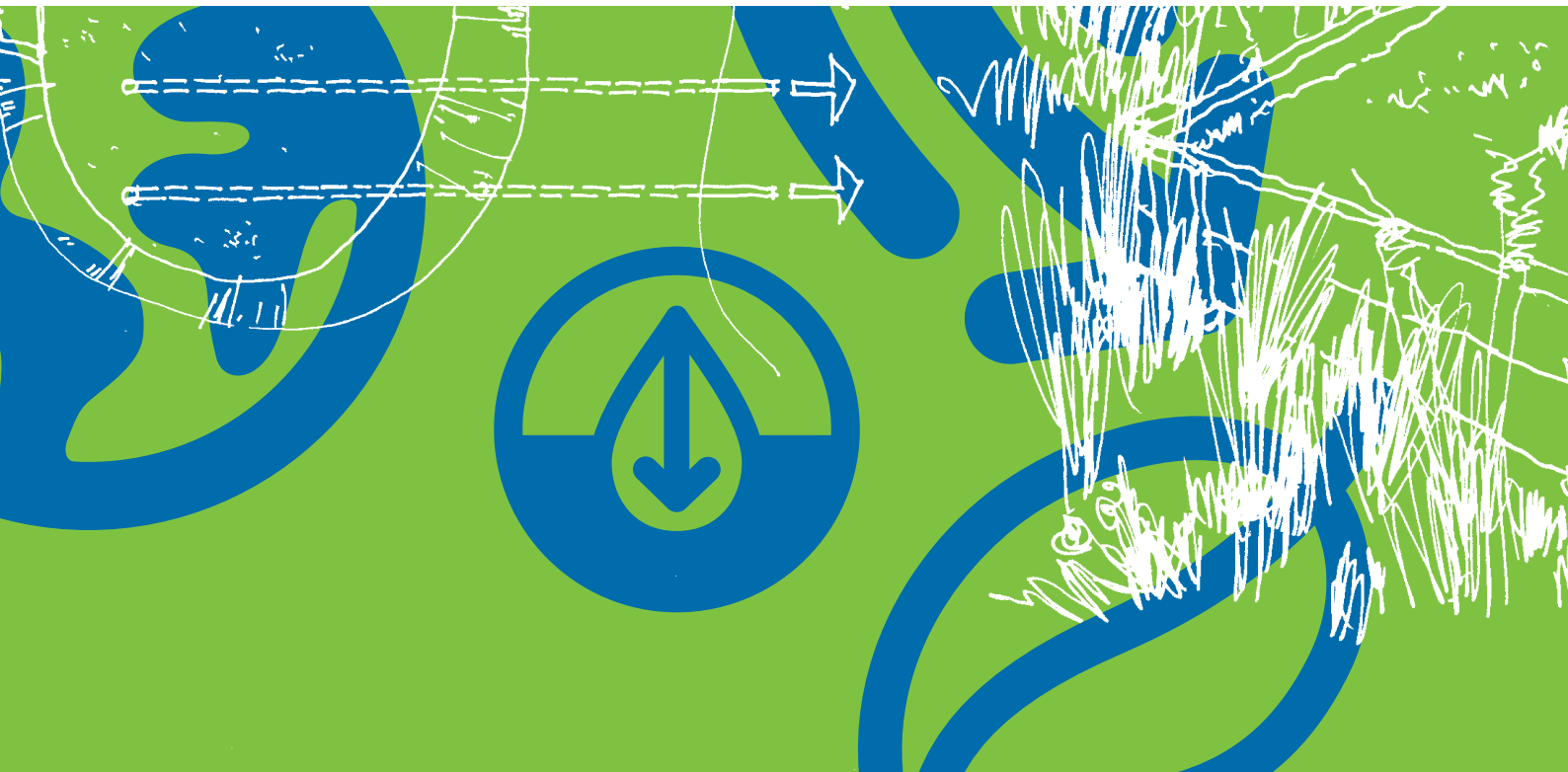
Water Sensitive Designs

small improvements, new ideas, concepts and
sketch designs for stormwater filtration systems

waterbydesign



This project is supported by Healthy Waterways, through funding from the Australian Government Reef Programme and was developed in collaboration with the Reef Urban Stormwater Management Improvement Group (RUSMIG). RUSMIG represents the key urban stakeholders in the Great Barrier Reef catchment, including Local Governments, Regional Natural Resource Management bodies, the Queensland Department of Environment and Heritage Protection, and the Great Barrier Reef Marine Park Authority. The principal role of RUSMIG is an information exchange forum to share experiences and knowledge about urban stormwater management and associated topics.

Water by Design 2014-008 / Lead Author: Glenn Browning / Water by Design Reef team: Andrew O'Neill, Dave Logan, Jack Mullaly, Karen Toms, Kristy Gooding, Scott Paten, Solvej Patschke / Design by Inkahoots / Sketches by Jim Gall.

Water Sensitive Designs

small improvements, new ideas, concepts and sketch designs for stormwater filtration systems

Protect & Enhance Waterways

Infiltration Flow Management Water Quality Habitat

Enhance Landscape Amenity

Community Interest Visual Impact Sense of Place Landscape Amenity

Maximise Benefits to Community

Microclimate

Stormwater Reuse

Safety

Passive Recreation

Manage Capital & Lifecycle Costs

Resource Efficient

Space Efficient

Efficient Maintenance

Material Sustainability

By promoting infiltration throughout catchments and adjacent to creeks we can help restore the natural watercycle and lessen the impact on downstream waterways.

Infiltration

Tree Pit

application: road verges / footpaths

advantage:

- promotes infiltration
- stormwater treatment
- economical to build
- improve tree growth /shade

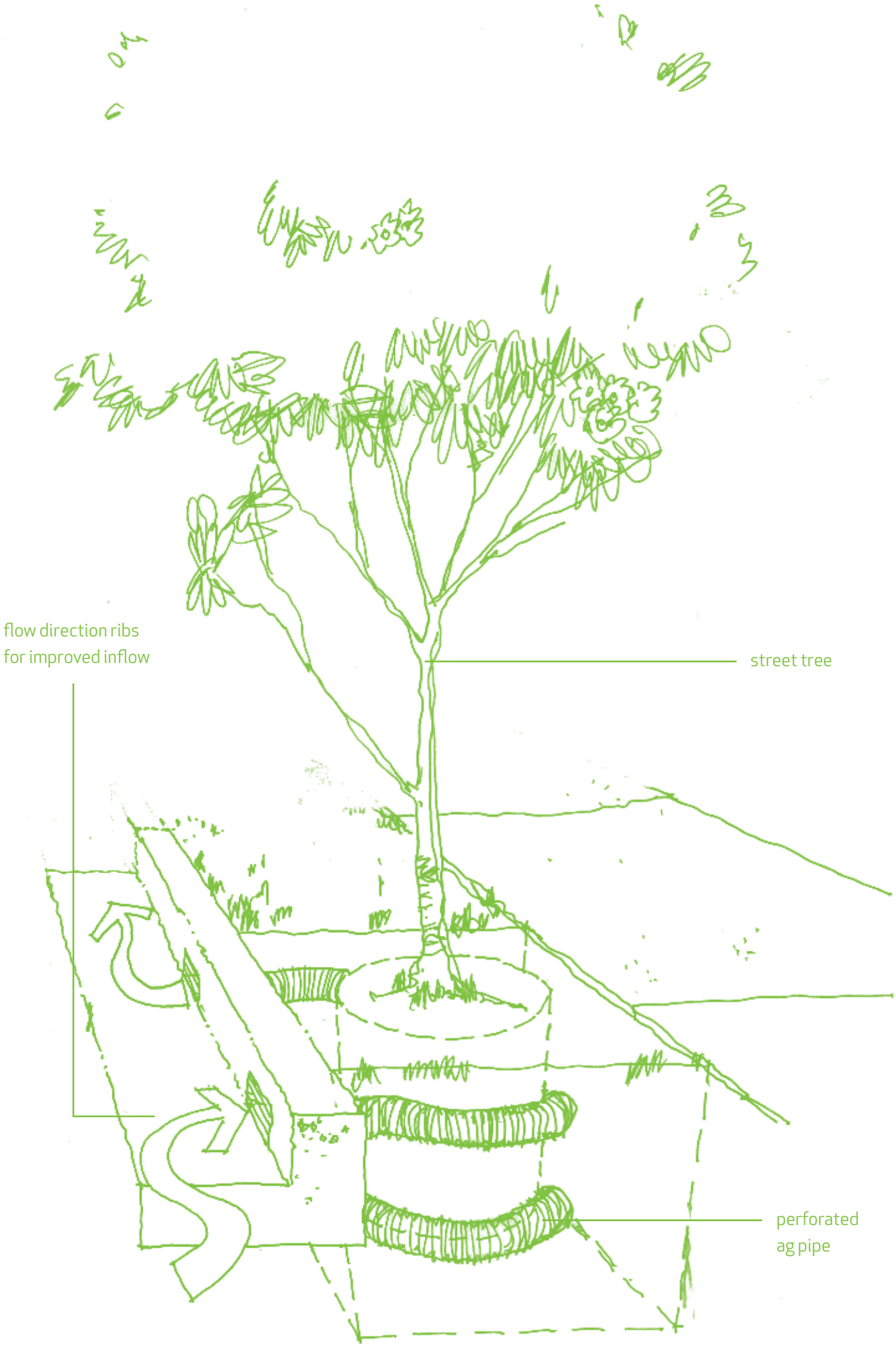
note: this can be modelled in MUSIC using a bioretention node with low hydraulic conductivity and no extended detention depth
idea (sourced or via): BCC & Matt Nolan EDAW

Infiltration

Water Quality

Resource Efficient

Microclimate


flow direction ribs
for improved inflow
street tree
perforated
ag pipe

Infiltration Basin

application: stormwater outlets next to riparian zones

advantage:

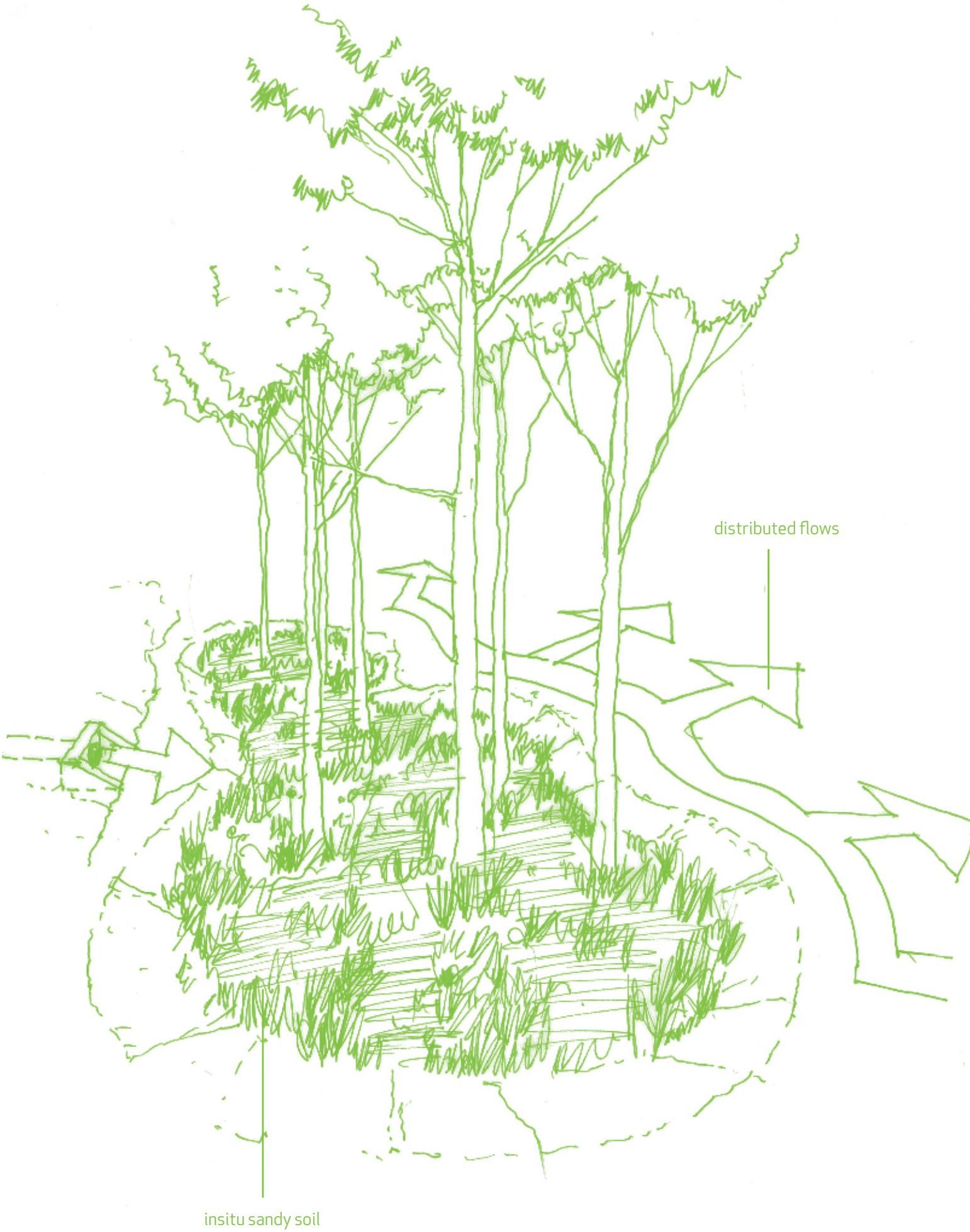
- infiltration & sheet flow to riparian zone
- stormwater treatment
- lower cost
- shade
- hydrological benefit

note: hydrological benefit can be modelled in MUSIC by adding infiltration to a bioretention node

refer: Water by Design - Field Guide for suitable tree species in your local area

idea (sourced or via): BMTWBM & BCC

Infiltration **Water Quality** **Resource Efficient** **Microclimate** **Flow Management**


distributed flows
insitu sandy soil

Infiltration Swale

application: adjacent to riparian zones

advantage:

- promotes infiltration
- stormwater treatment
- hydrological benefit
- lower cost

note: hydrological benefit can be modelled in MUSIC by adding infiltration to a swale node

Infiltration

Water Quality

Resource Efficient

Flow Management

Coastal Bioretention

application: coastal bioretention systems on sand

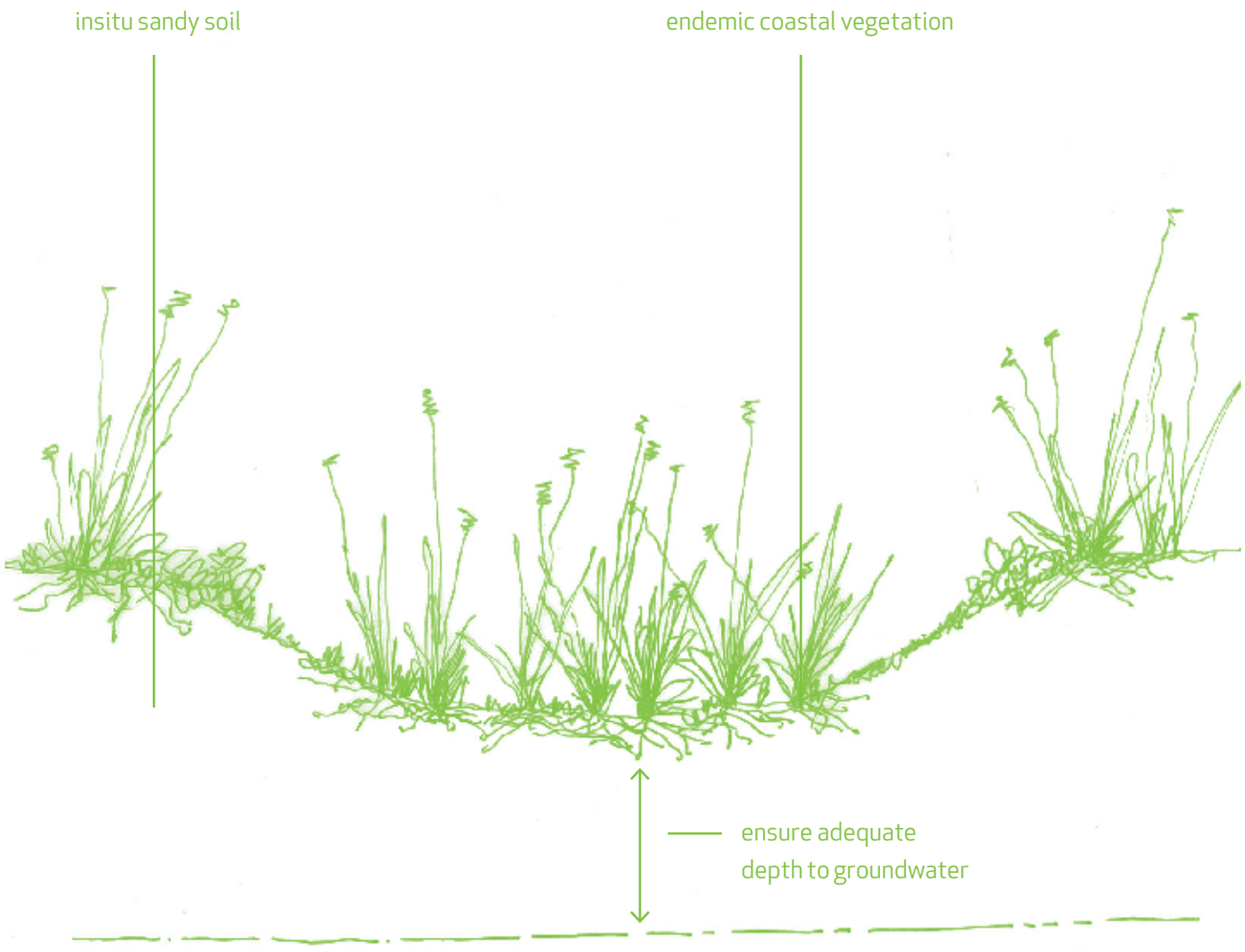
advantage:

- maximise infiltration
- low cost
- minimise stormwater pipes

note: groundwater level / adjacent landuse and structures

Infiltration

Resource Efficient


insitu sandy soil
endemic coastal vegetation
ensure adequate
depth to groundwater

Unless regulated, the development and hardening of catchments can have detrimental impacts on local streams and creeks. It is important to try and avoid these impacts before repair work becomes necessary.

Flow management can be achieved by increasing permeable areas, promoting infiltration, stormwater harvesting and stormwater detention.

Flow Management

Lotscale Infiltration

application: residential lots

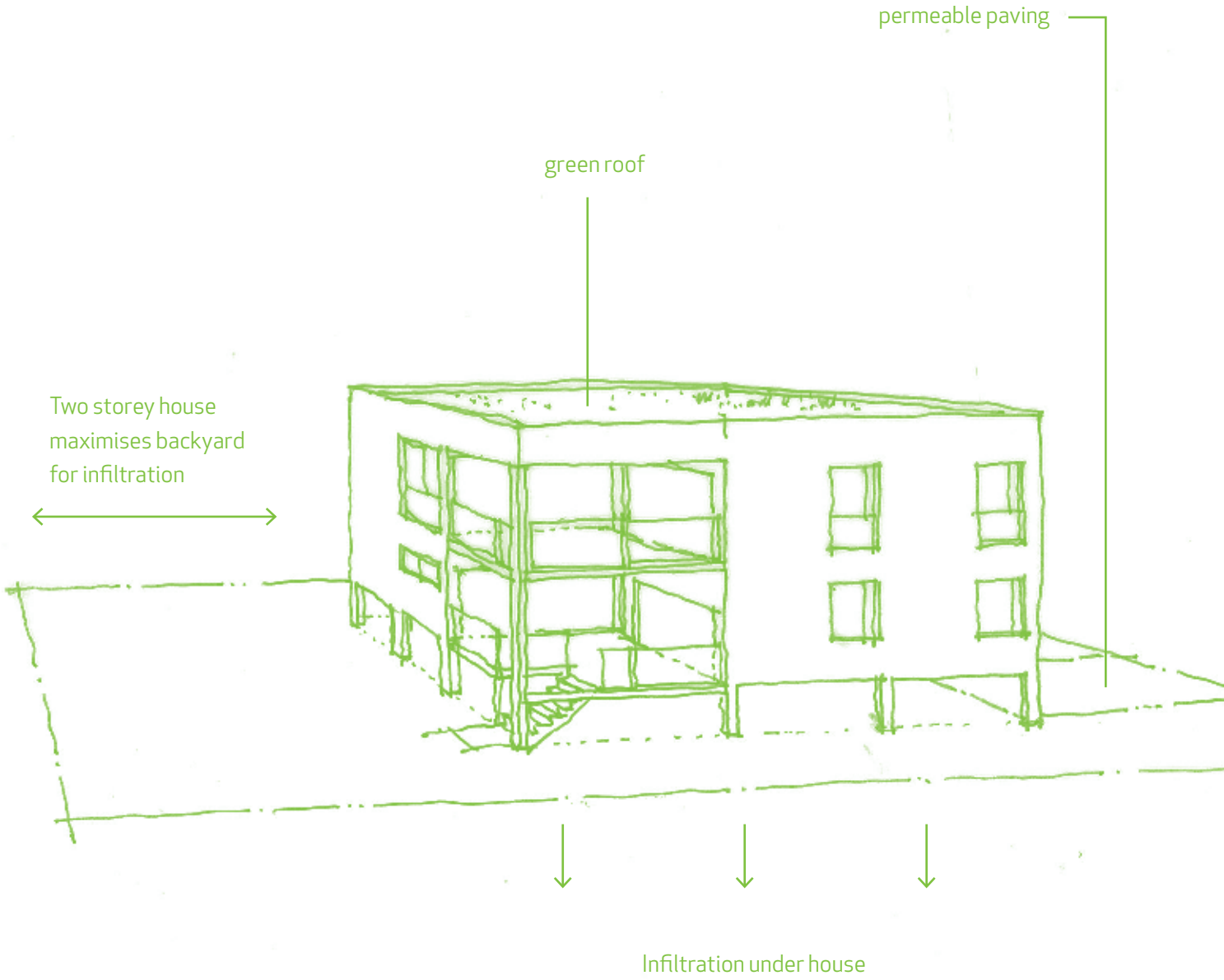
advantage:

- avoids hydrological impacts
- promote infiltration

note: consult geotech for infiltration near footings
refer: green roof design guidelines http://www.growinggreenguide.org/
idea (sourced or via): Alan Hoban – Bligh Tanner

Flow Management

Infiltration


permeable paving
green roof
Two storey house
maximises backyard
for infiltration
Infiltration under house

