \times 0.005$$

$$V = 0.25\text{m}^3$$



Green Roof – Example

Calculation for estimating
storage volume of
Geocomposite Layer

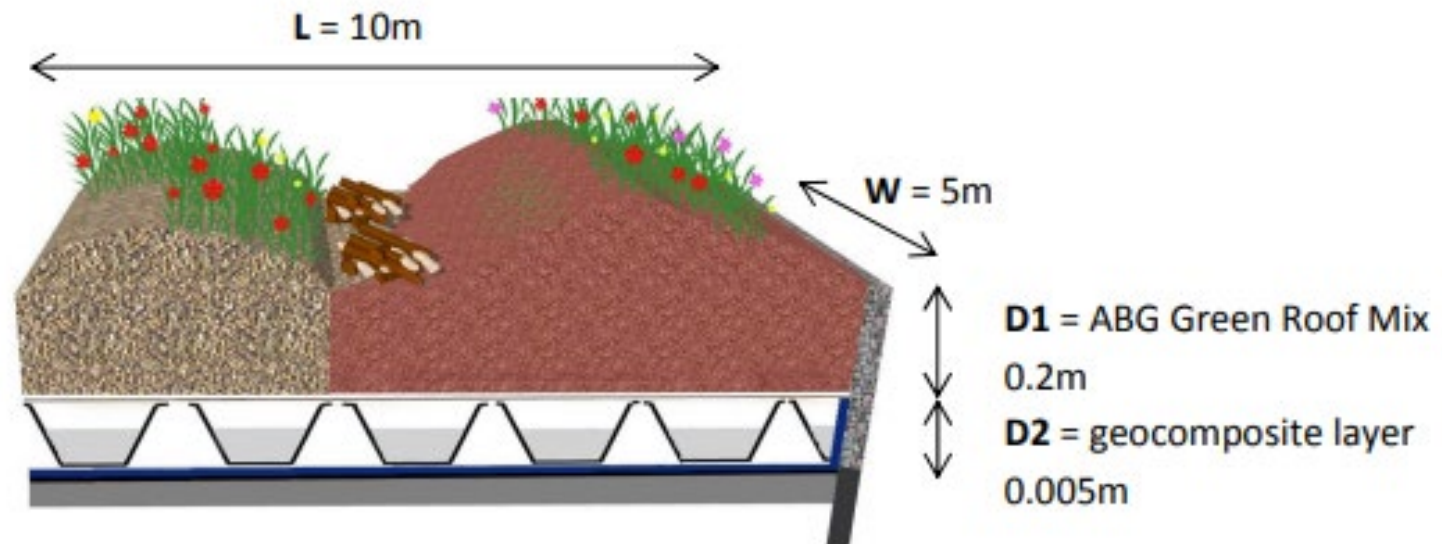
$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 0.25 \times 0.50$$