Infiltration Terrace

application: sites with sufficient space

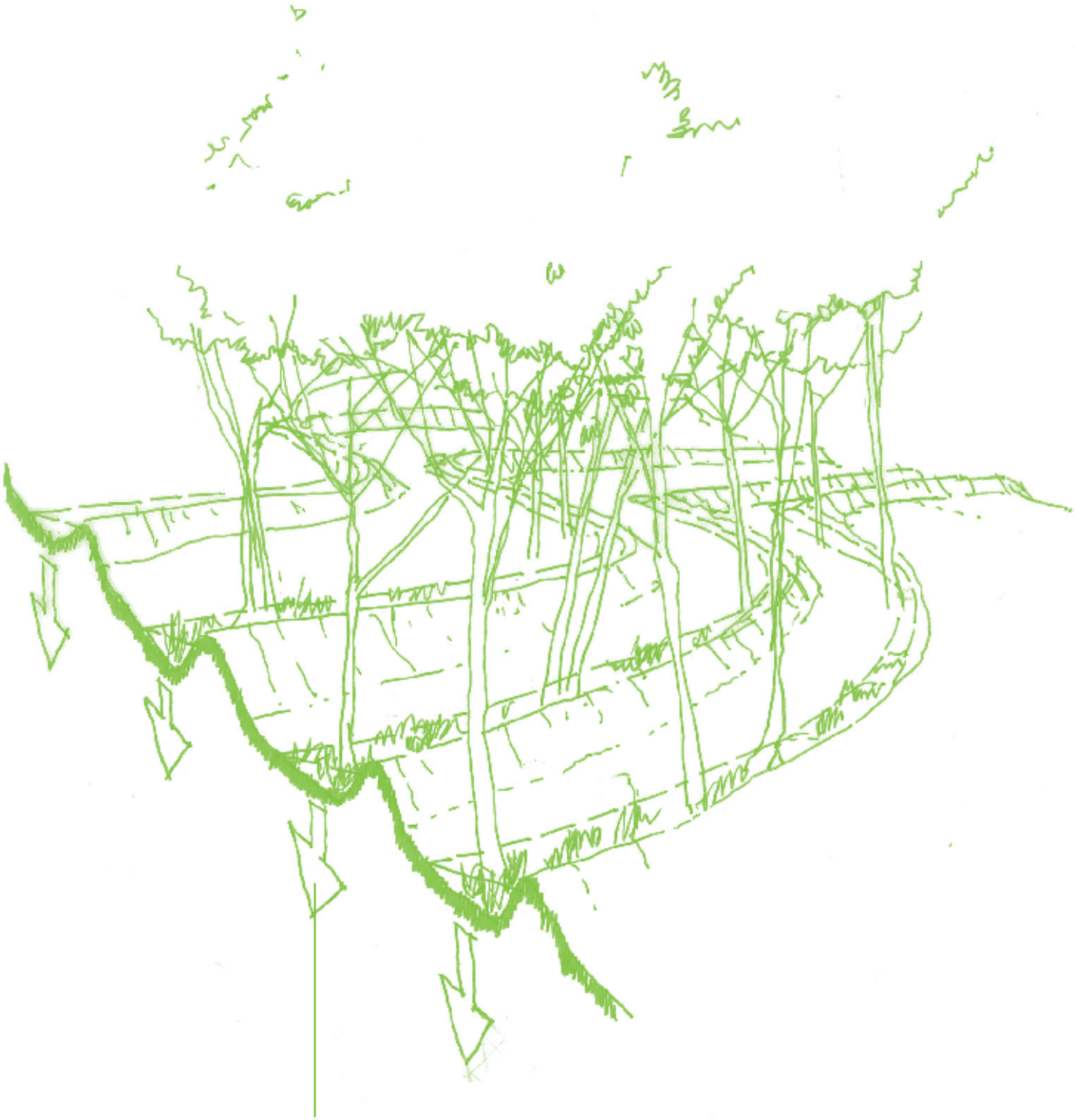
advantage:

- flow management
- infiltration

note: consider groundwater depth / adjacencies / insitu soil type
idea (sourced or via): Peter Breen - AECOM

Flow Management

Infiltration



Infiltration replenishes groundwater

Basin Outlet Control

application: bioretention systems with detention

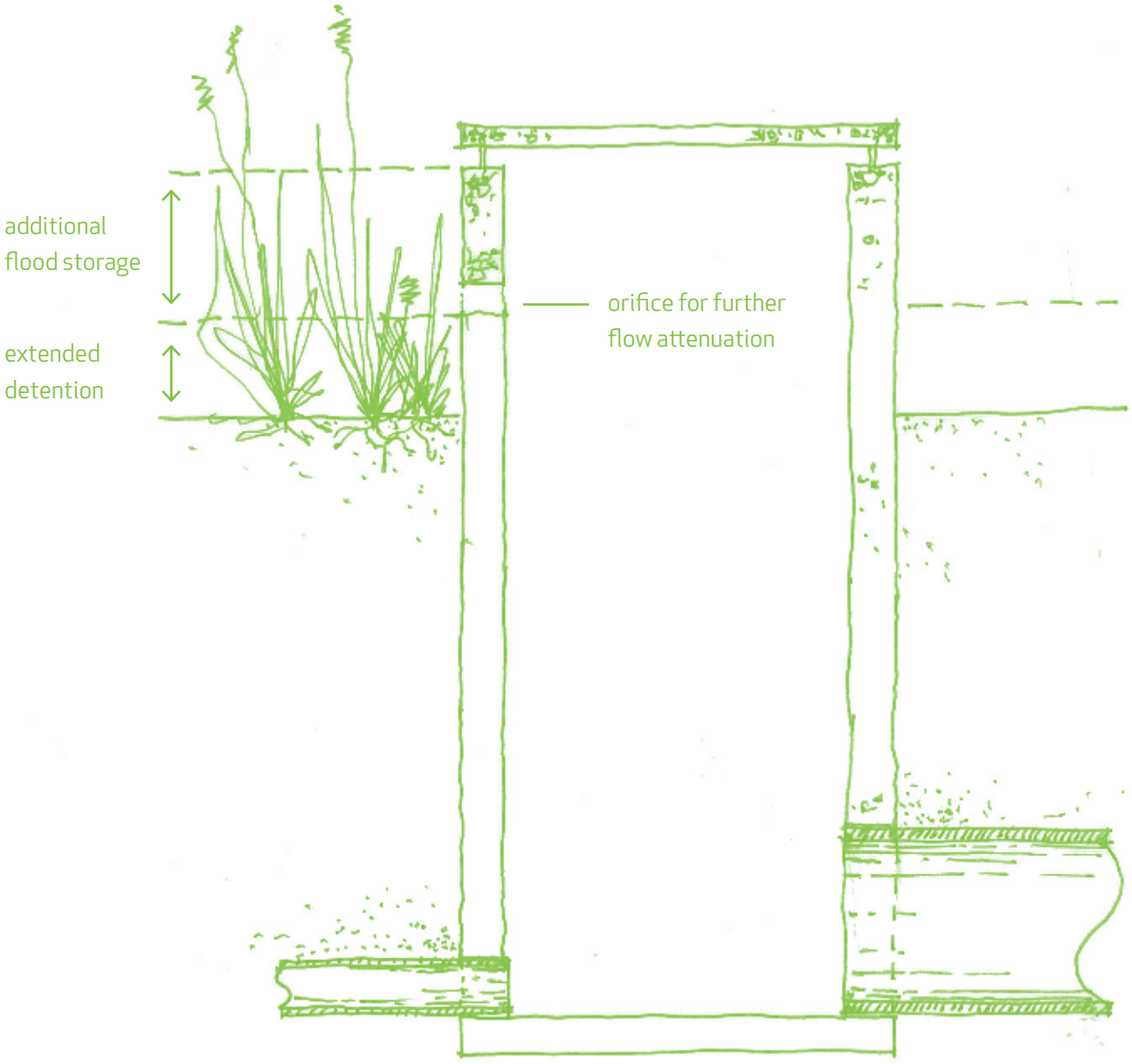
advantage:

- hydrological benefit
- help achieve waterway stability objective
- single outlet pit

note: requires hydraulic design / note safety (depth) considerations

Flow Management

Resource Efficient


additional
flood storage
extended
detention
orifice for further
flow attenuation

Pollution threatens the health of our local waterways. An important function of any WSUD device is to capture and treat pollutants and improve water quality.

Water Quality

Floating Wetlands

application: retrofit to urban lakes and ponds with poor water quality

advantage:

- water quality treatment

note: specific maintenance requirements / potential low DO conditions beneath mats if no flow

idea (sourced or via): SPEL environmental and Redlands IndigiScapes Centre

Water Quality

pollutants removed
via root system

Dedicated Carwash Parking Bay

application: multiunit developments

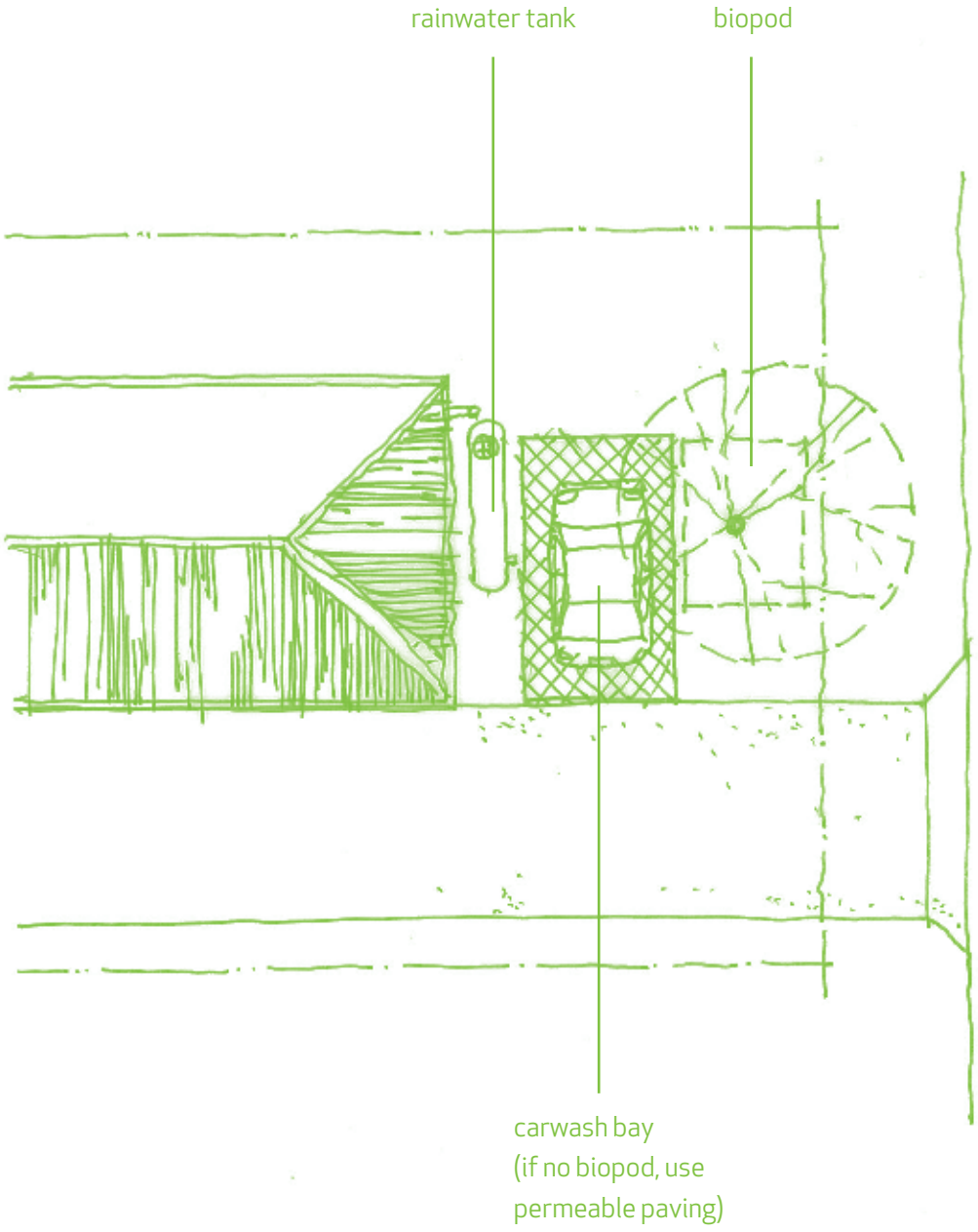
advantage:

- capture pollutants at source
- minimise potable water use

note: check groundwater proximity if using infiltration methods
idea (sourced or via): Dylan Cain – CCE & Australian Carwash Association

Water Quality

Stormwater Reuse


rainwater tank
biopod
carwash bay
(if no biopod, use
permeable paving)

Side Cast Weir

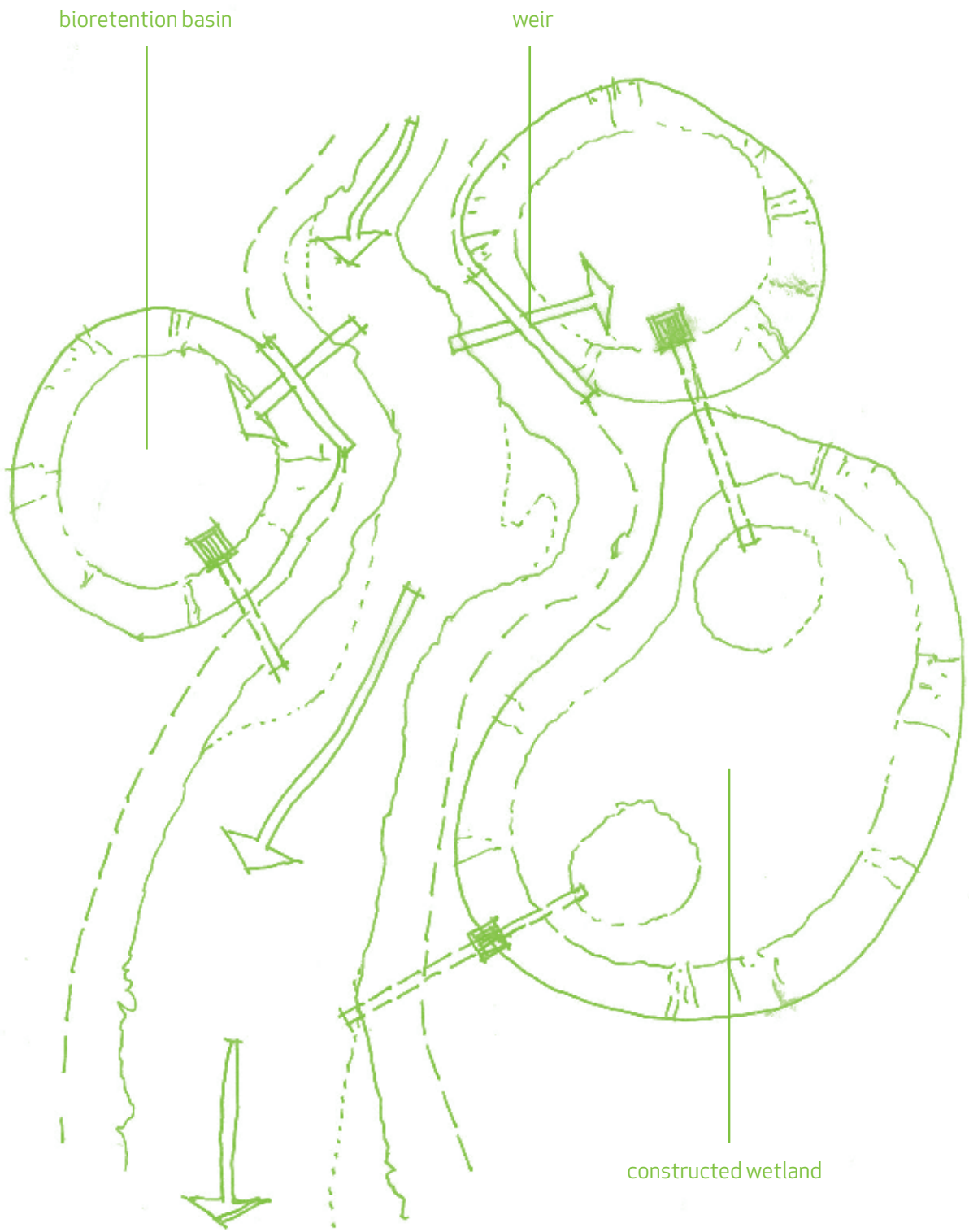
application: retrofit of WSUD into developed catchments

advantage:

- improve water quality in creek and adjacent stream
- offline systems reduce the likelihood of high velocities within treatment systems

note: consider flooding issues / sediment loading and blinding issues
idea (sourced or via): Peter Breen and AECOM

Water Quality


bioretention basin
weir
constructed wetland

It is important when designing stormwater treatment systems that we not to lose sight of the fundamental goal of habitat preservation. Habitat needs can be accommodated by:

- Conserving existing creeks
- Providing sufficient riparian buffer widths
- Assessing fauna needs
- Sourcing local plant stock
- Managing the interface between urban and riparian zones

Habitat

Habitat Logs

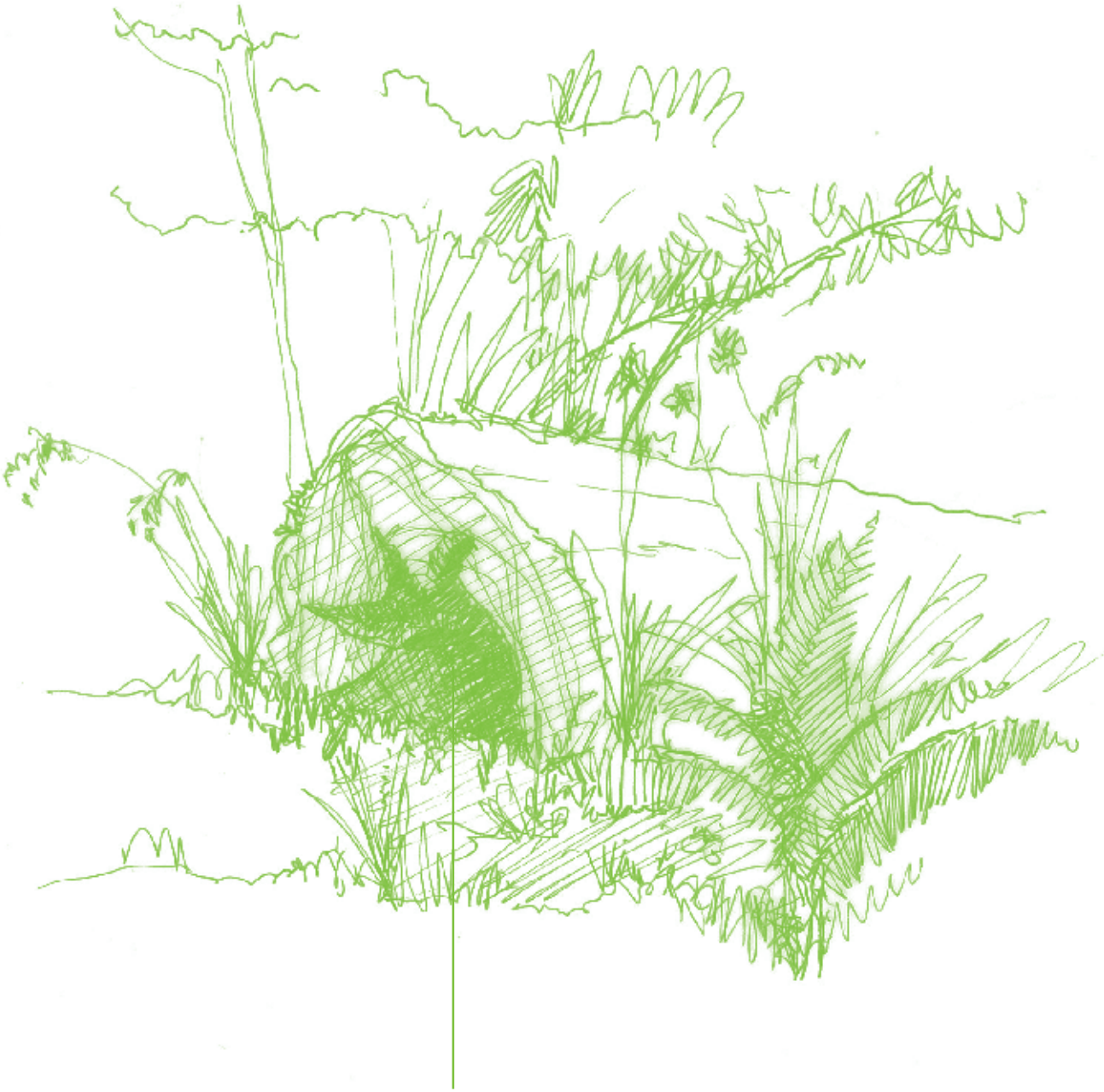
application: bioretention basins and constructed wetlands

advantage:

- provides habitat
- make use of any trees cleared for development

note: local fauna requirements
idea (sourced or via): Dean Challenor & Christoph Pester - EDAW

Habitat



hollows for fauna

Flow Spreader

application: basins outlets next to riparian zones

advantage:

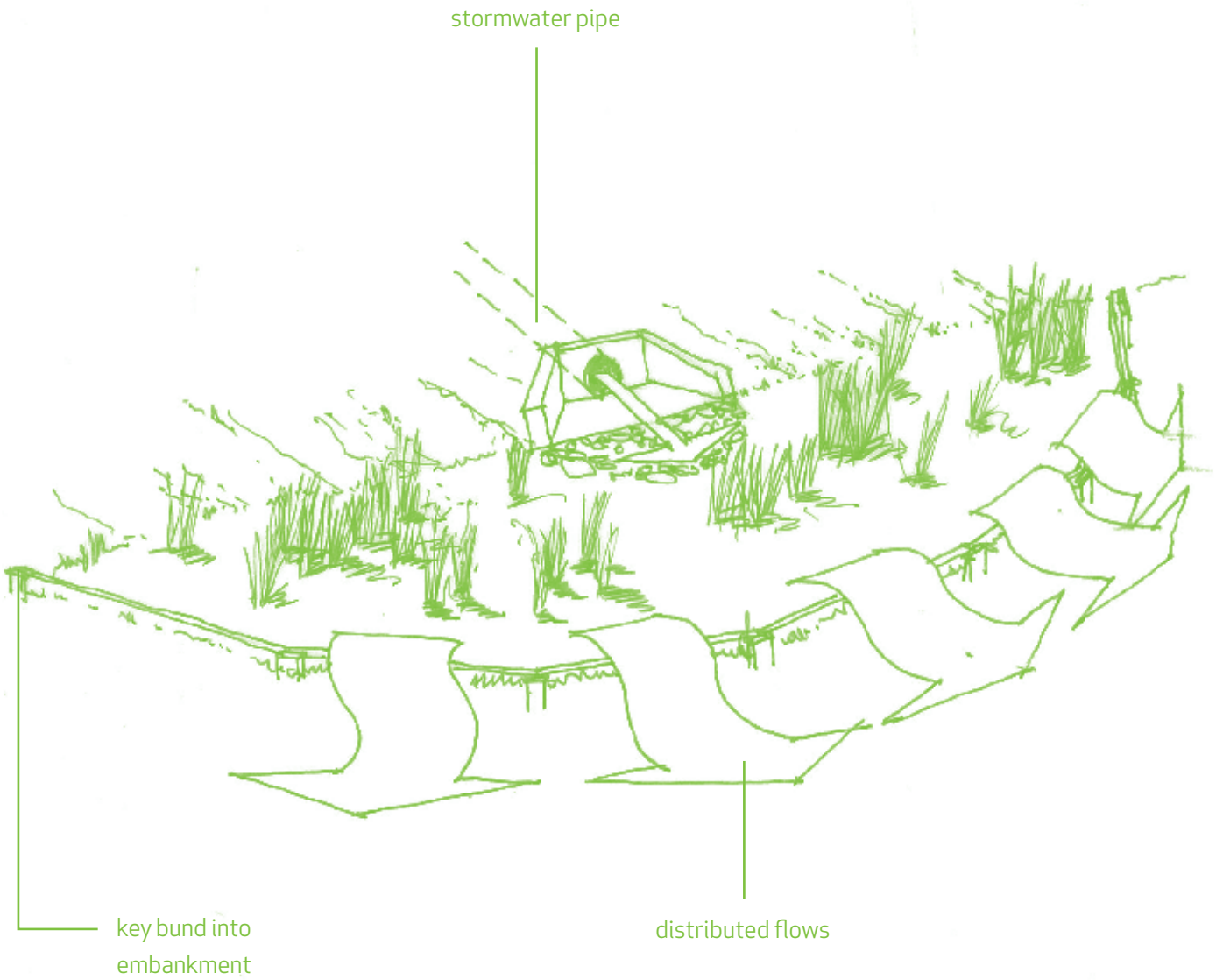
- sheet flow to riparian zone
- promotes infiltration
- supplies water to more vegetation
- more treatment of stormwater

note: scour protection requirements

Habitat

Infiltration

Water Quality


stormwater pipe
key bund into
embankment
distributed flows

Fish Friendly Outlet

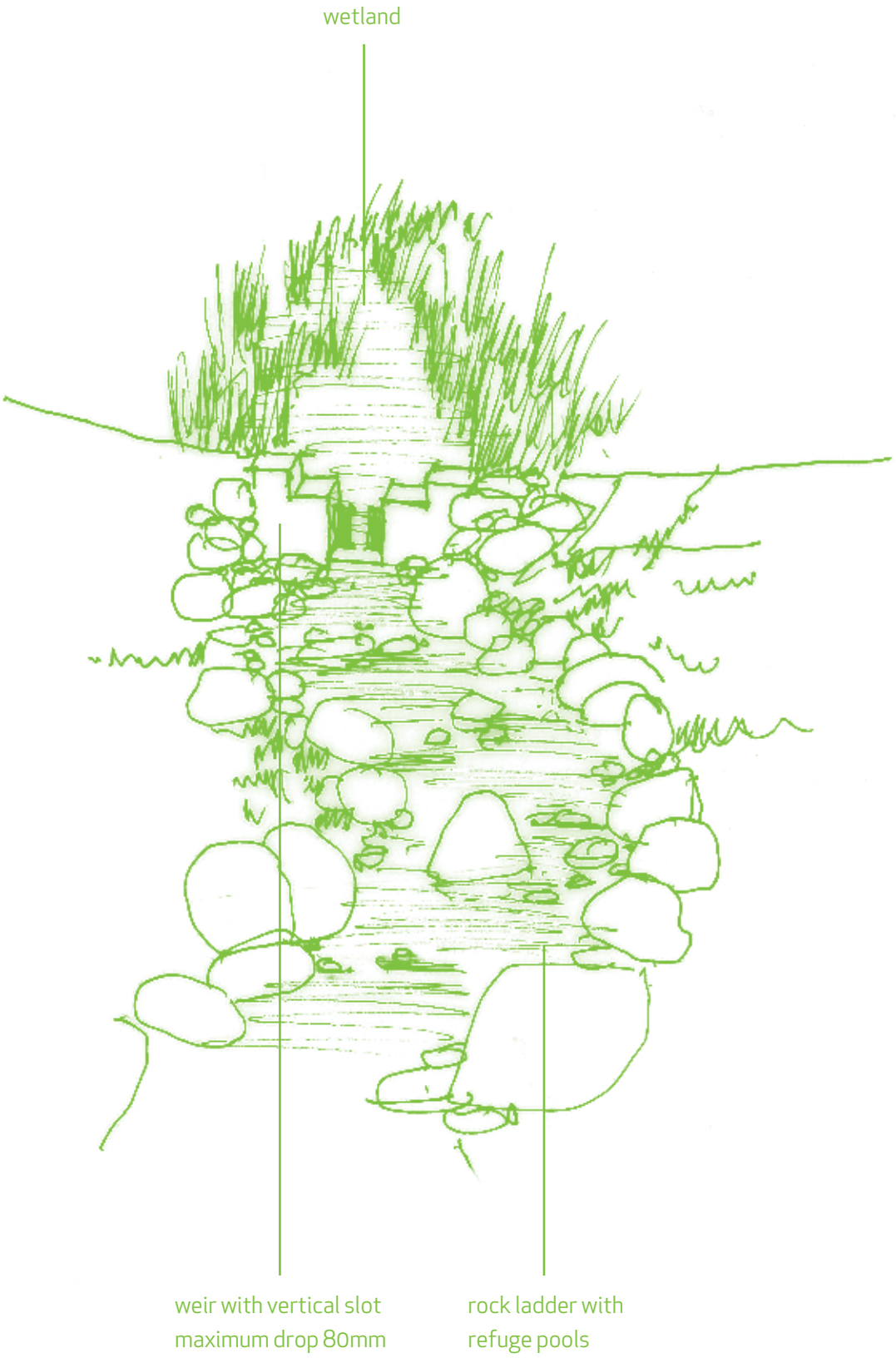
application: large scale constructed wetlands adjacent to riparian zones

advantage:

- habitat
- simple construction

note: exotic fish species may disturb base sediments within wetlands
idea (sourced or via): Matt Moore - Reef Catchments

Habitat


wetland
weir with vertical slot
maximum drop 80mm
rock ladder with
refuge pools

The general community can be valuable allies for environment causes. WSUD should improve community understanding of the water cycle and promote stewardship.

Community Interest

Feature Biopod

application: prominent sites with limited available space

advantage:

- point of interest
- small footprint
- capture rainwater
- water treatment

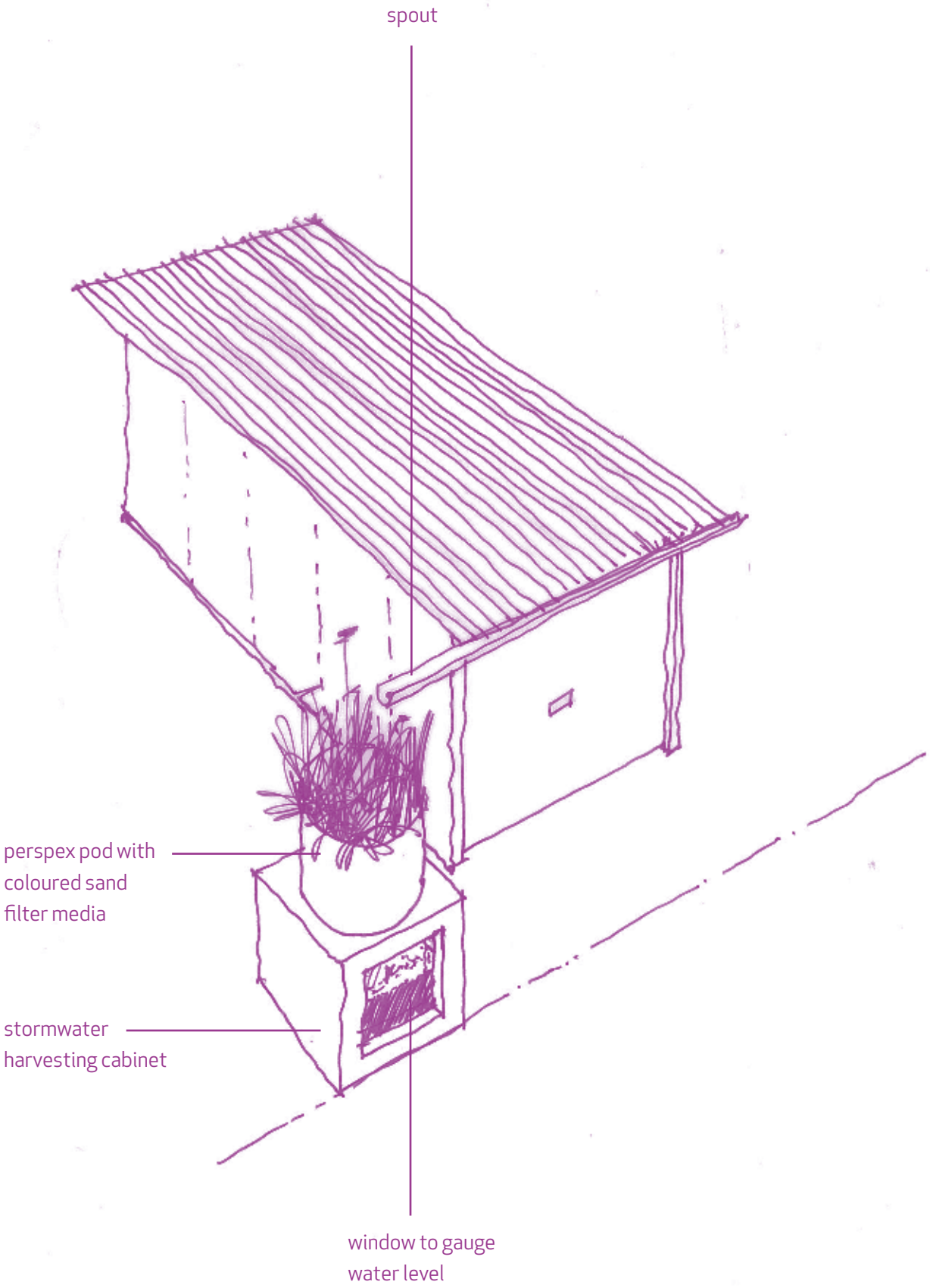
note: additional irrigation may be required to sustain plants

Community Interest

Space Efficient

Stormwater Reuse

Water Quality


spout
perspex pod with
coloured sand
filter media
stormwater
harvesting cabinet
window to gauge
water level

Art Feature Pit Grate

application: prominent overflow pits

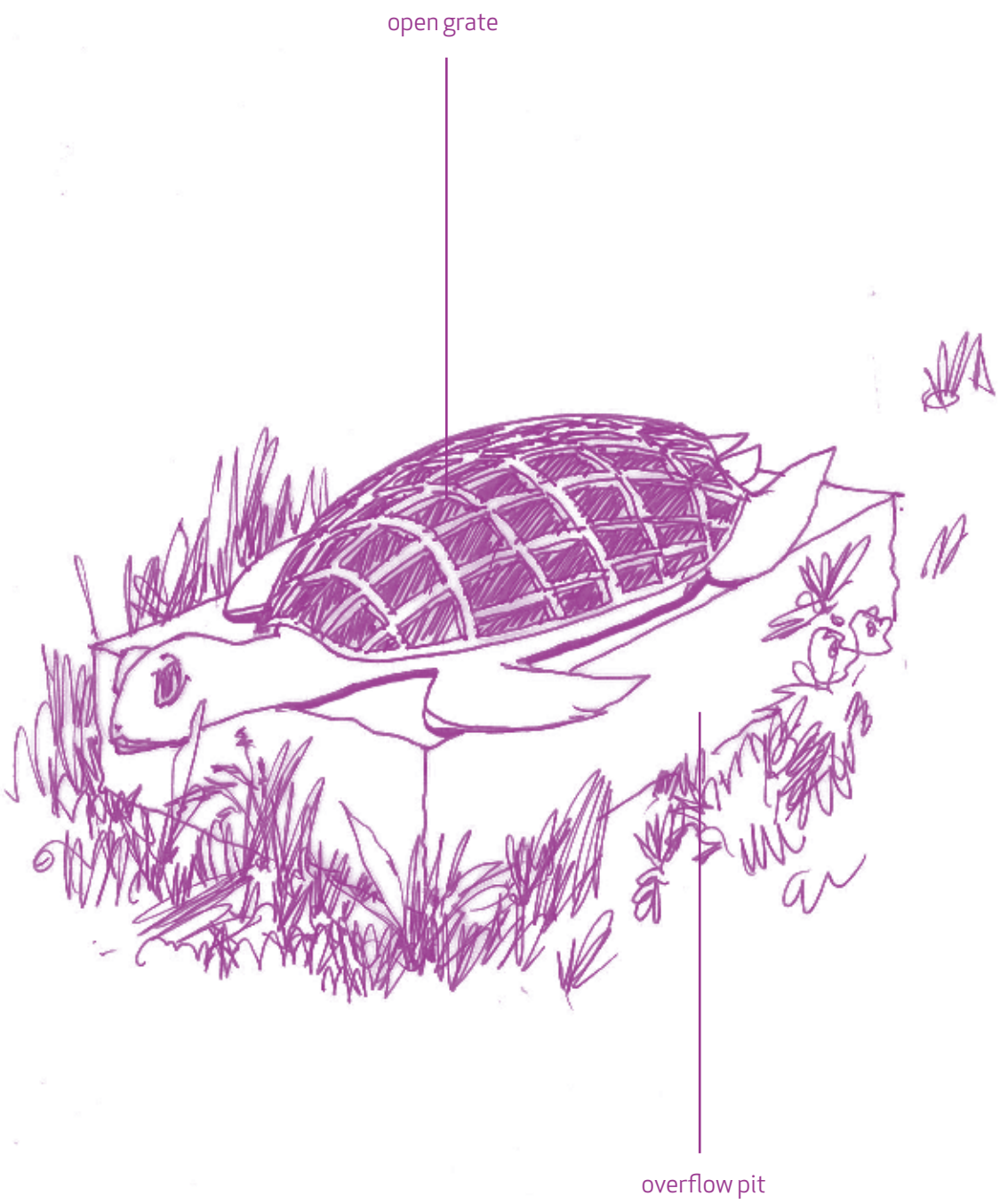
advantage:

- connect public to marine conservation
- aesthetics

note: integration of hydraulics / maintenance access

Community Interest

Sense of Place


open grate
overflow pit

Grate Detailing

application: shallow streetscape bioretention systems with grate/drains

advantage:

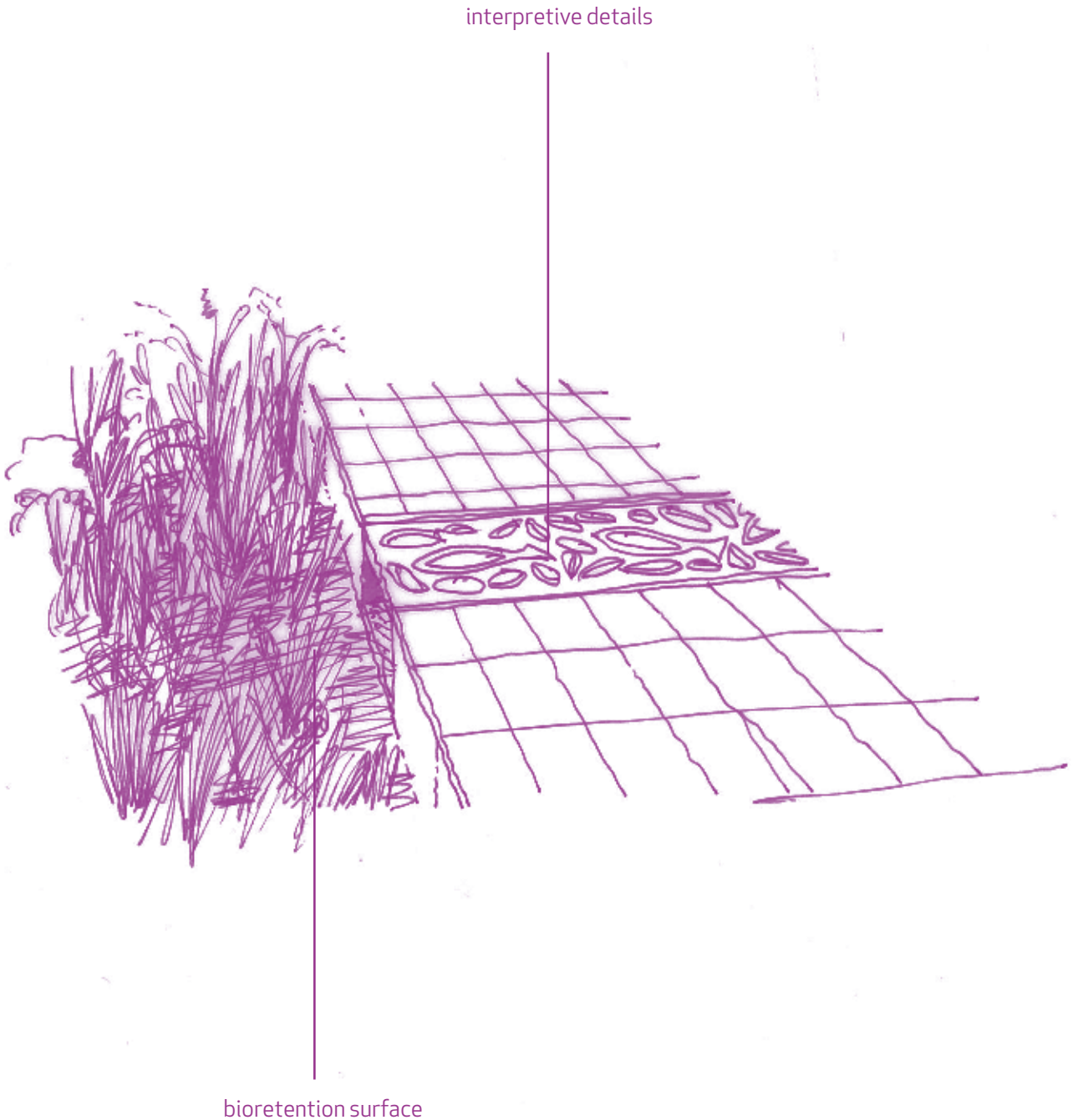
- create community interest
- aesthetics
- low profile drain

note: trafficability considerations

Community Interest

Sense of Place

Space Efficient


interpretive details
bioretention surface

Eco Shower

application: beachside showers / eco resorts

advantage:

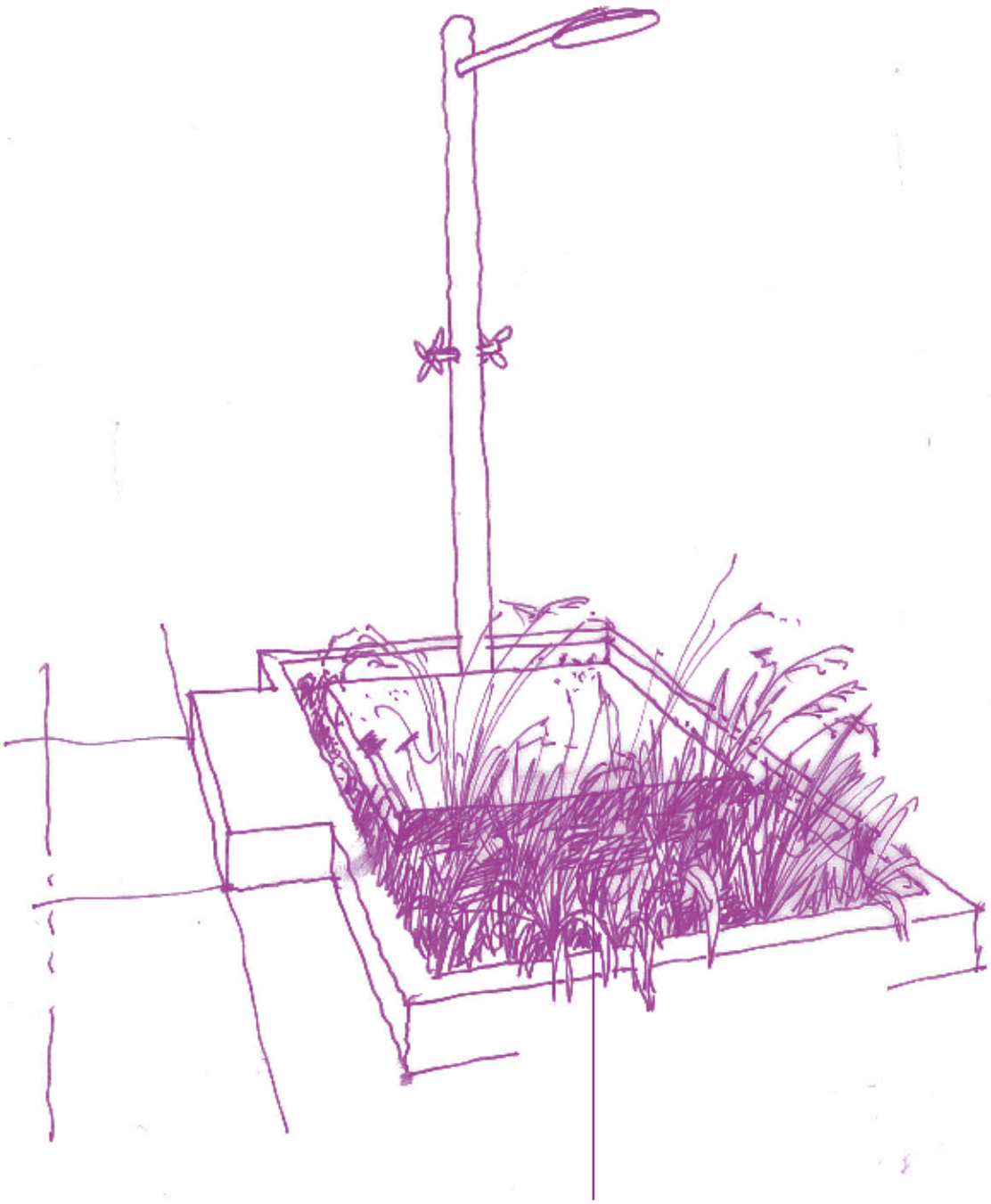
- create community interest
- feature
- at source treatment

idea (sourced or via): Jun Yasumoto - inhabitat.com

Community Interest

Sense of Place

Water Quality



hardy endemic coastal vegetation

Concrete pits, headwalls, scour pads and retaining walls should seamlessly blend into the landscape or be used to create striking features.