$$V_s = 0.125\text{m}^3$$

$$\text{Total storage} = 1.5 + 0.125$$

$$\text{Total storage} = 1.625\text{m}^3$$



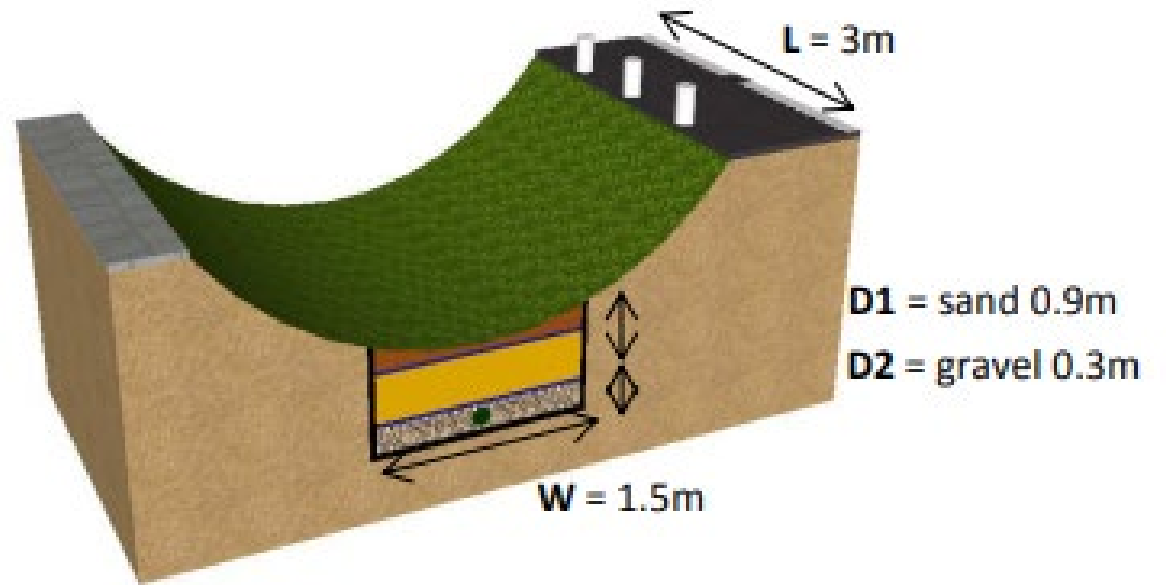
Swale – Example

Calculation for estimating
volume of Sand

$$V = L \times W \times D_1$$

$$V = 3.0 \times 1.5 \times 0.9$$

$$V = 4.05\text{m}^3$$



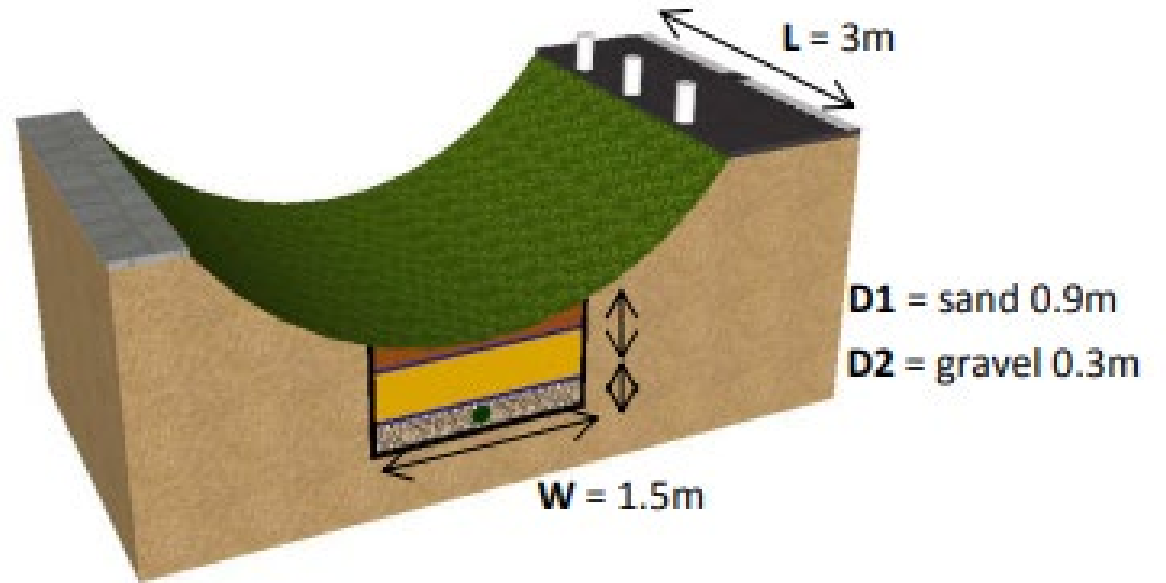
Swale – Example