Visual Impact

Circular Pit

application: urban bioretention systems

advantage:

- improved aesthetics
- comparable cost

note: maintenance access requirements
idea (sourced or via): Shaun Leinster – DesignFlow

Visual Impact

Resource Efficient

Perimeter Step

application: urban bioretention systems with dropoff

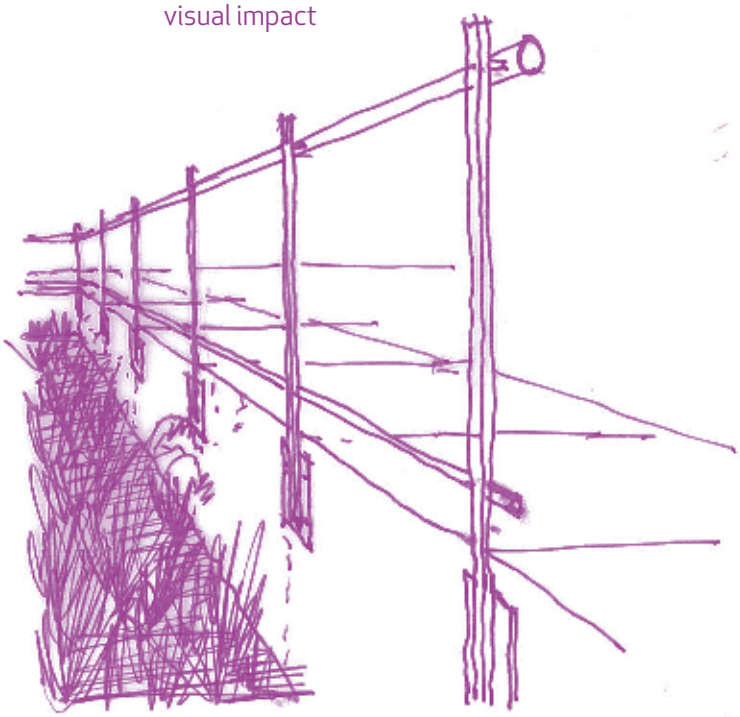
advantage:

- reduced visual impact

note: risk assessment requirements

Visual Impact

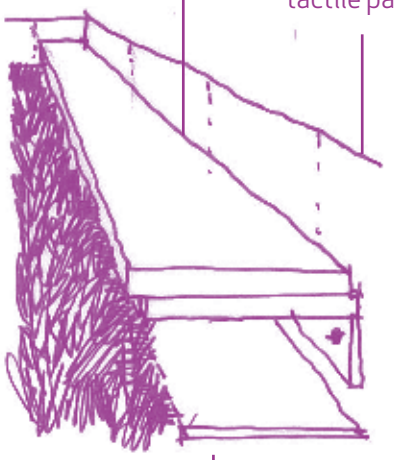
fence has negative
visual impact



reduced visual impact

fixed to wall

tactile paving



utilise filtermedia
under step

Energy Dissipation Sculpture

application: basins with high velocity flows

advantage:

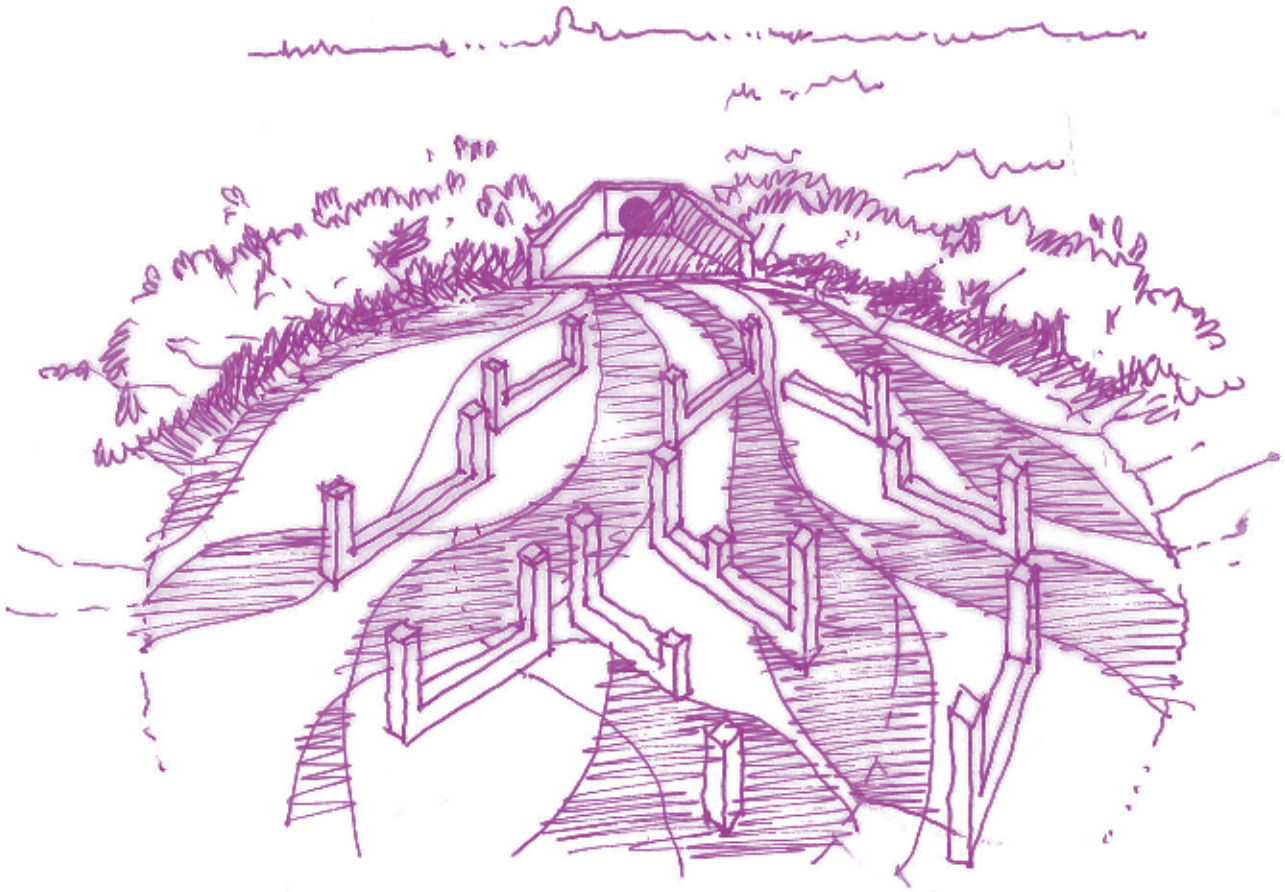
- reduced visual impact
- energy dissipation
- scour protection
- point of interest

note: safety / maintenance / structural considerations

Visual Impact

Efficient Maintenance

Community Interest



Designs should aim to create unique localities that reference local character and enhance a sense of place.

One way this can be achieved is by providing opportunities for the general community to observe flowing water.

Sense of Place

Downpipe Garden

application: on-lot bioretention systems

advantage:

- ownership by resident
- small footprint
- low cost
- at source water treatment

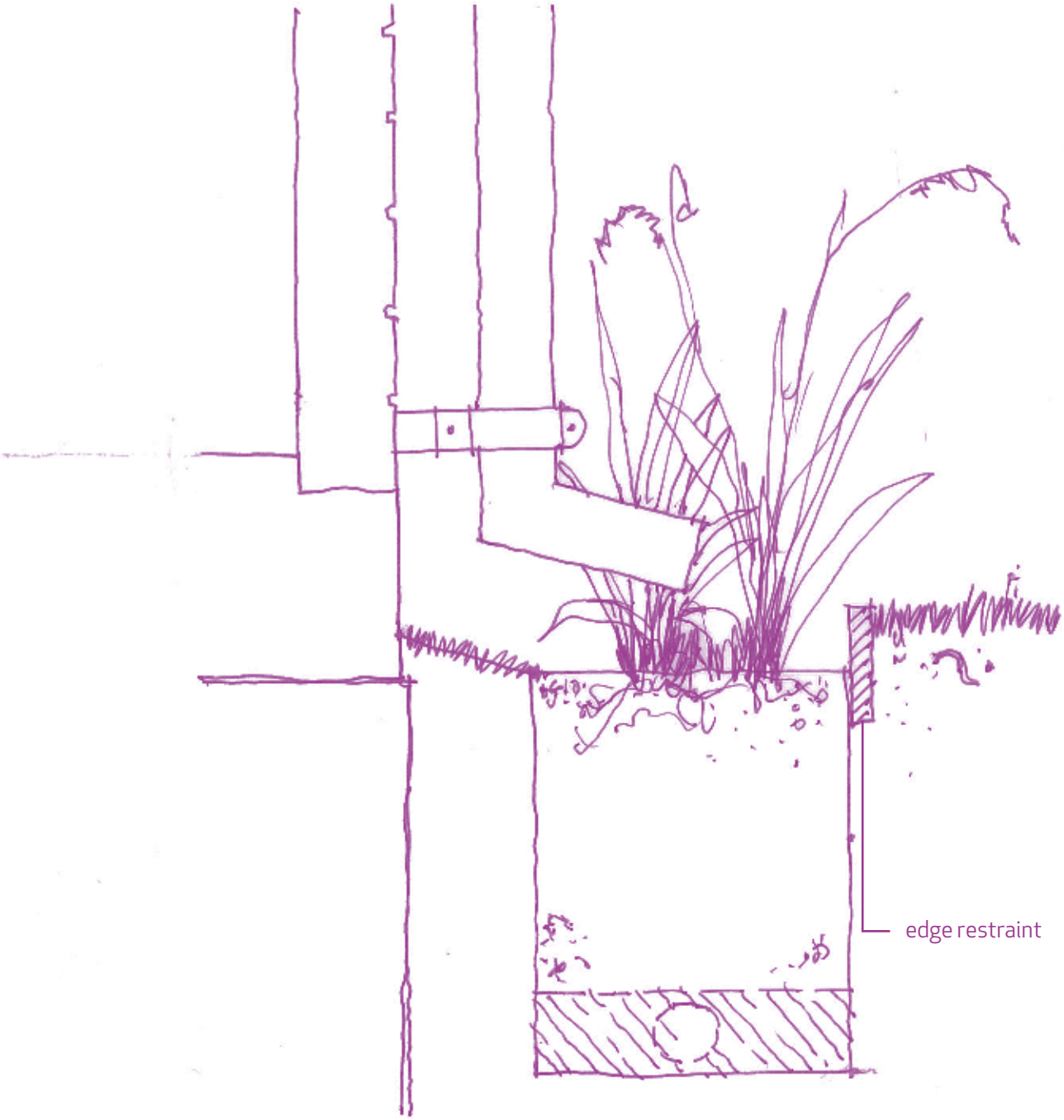
note: consult geotech for infiltration next to footings
(or try a surcharge outlet away from house - idea: Sally Boer – E2 Designlab)

Sense of Place

Space Efficient

Resource Efficient

Water Quality


edge restraint

Internal Biopod

application: office space / hotel lobby

advantage:

- sense of place
- connection to outside rainfall
- no external footprint
- stormwater treatment

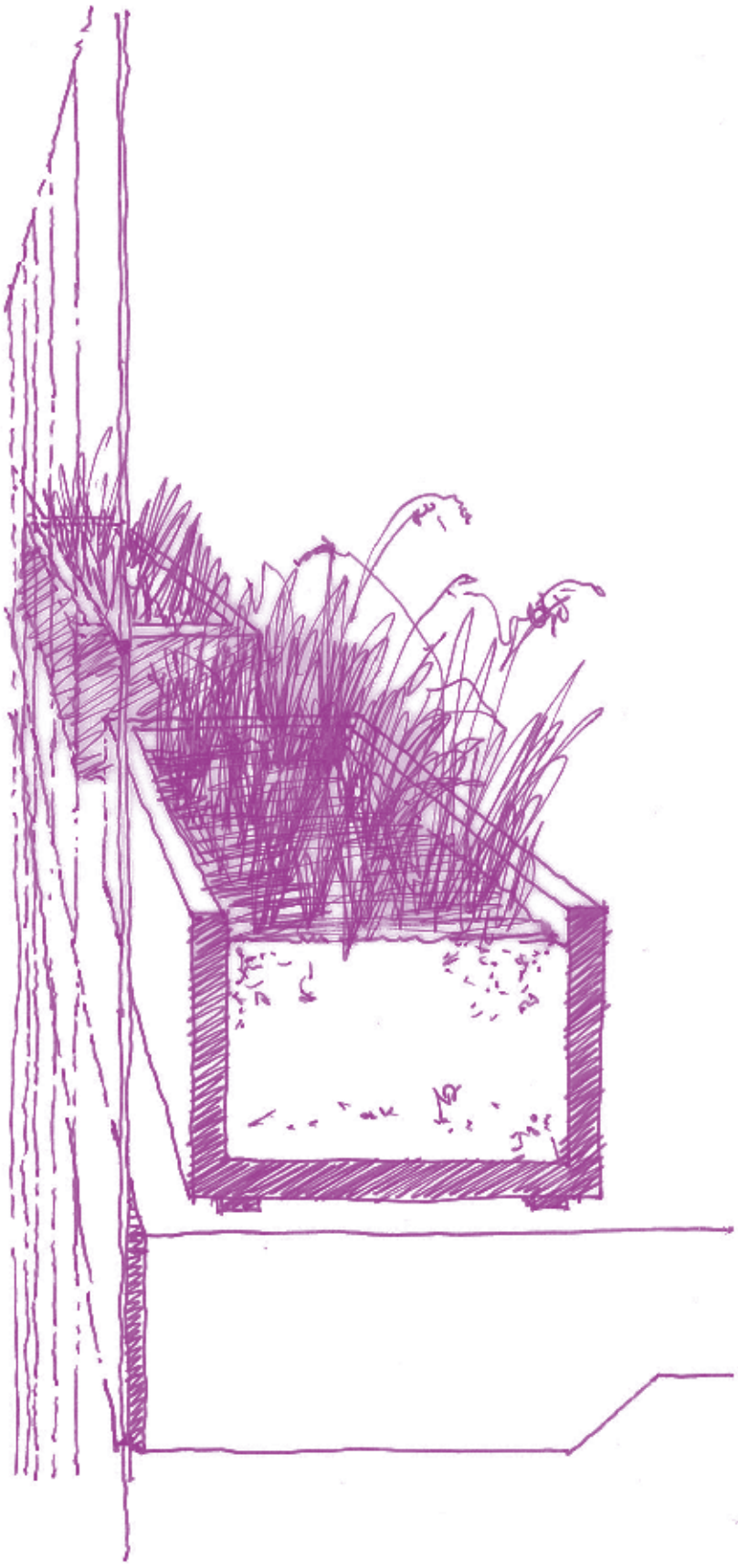
note: integration of hydraulics

Sense of Place

Community Interest

Space Efficient

Water Quality



Cascade Outlet

application: roofwater treatment systems

advantage:

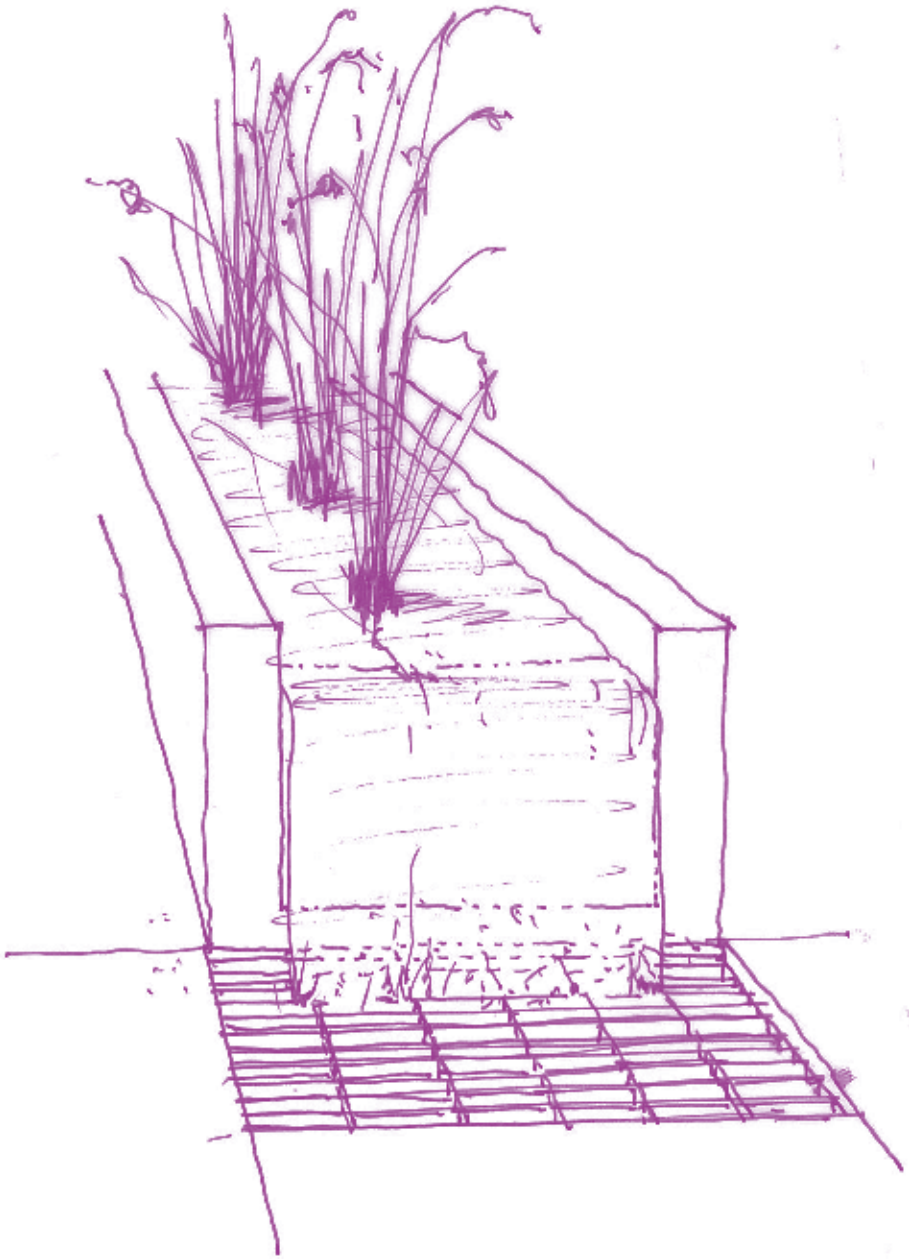
- water feature
- improve dissolved oxygen
- community interest when raining

note: consider signage / public interaction with stormwater and associated safety issues

Sense of Place

Habitat

Community Interest



Urban Waterfall

application: outlets with difficult grade issues

advantage:

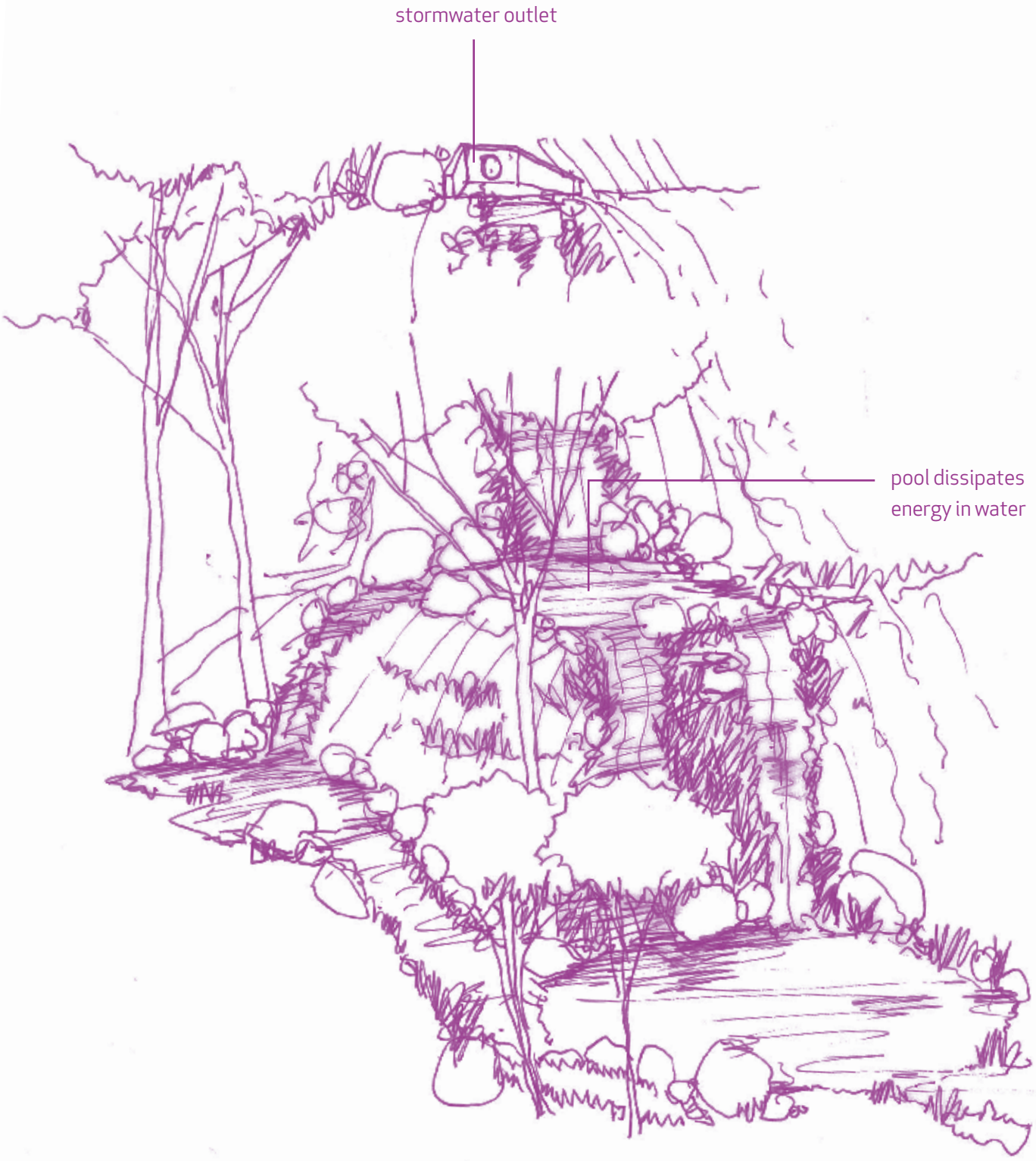
- water feature
- aesthetics
- improved dissolved oxygen
- prevents erosion

note: safety / structural stability issues

Sense of Place

Visual Impact

Habitat


stormwater outlet
pool dissipates
energy in water

With the density of developments ever increasing, there are strong drivers for enhancing the local environmental, social and cultural amenity.

This can be achieved by introducing elements that beautify and soften the urban landscape.

17

Landscape Amenity

Vertical Garden

application: sites with limited available space

advantage:

- soften urban landscape
- small footprint
- point of interest
- passive cooling benefits

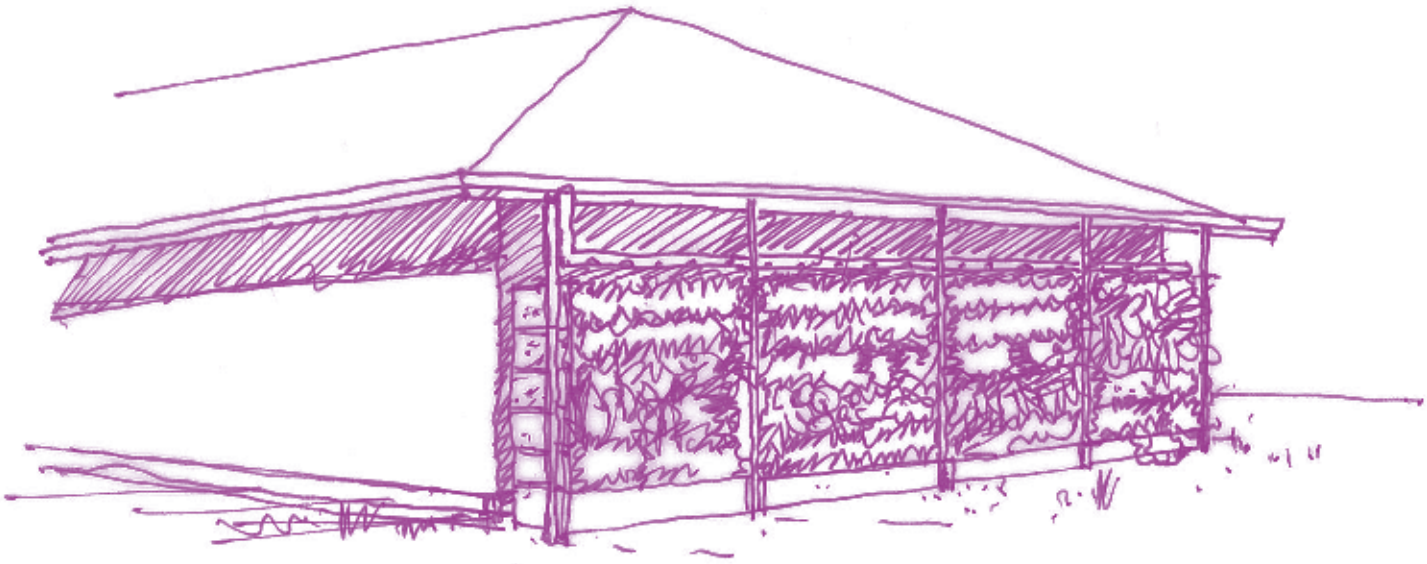
note: additional irrigation may be required

Landscape Amenity

Space Efficient

Community Interest

Microclimate



Terrace Planter

application: steep sites with terraced retaining walls

advantage:

- soften urban landscape
- optimal use of space between walls
- feature wall
- stormwater treatment

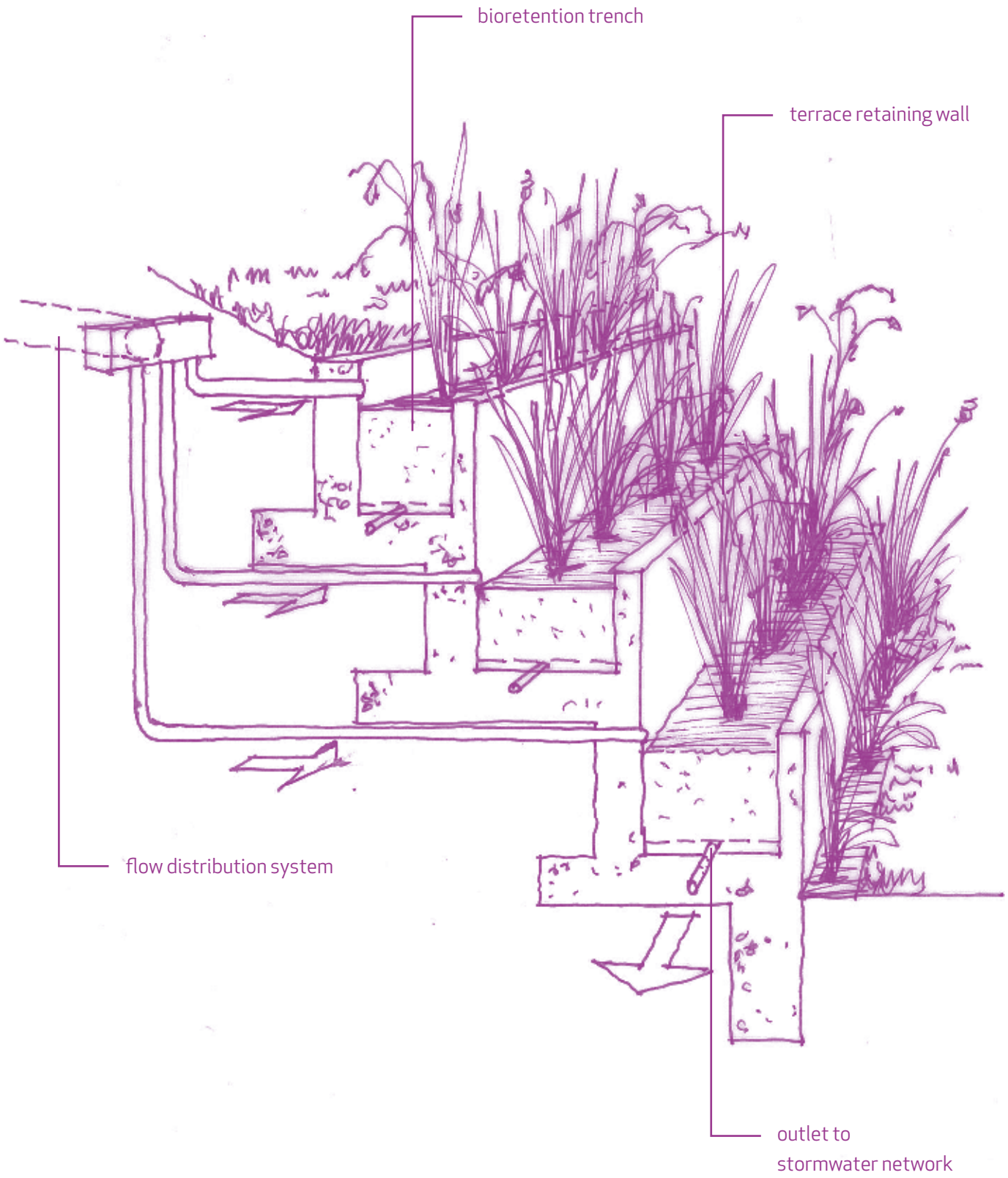
note: maintenance / structural and drainage requirements of retaining wall

Landscape Amenity

Space Efficient

Sense of Place

Water Quality


bioretention trench
terrace retaining wall
flow distribution system
outlet to
stormwater network

Water and shade can be used in combination to mitigate the effects of the urban heat island and create cooler more liveable environments.