Calculation for estimating storage volume of Sand

$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 4.05 \times 0.225$$

$$V_s = 0.911\text{m}^3$$



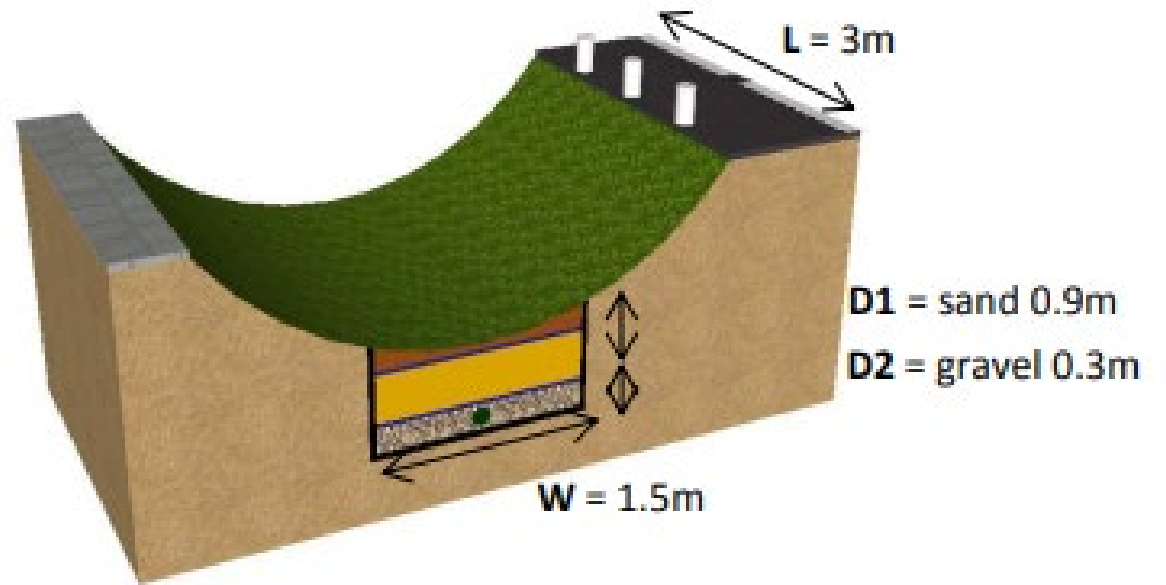
Swale – Example

Calculation for estimating
volume of Gravel

$$V = L \times W \times D_2$$

$$V = 3.0 \times 1.5 \times 0.3$$

$$V = 1.35\text{m}^3$$



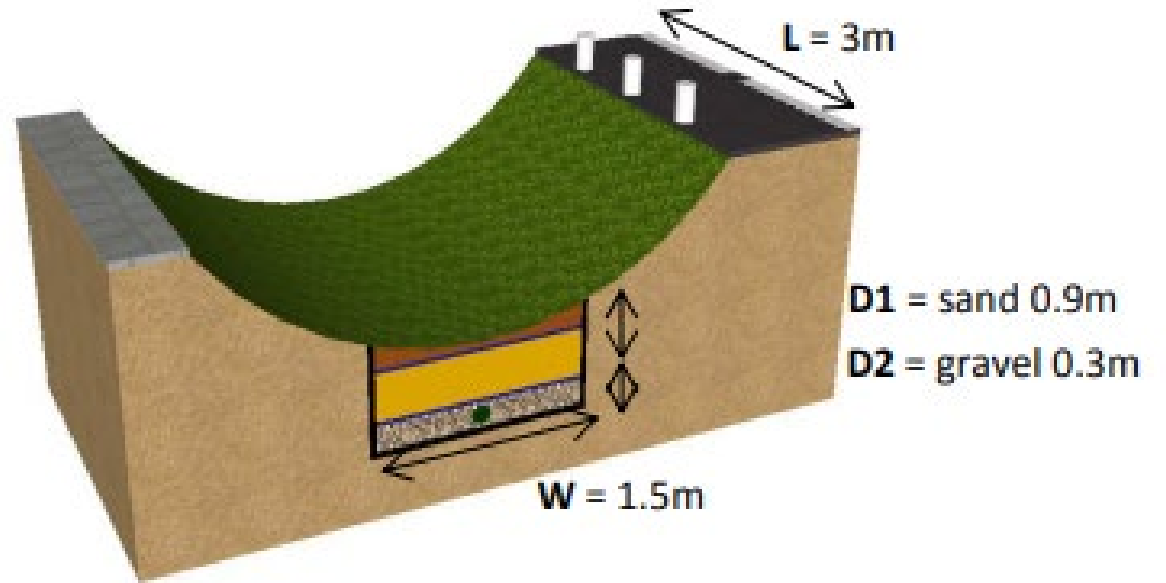
Swale – Example

Calculation for estimating
storage volume of Gravel

$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 1.35 \times 0.255$$

$$V_s = 0.344 \text{ m}^3$$



Swale – Example

Calculation for estimating
(storage) volume of swale

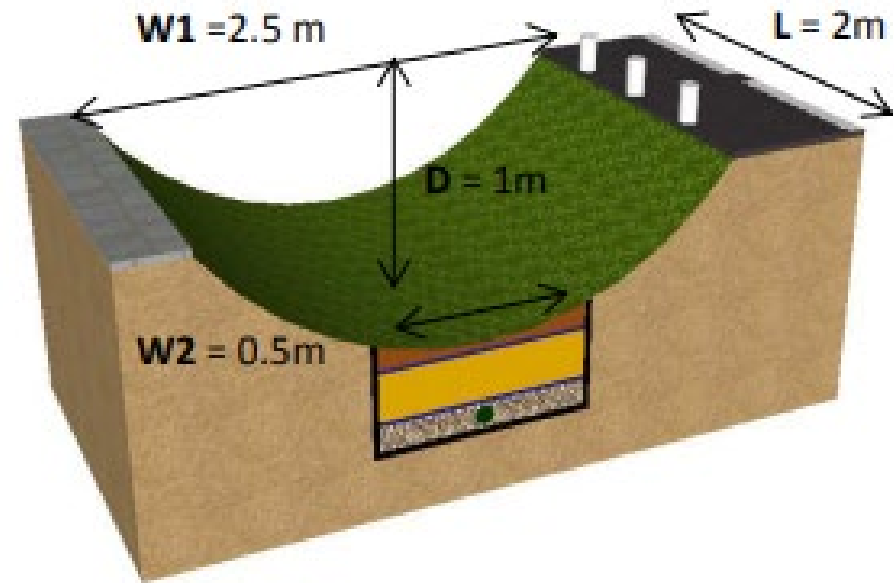
$$V = 0.5 \times D \times (W_1 + W_2) \times L$$