Microclimate

Microclimate Design

application: bioretention systems

advantage:

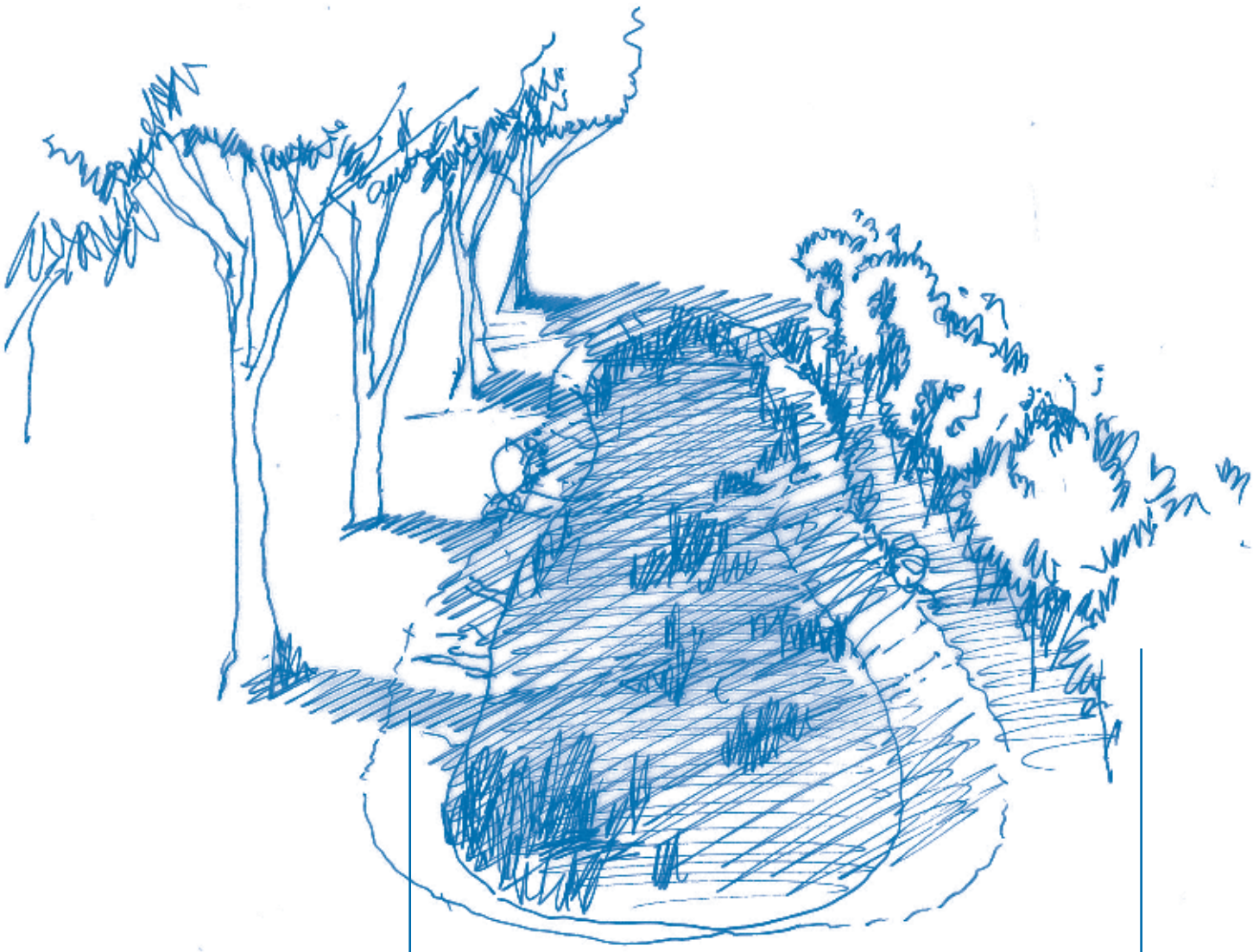
- improved plant establishment
- reduced weed growth and maintenance

note: CPTED issues

idea (sourced or via): Andrew Cook - AECOM

Microclimate

Efficient Maintenance



shadows cool
surface of basin

shrubs protect from
prevailing winds

Tree Island

application: large bioretention basins with insufficient depth for trees

advantage:

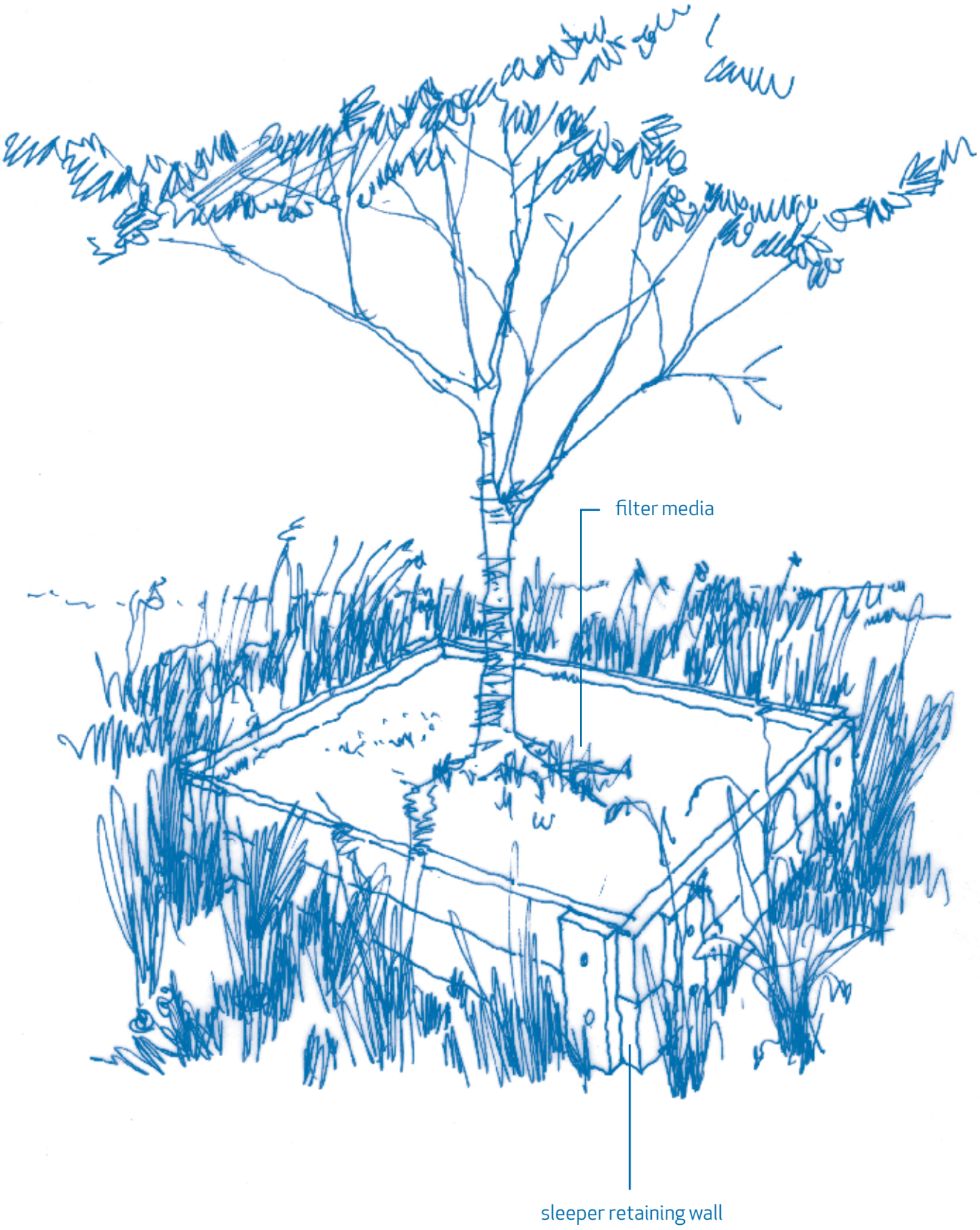
- aesthetics
- improve plant establishment
- reduced weed growth and maintenance

note: tree suitability
idea (sourced or via): Ben Walker – ICC

Microclimate

Visual Impact

Efficient Maintenance


filter media
sleeper retaining wall

Urban Cool Pool

application: urban plazas

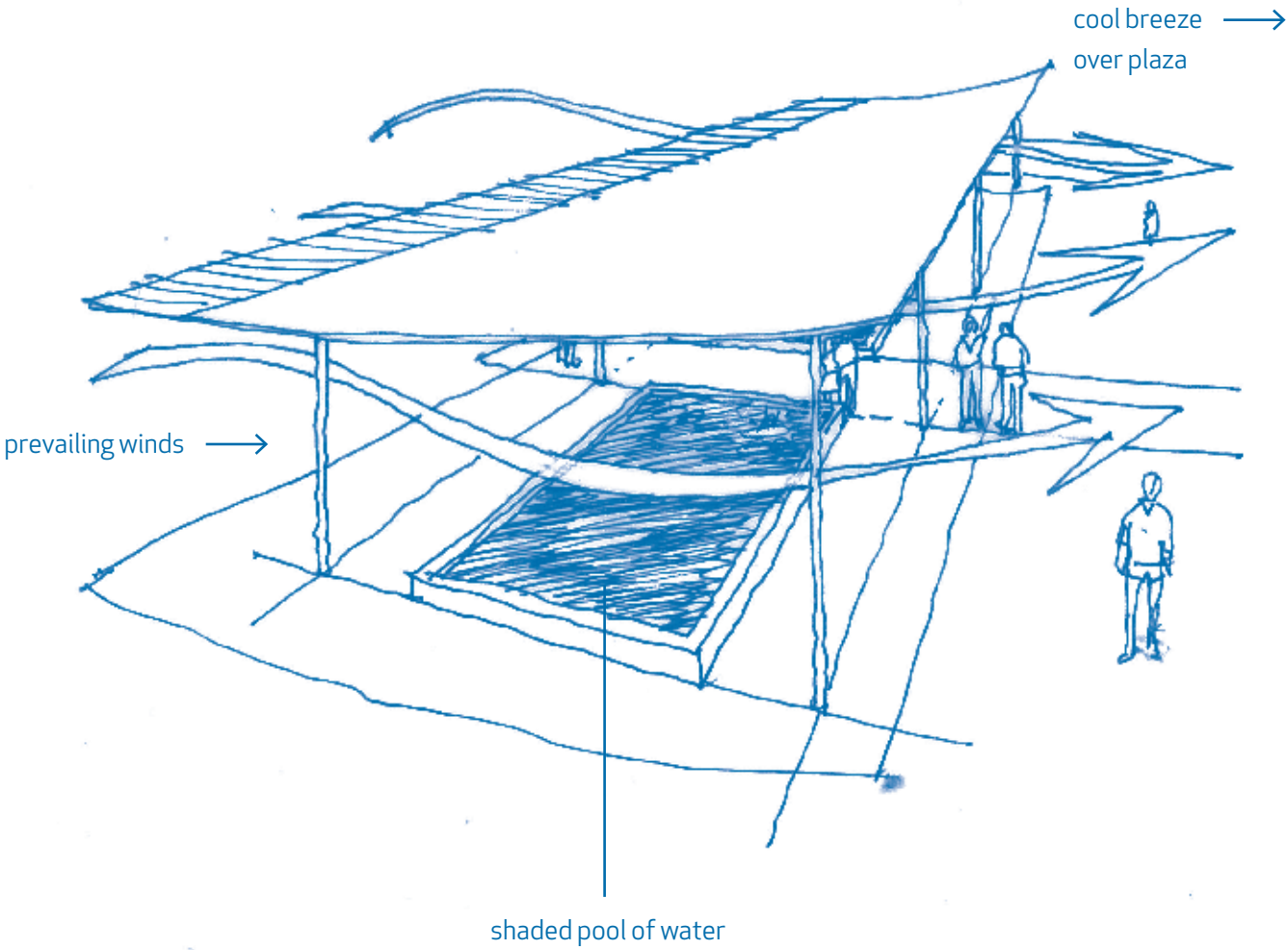
advantage:

- reduce temperatures in local area
- community feature

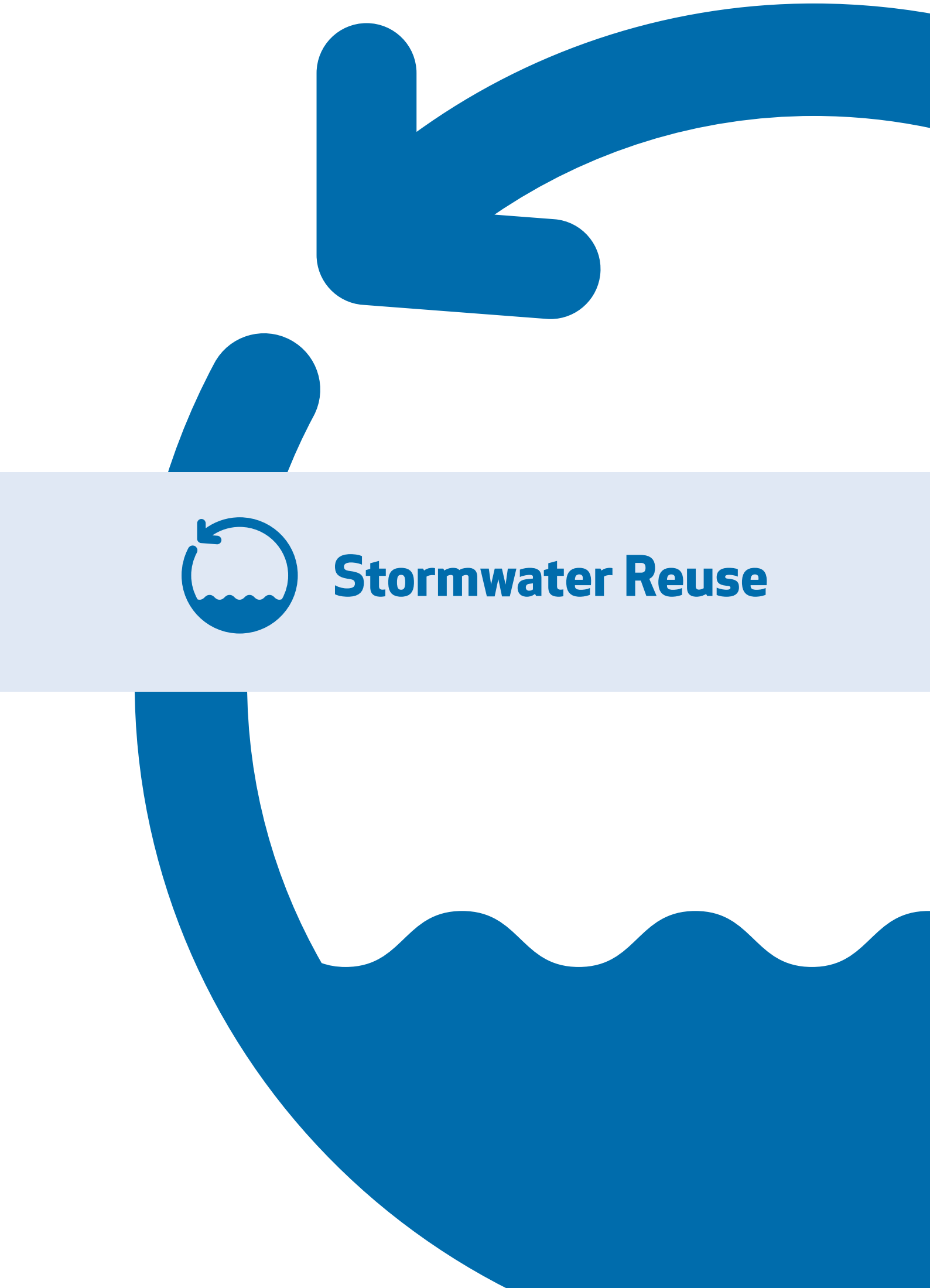
note: water to be fit for purpose / safety considerations
idea (sourced or via): Peter Skinner, UQ & Masdar Project, AECOM

Microclimate

Sense of Place


cool breeze
over plaza
prevailing winds
shaded pool of water

Extended droughts can greatly diminish the available water supply for communities. In order to to build resilience, smart development makes best use of it's water resources via fit for purpose stormwater reuse schemes.



Stormwater Reuse

Stormwater Harvest

application: bioretention systems adjacent parks

advantage:

- alternative water supply
- hydrological benefit
- improved landscape outcomes
- additional treatment

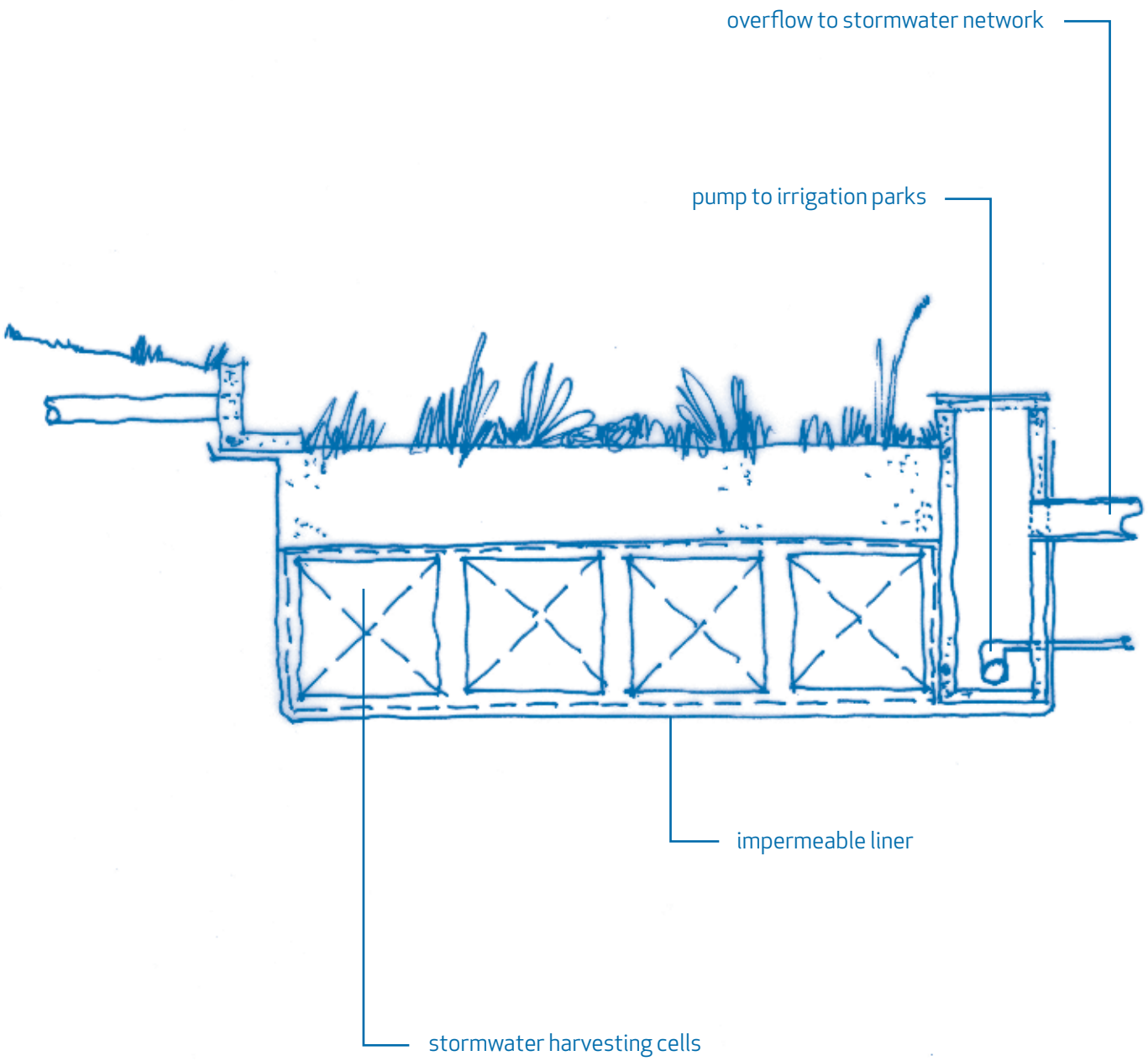
note: water to be fit for purpose

Stormwater Reuse

Flow Management

Landscape Amenity

Water Quality


overflow to stormwater network
pump to irrigation parks
impermeable liner
stormwater harvesting cells