$$V = 0.5 \times 1 \times (2.5 + 0.5) \times 2$$

$$V = 3.0 \text{ m}^3$$

$$\text{Total storage} = 0.911 + 0.344 + 3.0$$

$$\text{Total storage} = 4.255 \text{ m}^3$$



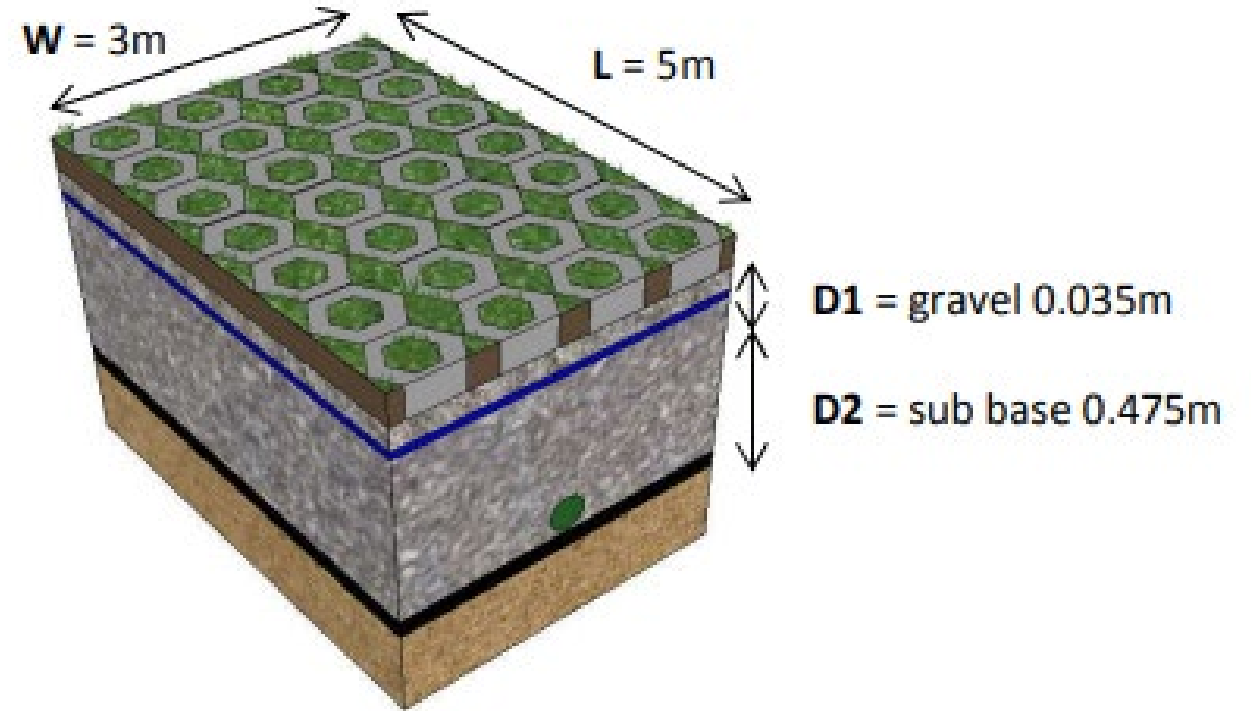
Permeable Paving – Example

Calculation for estimating
volume of gravel

$$V = L \times W \times D_1$$

$$V_s = 5 \times 3 \times 0.035$$

$$V_s = 0.525 \text{m}^3$$



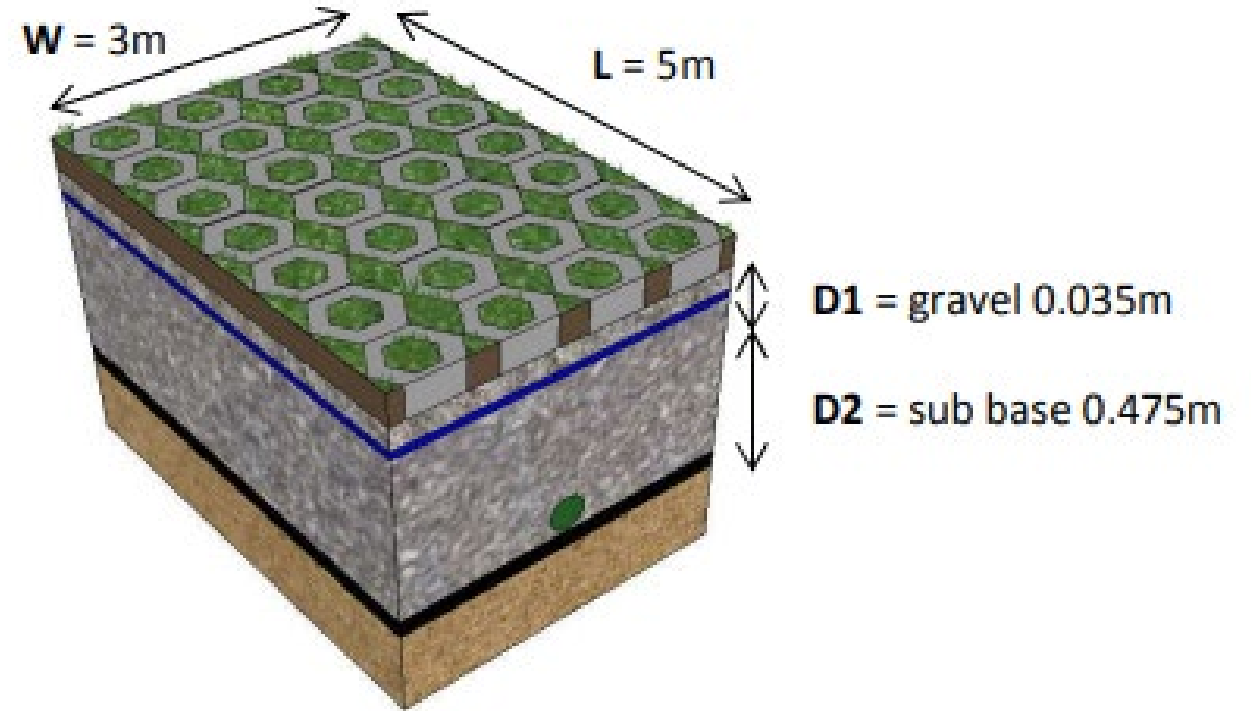
Permeable Paving – Example