Infiltration Branch

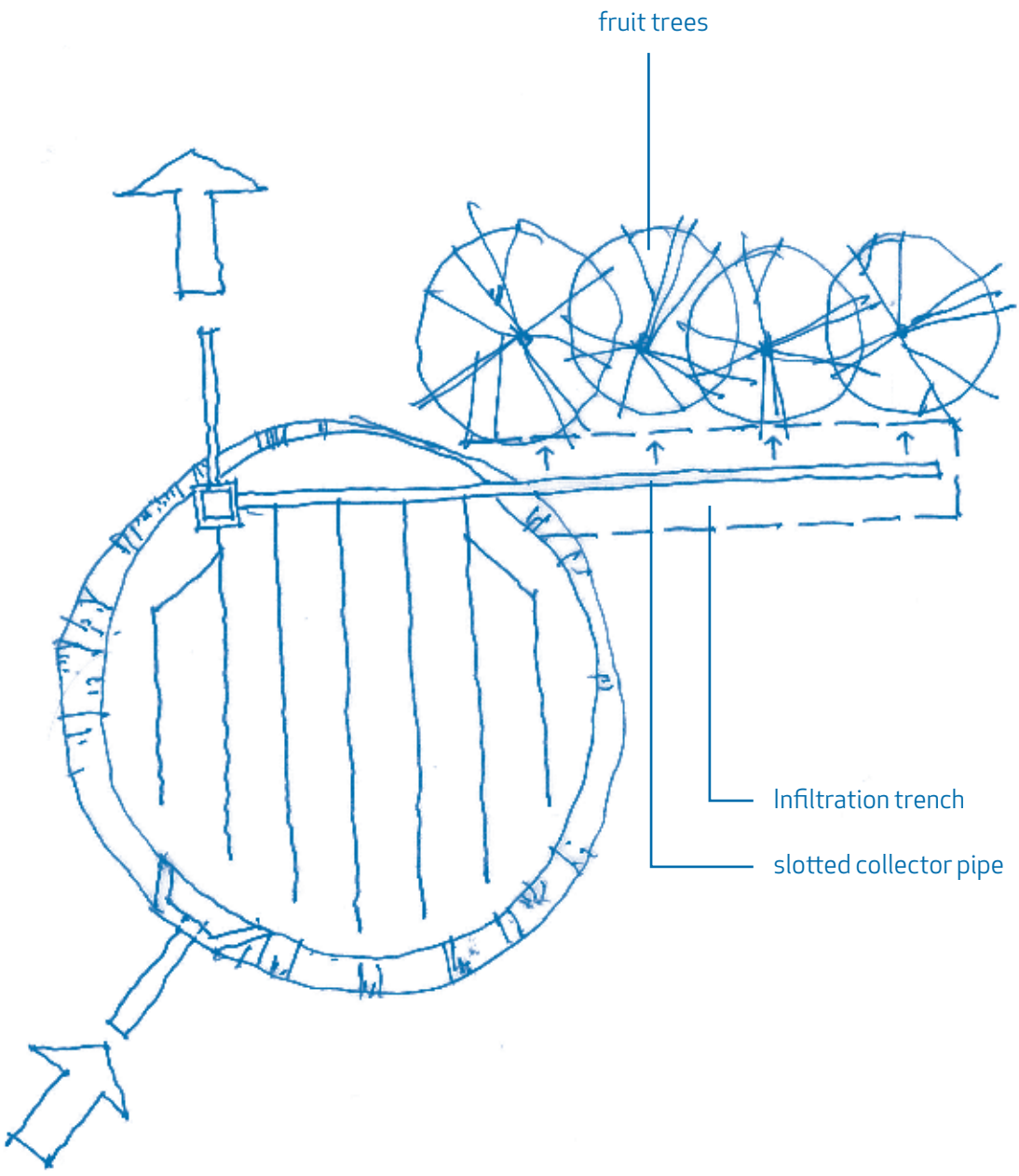
application: downstream of bioretention basins

advantage:

- utilise treated stormwater
- promote infiltration
- improved tree growth
- hydrological benefit
- additional treatment

note: groundwater conditions / water needs for tree species / tree suitability

Stormwater Reuse **Infiltration** **Landscape Amenity** **Water Quality**


fruit trees
Infiltration trench
slotted collector pipe

Stormwater Mining

application: opportunistic / stormwater lines with capacity issues

advantage:

- harvest stormwater for reuse
- hydrological benefit
- promote infiltration
- reduce pressure on stormwater network
- additional treatment

note: groundwater conditions, water to be fit for purpose

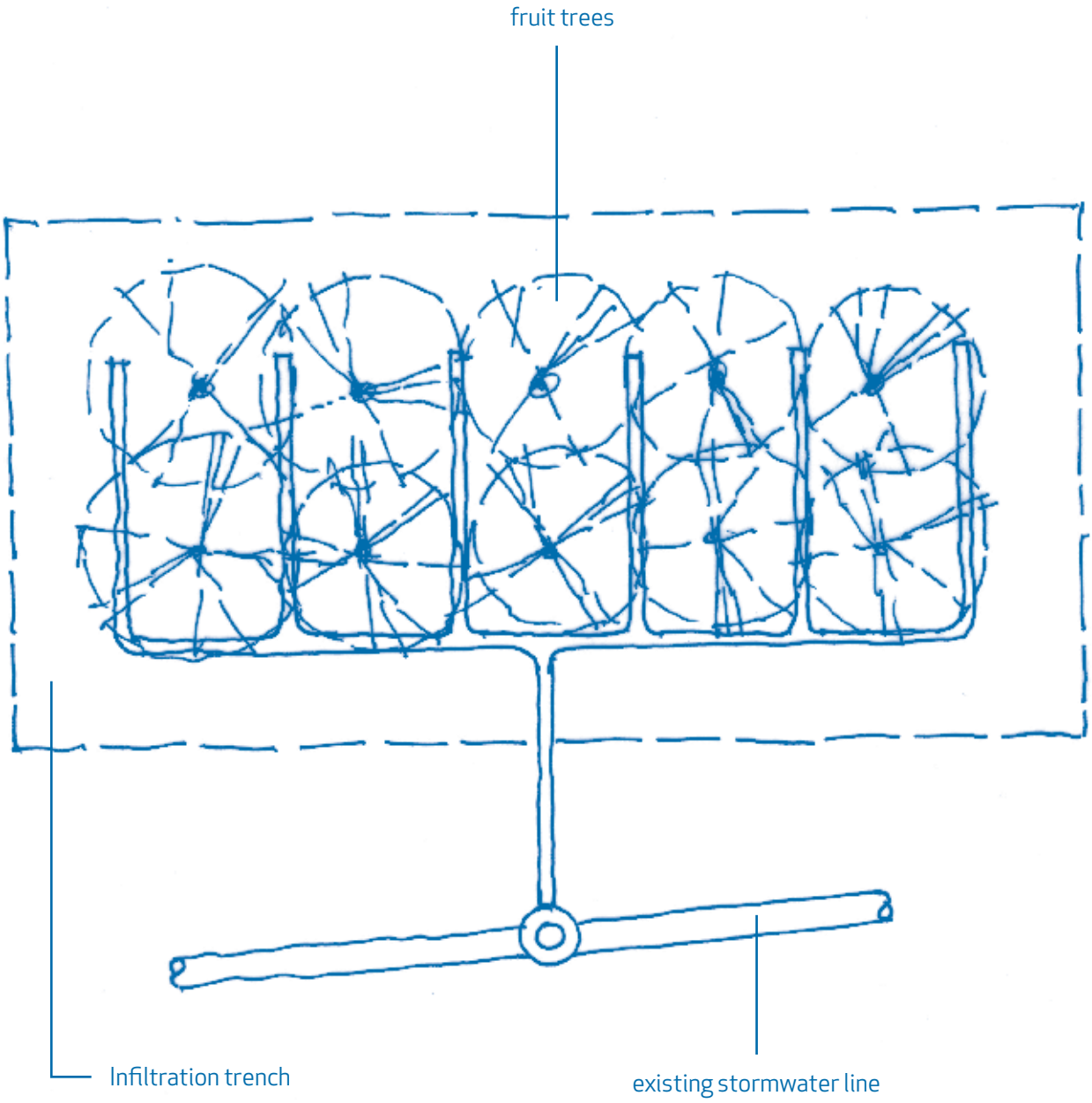
Stormwater Reuse

Flow Management

Infiltration

Resource Efficient

Water Quality


fruit trees
Infiltration trench
existing stormwater line

Any infrastructure placed within community reach should consider public safety.

Safety

Pod Lighting

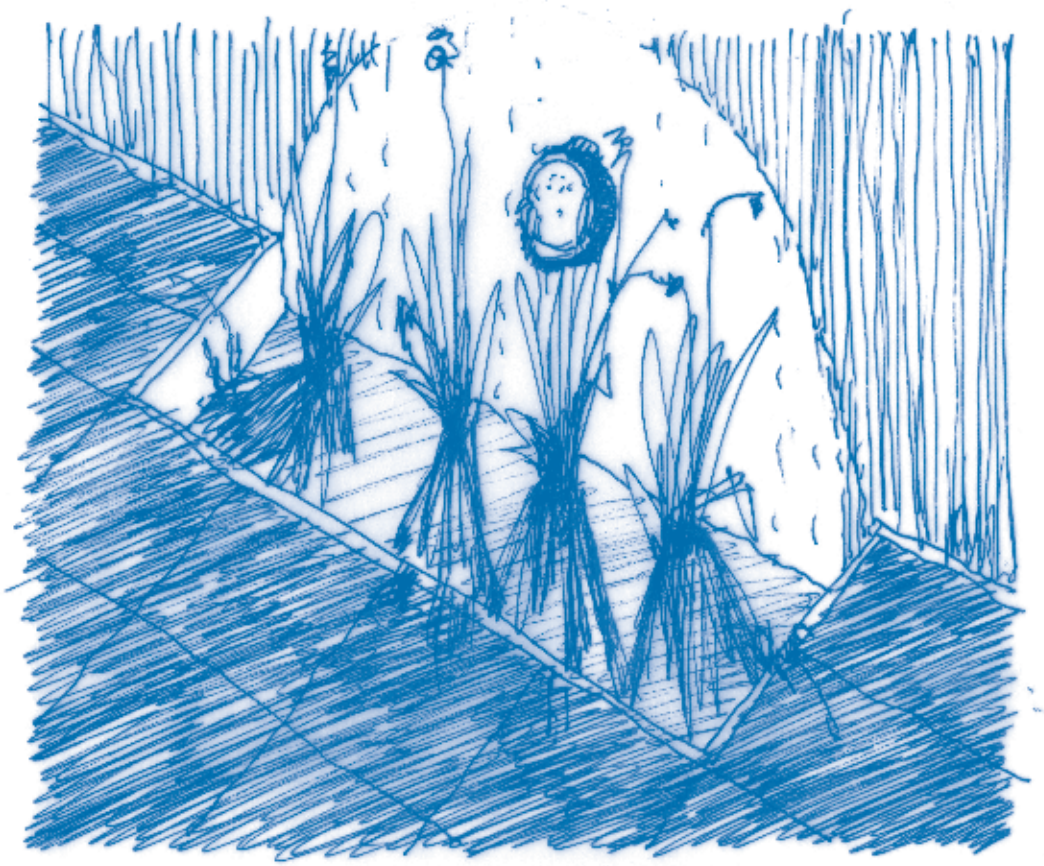
application: urban basins with dropoff / lighting requirements

advantage:

- safety
- water ripples cast onto wall
- night time aesthetics

note: use submersible electrics if below water level

Safety **Sense of Place** **Visual Impact**



Letterbox Pit / Seat

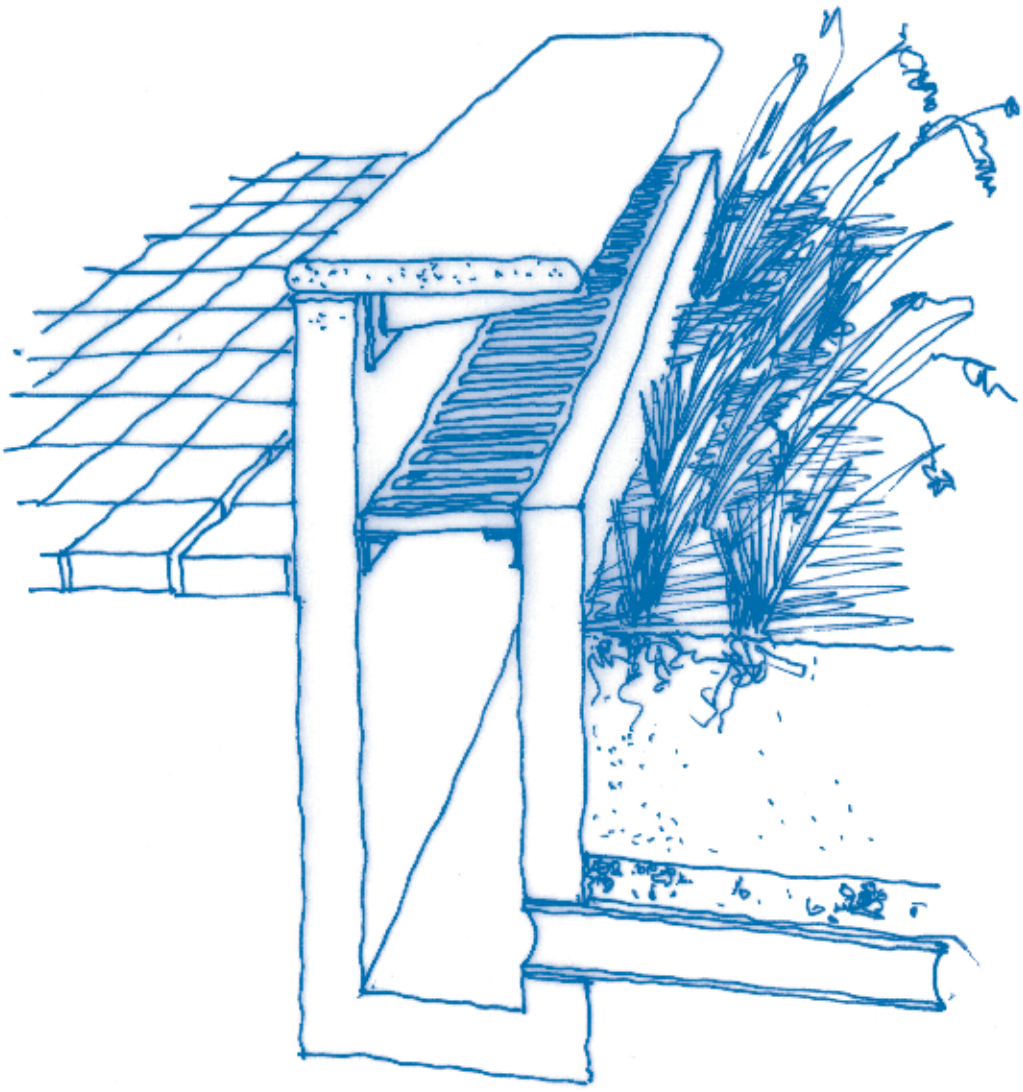
application: urban bioretention systems

advantage:

- seat acts as barrier to drop off
- pit hidden from view
- pit can function as seat

note: maintenance requirements
idea (sourced or via): Tarek Barklay - AECOM

Safety **Visual Impact** **Passive Recreation**



Carpark Bioretention Swale

application: carpark bioretention systems

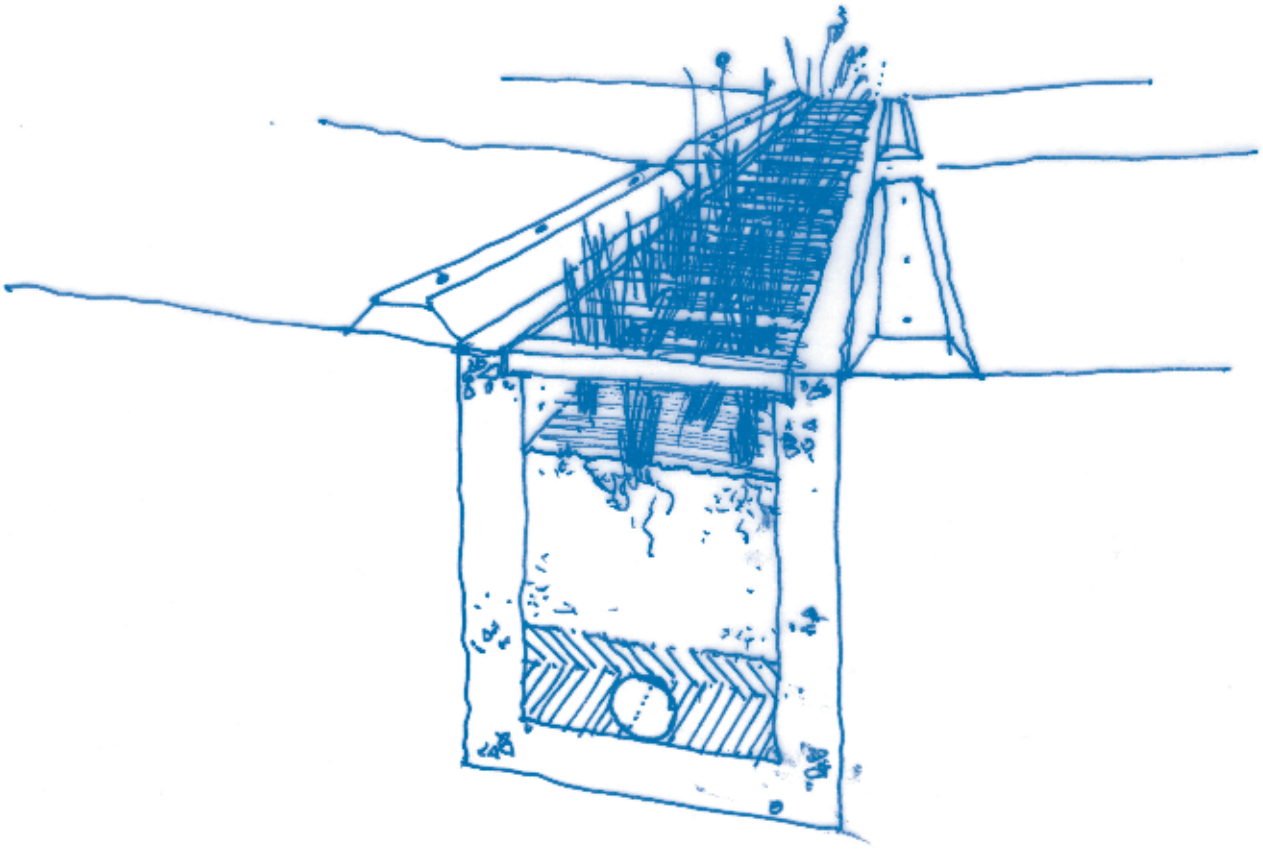
advantage:

- trafficable surface eliminates drop off
- minimise footprint

note: structural loading requirements / sunlight penetration for deep systems

Safety

Space Efficient



Design outcomes can contribute to healthy living aspirations within communities by encouraging recreation, contemplation and general well-being.

Passive Recreation

View Deck

application: wetlands

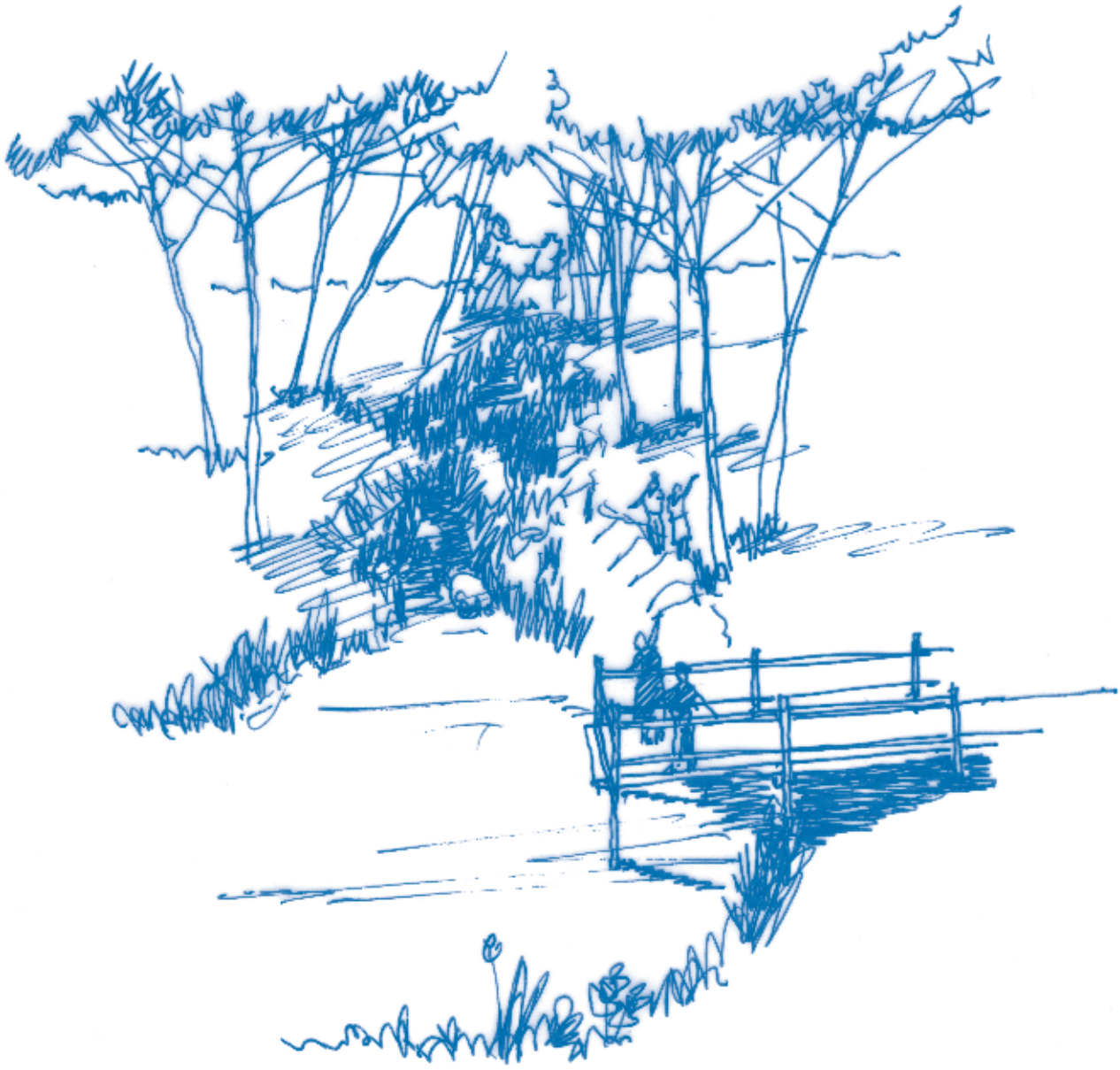
advantage:

- passive recreation
- sense of place

note: safety considerations

Passive Recreation

Sense of Place



Ornamental Pond Filtration System

application: ornamental ponds

advantage:

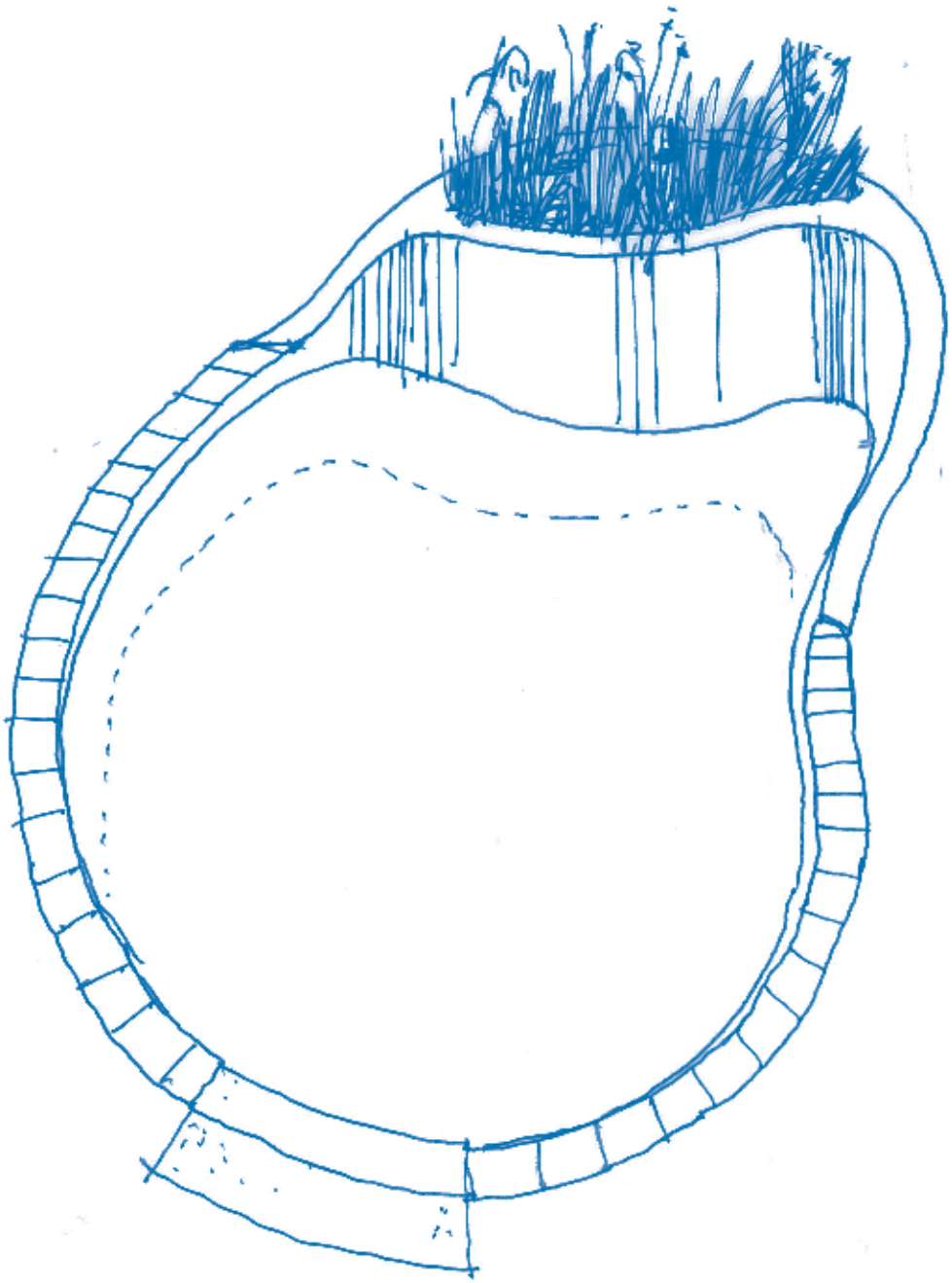
- passive recreation
- point of interest
- help maintain pond water quality

note: saftey considerations

Passive Recreation

Community Interest

Material Sustainability



With funding often in short supply, it is beneficial to create resource efficient WSUD systems that maximise outcomes while considering the upfront and ongoing life-cycle costs.

Resource Efficiency

F

Small Sediment Forebay

application: streetscape bioretention systems

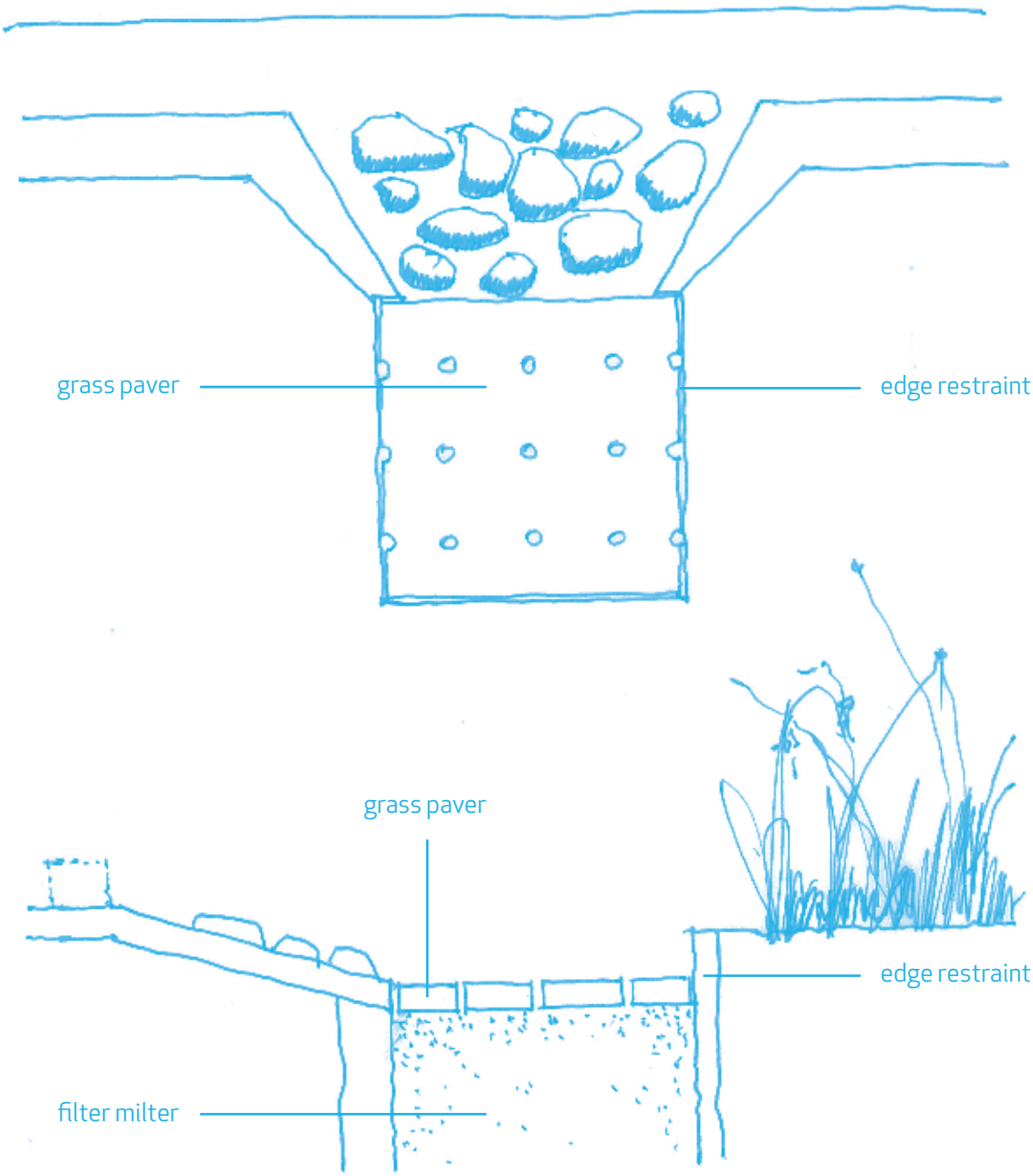
advantage:

- low cost
- easy maintenance / no ponding / scour protection

idea (sourced or via): Christoph Pester & Courtney Henderson AECOM

Resource Efficient

Efficient Maintenance


grass paver
edge restraint
grass paver
edge restraint
filter milter

Medium Sediment Forebay

application: bioretention basin

advantage:

- low cost
- easy maintenance / no ponding / scour protection

note: allow for impacts on hydraulics / beams can be removed at later date
idea (sourced or via): Gary Deans Constructions - Freshwater Estate

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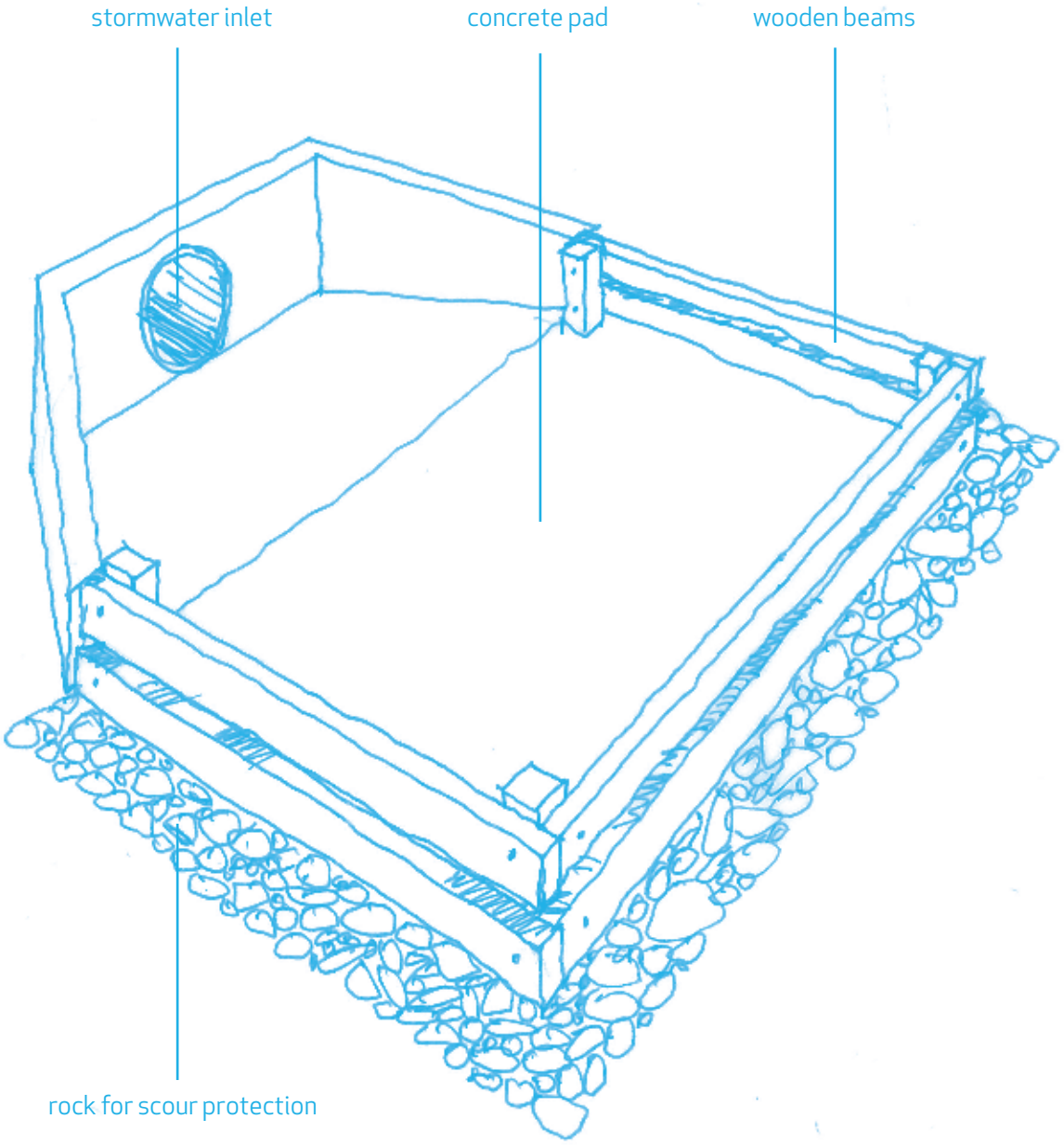
Resource Efficient

Efficient Maintenance


stormwater inlet
concrete pad
wooden beams
rock for scour protection

Low Impact Access Track

application: basin access tracks

advantage:

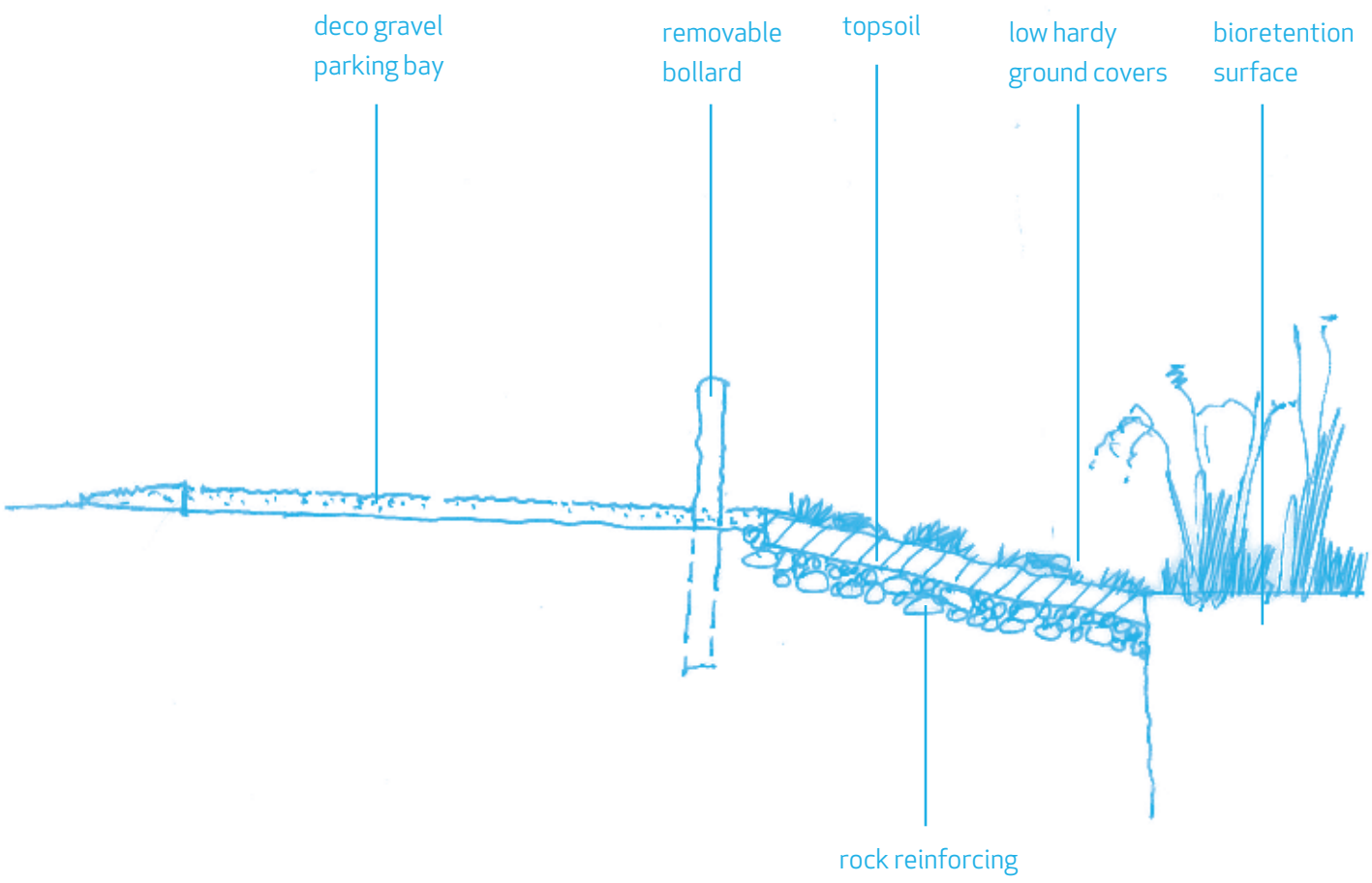
- low cost
- aesthetics
- minimises materials

note: batter slope requirements
idea (sourced or via): Andrew Cook - AECOM

Resource Efficient

Visual Impact

Material Sustainability


deco gravel
parking bay
removable
bollard
topsoil
low hardy
ground covers
bioretention
surface
rock reinforcing

Pitless Bioretention

application: bioretention systems next to riparian zones

advantage:

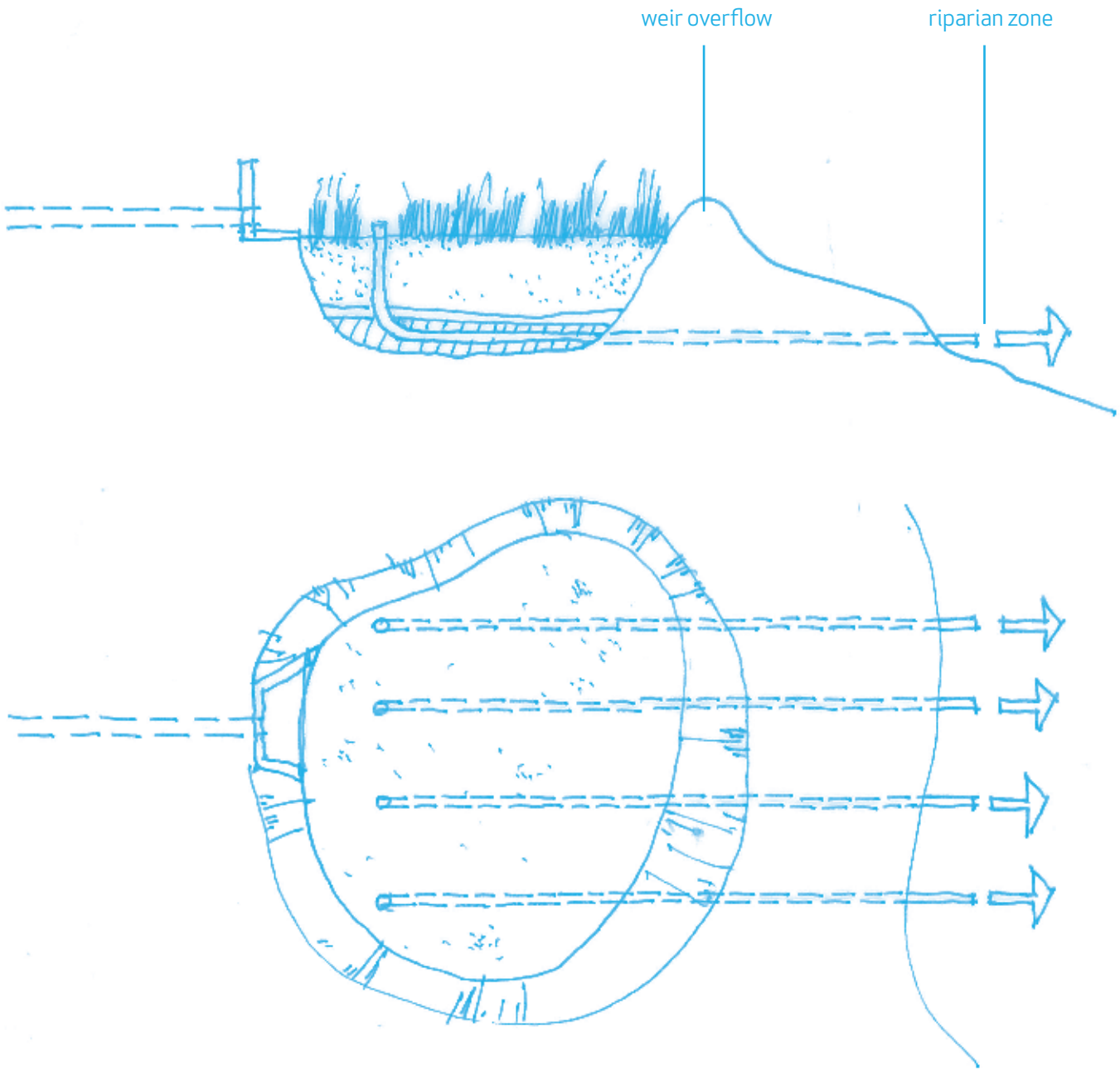
- cost saving for pits
- multiple distributed stormwater outlets
- engage riparian zone

note: surface protection at outlets and overflow weir

Resource Efficient

Flow Management

Habitat


weir overflow
riparian zone

During the planning and concept design phases, system designs should recognise the relative price of land and provide the appropriate level of space efficiency.