Calculation for estimating storage volume of gravel

$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 0.525 \times 0.255$$

$$V_s = 0.134 \text{ m}^3$$



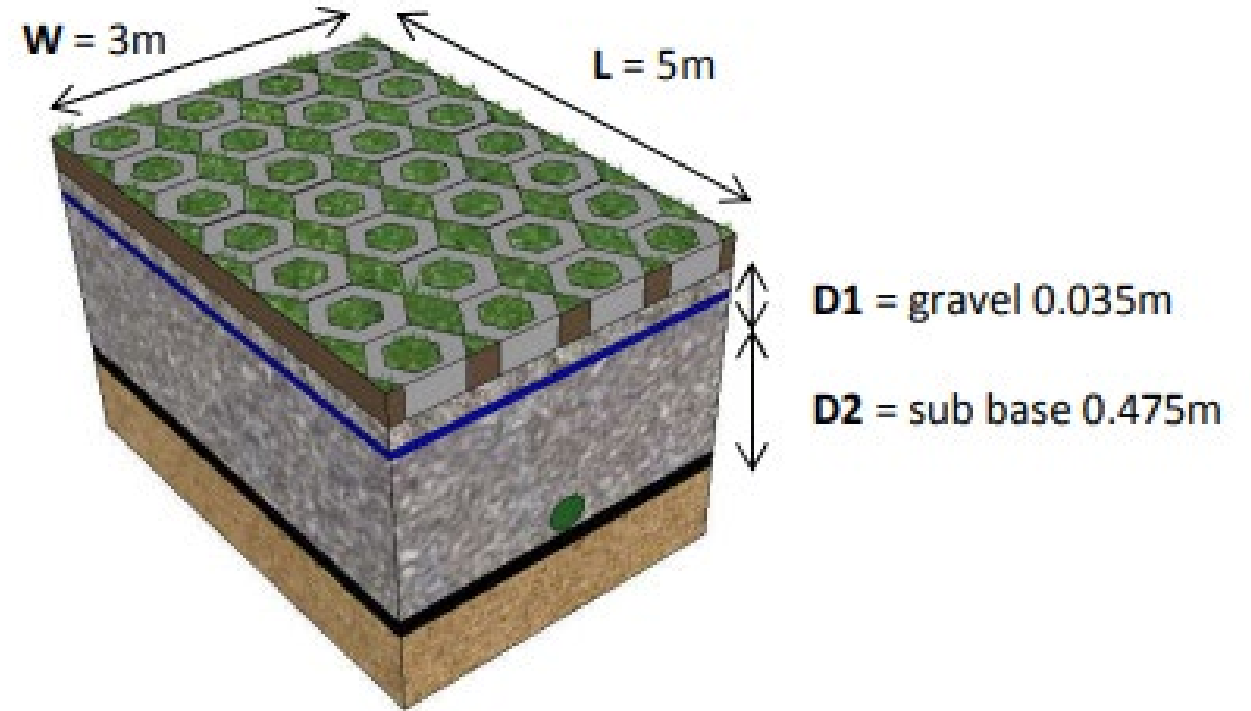
Permeable Paving – Example

Calculation for estimating
volume of sub base

$$V = L \times W \times D_2$$

$$V_s = 5 \times 3 \times 0.475$$

$$V_s = 7.125 \text{m}^3$$



Permeable Paving – Example

Calculation for estimating storage volume of gravel

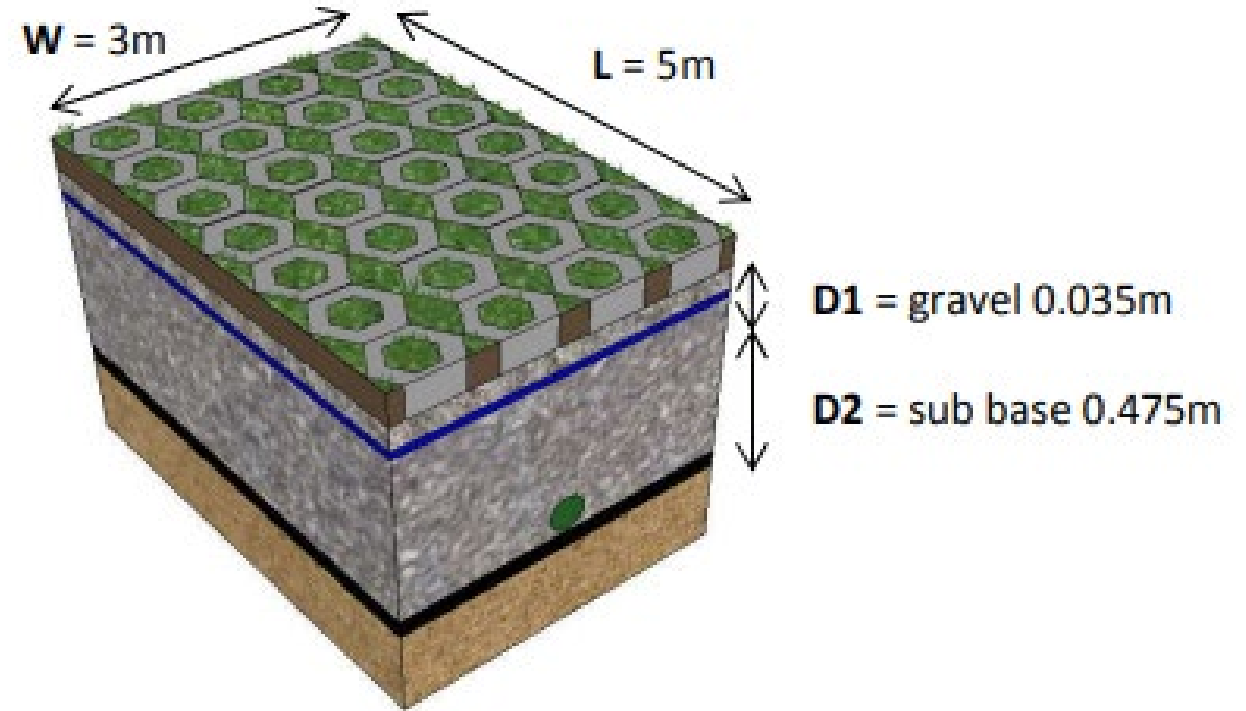
$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 7.125 \times 0.195$$

$$V_s = 1.40 \text{ m}^3$$

$$\text{Total storage} = 0.134 + 1.40$$

$$\text{Total storage} = 1.52 \text{ m}^3$$



Permeable Paving – Example

Calculation for estimating storage volume of gravel

$$V_s = V \times SVP(1 - VFC)$$

$$V_s = 7.125 \times 0.195$$

$$V_s = 1.40 \text{ m}^3$$

$$\text{Total storage} = 0.134 + 1.40$$

$$\text{Total storage} = 1.52 \text{ m}^3$$