Space Efficiency

Balcony Planter

application: multi storey units

advantage:

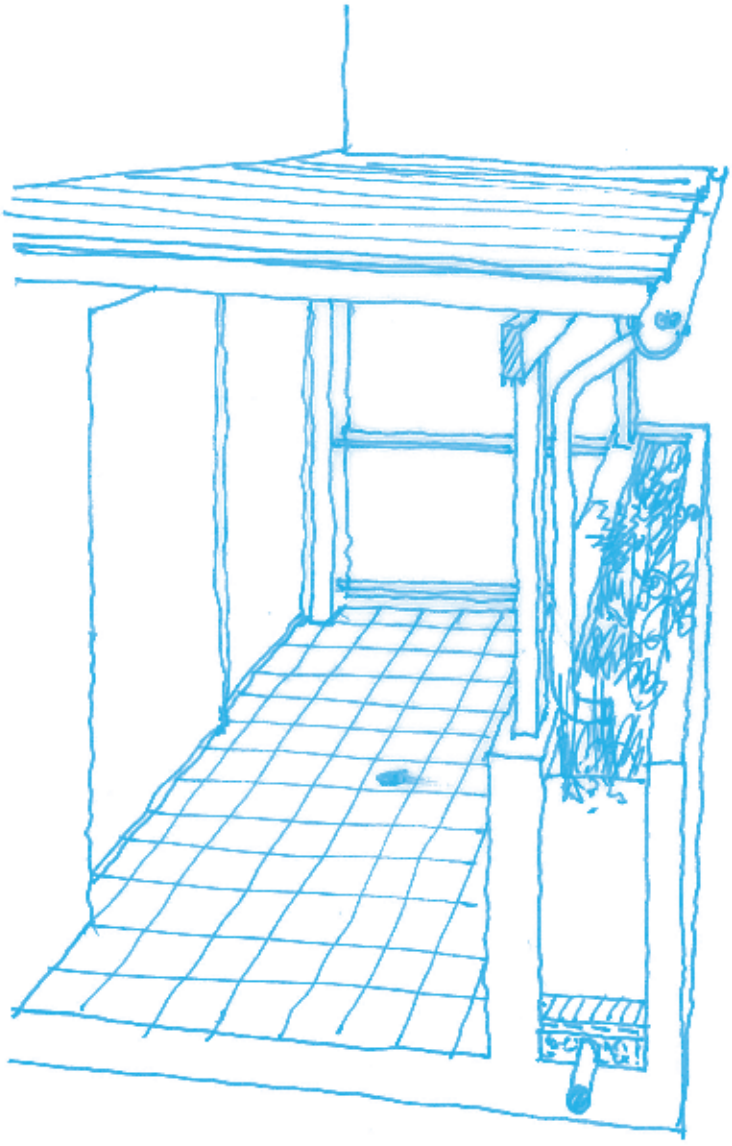
- minimise footprint
- treatment of roofwater
- aesthetics

note: structural support as required / filter media specification can be adapted to ensure adequate landscape outcome

Space Efficient

Water Quality

Sense of Place



Raised Planter Box

application: urban areas with outlet depth issues

advantage:

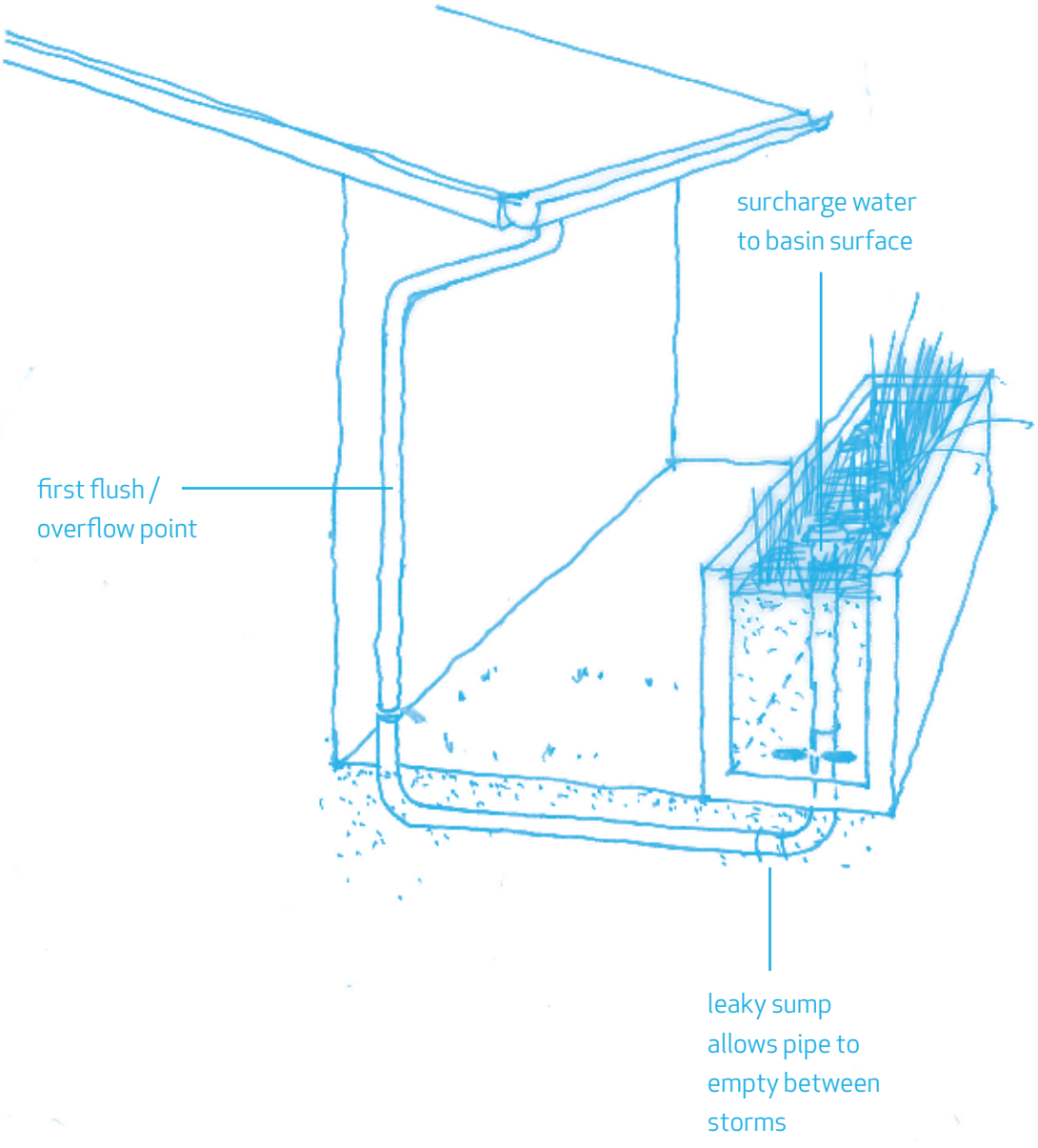
- can be free draining
- landscape feature
- roofwater treatment

note: include small soakage pit to empty surcharge pipe after storm / consult geotech for infiltration

Space Efficient

Sense of Place

Water Quality


surcharge water
to basin surface
first flush /
overflow point
leaky sump
allows pipe to
empty between
storms

Constrained Drainage Layer

application: bioretention systems with a constrained drainage layer

advantage:

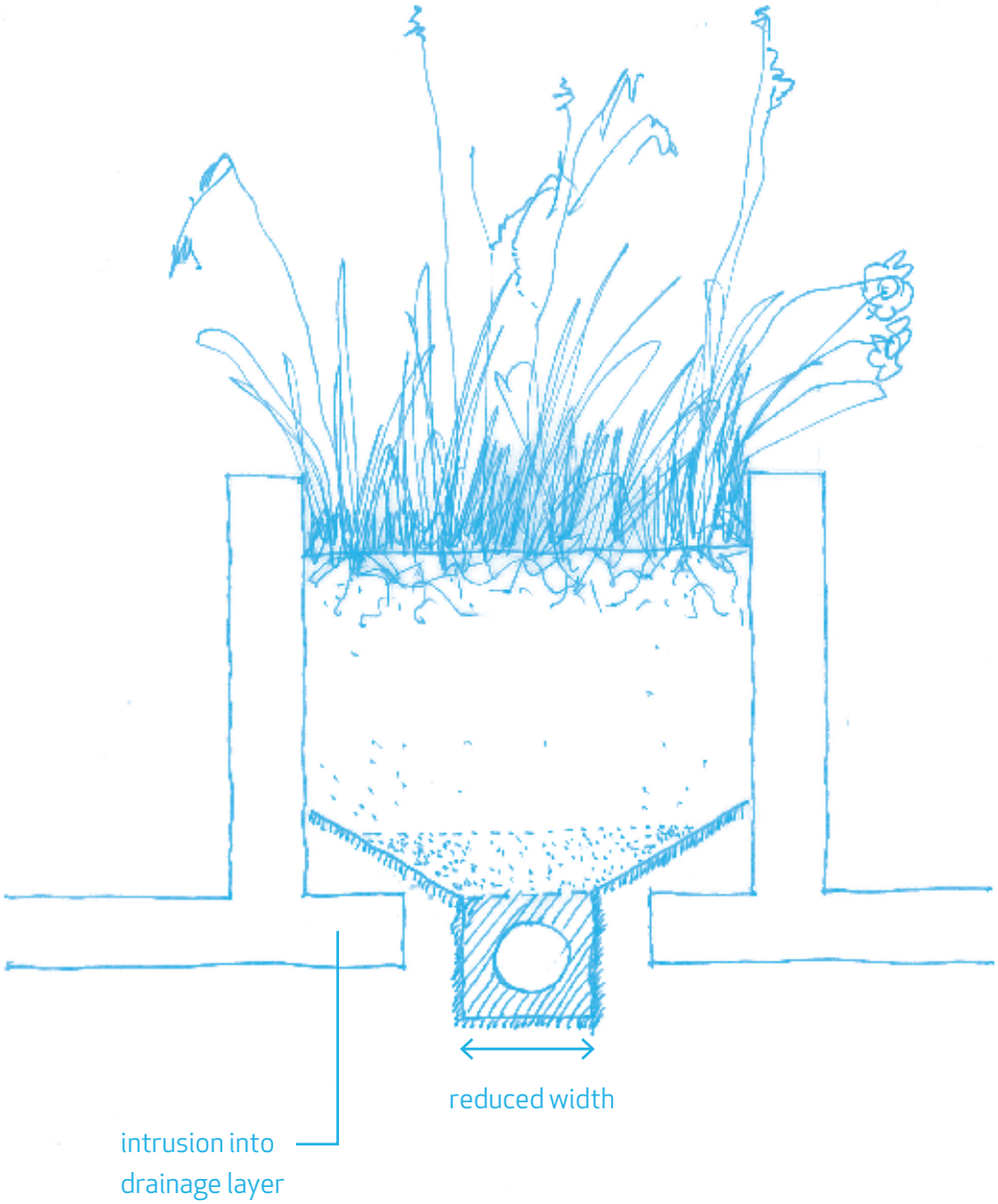
- utilise available space
- maximise surface area
- minimise materials

note: consult geotechnical engineer for infiltration systems next to footings / piered footings may reduce intrusions
idea (sourced or via): Hoyland Street bioretention basin

Space Efficient

Resource Efficient

Material Sustainability


reduced width
intrusion into
drainage layer

Pool to Pond Conversion

application: infill residential subdivisions

advantage:

- make use of existing pool
- minimise materials
- water treatment
- aesthetics

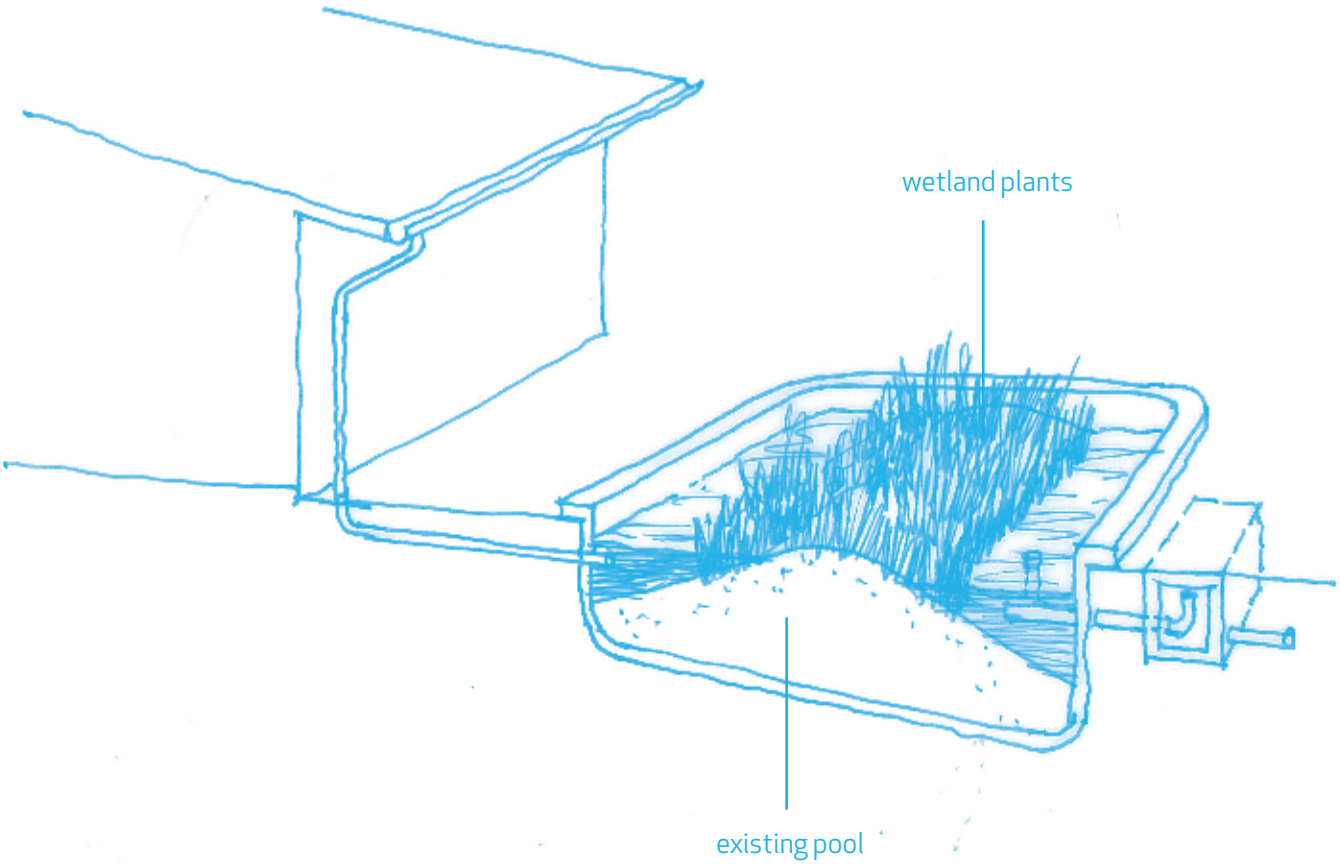
note: consider integration of hydraulics / public interaction and associated safety issues
idea (sourced or via): Ku-ring-gai Council - Pool to Pond

Space Efficient

Resource Efficient

Water Quality

Sense of Place


wetland plants
existing pool

As with most functioning landscapes, WSUD systems require ongoing maintenance for them to be kept in a functional and attractive state. Designs can reduce ongoing maintenance requirements for asset owners by ensuring good initial plant establishment and coverage.

One way this can be achieved is by carefully managing flow distribution and ponding within systems.

Efficient Maintenance

Wet Zone / Dry Zone Planting

application: bioretention systems with intermittent flows causing algae at inlet

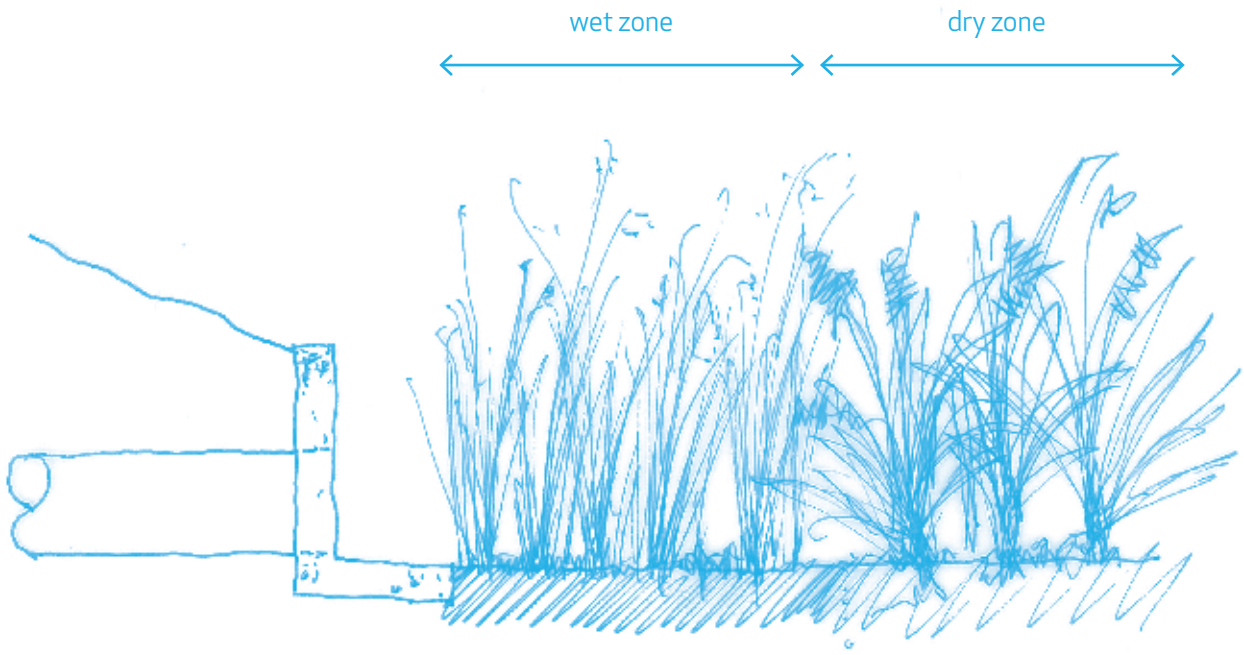
advantage:

- prevent algae takeover and plant loss
- no change to basin design

note: plants to be fit for purpose
idea (sourced or via): Wiebke Witte - AECOM

Efficient Maintenance

Resource Efficient



melalueca
quinquenervia
juncus usitatus
gahnia seiberiana

ficinia nodosa
lomandra hysterix
themeda triandra

Trickle Flows

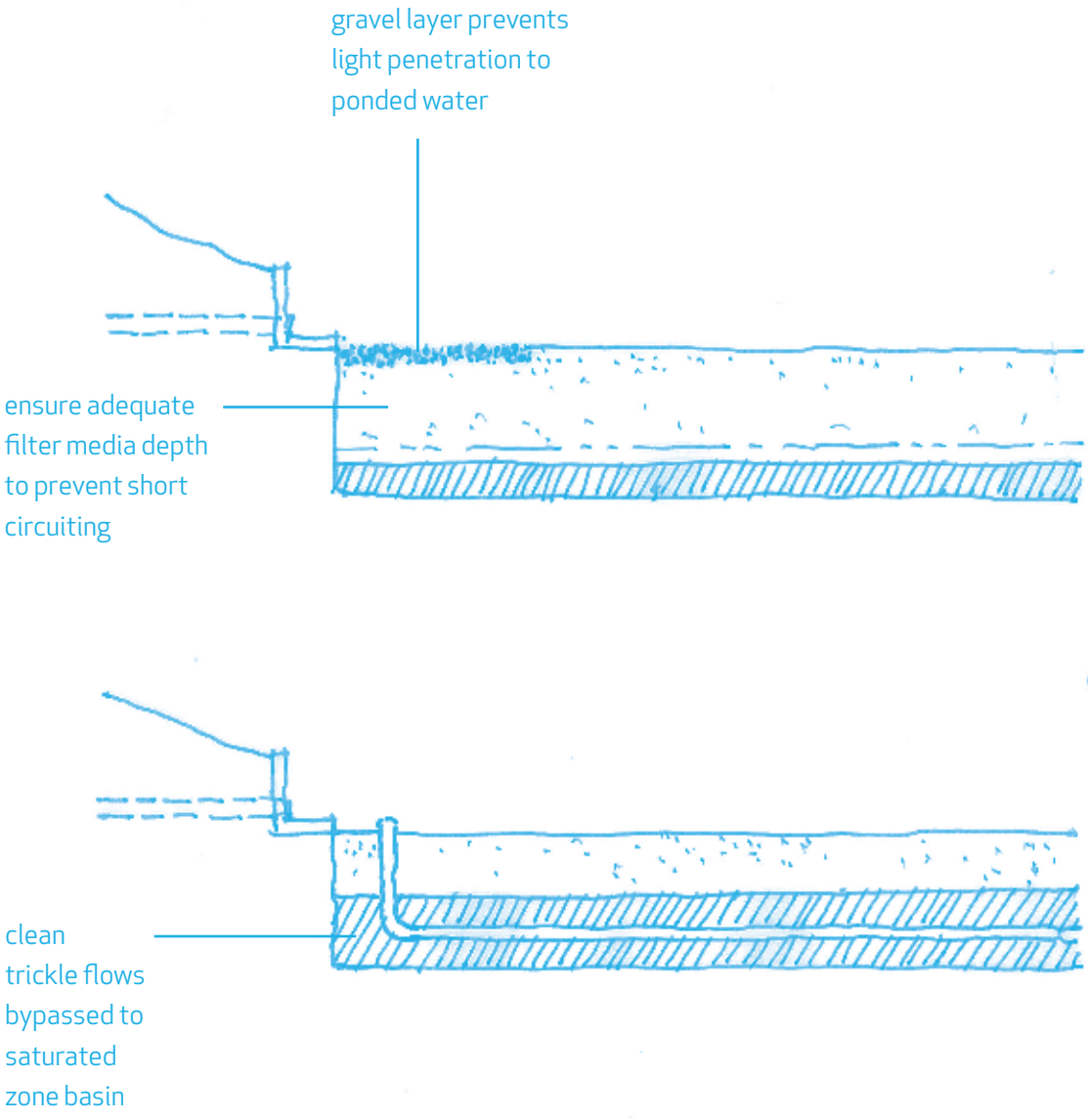
application: basins with trickle flows causing algae at inlet

advantage:

- prevent algae growth and plant loss

note: trickle flows depend on catchment behaviours and can change over time
idea (sourced or via): Courtney Henderson & Sally Boer AECOM

Efficient Maintenance


gravel layer prevents
light penetration to
ponded water
ensure adequate
filter media depth
to prevent short
circuiting
clean
trickle flows
bypassed to
saturated
zone basin

Pilot Channel

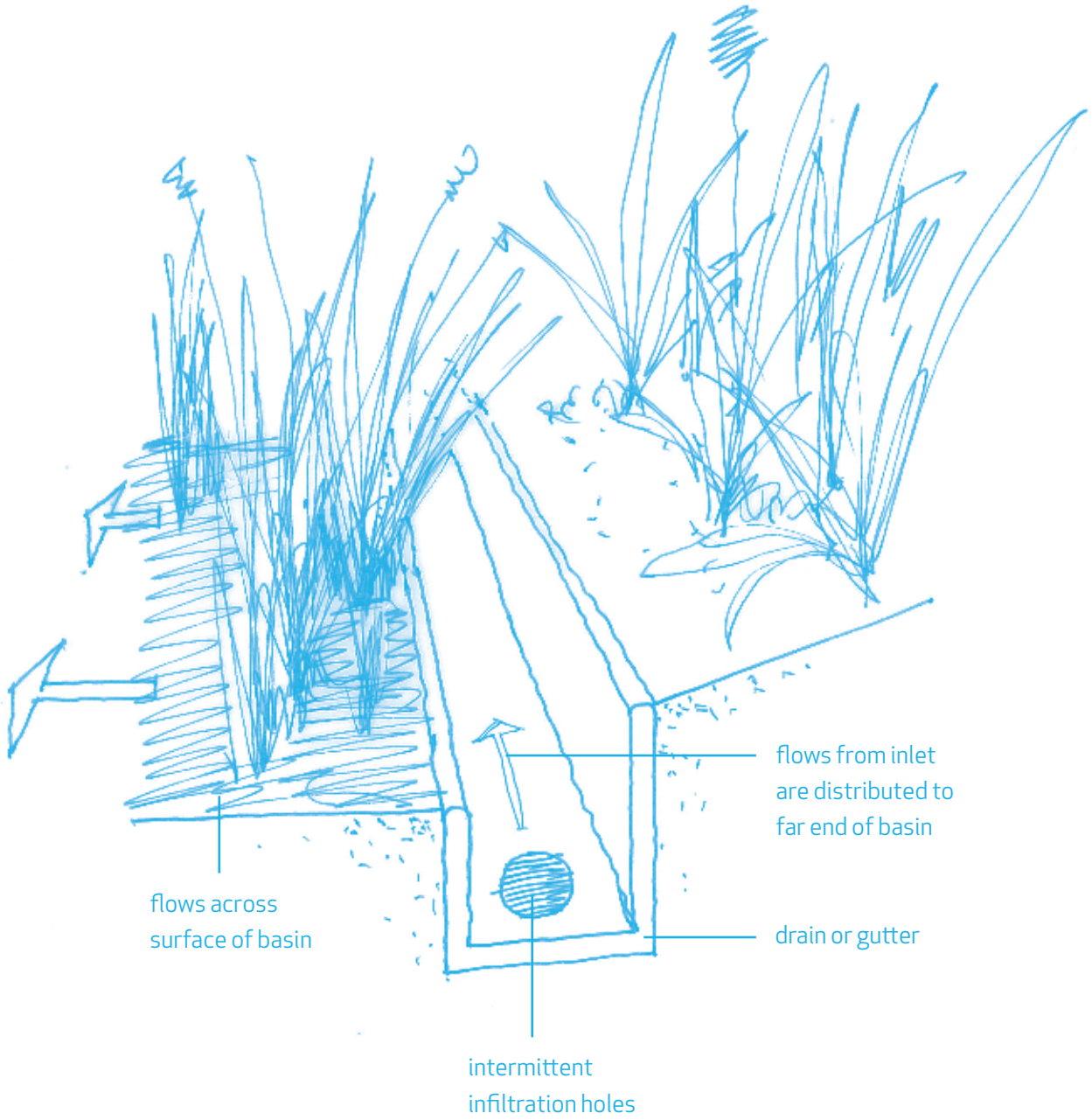
application: large basins with flow distribution issues or moisture gradients

advantage:

- even distribution of flow
- improve plant health at far end of basin

note: sediment buildup issues
idea (sourced or via): Peter Breen - AECOM

Efficient Maintenance


flows from inlet
are distributed to
far end of basin
flows across
surface of basin
drain or gutter
intermittent
infiltration holes

Temporary Upstand

application: establishing plants in bioretention systems

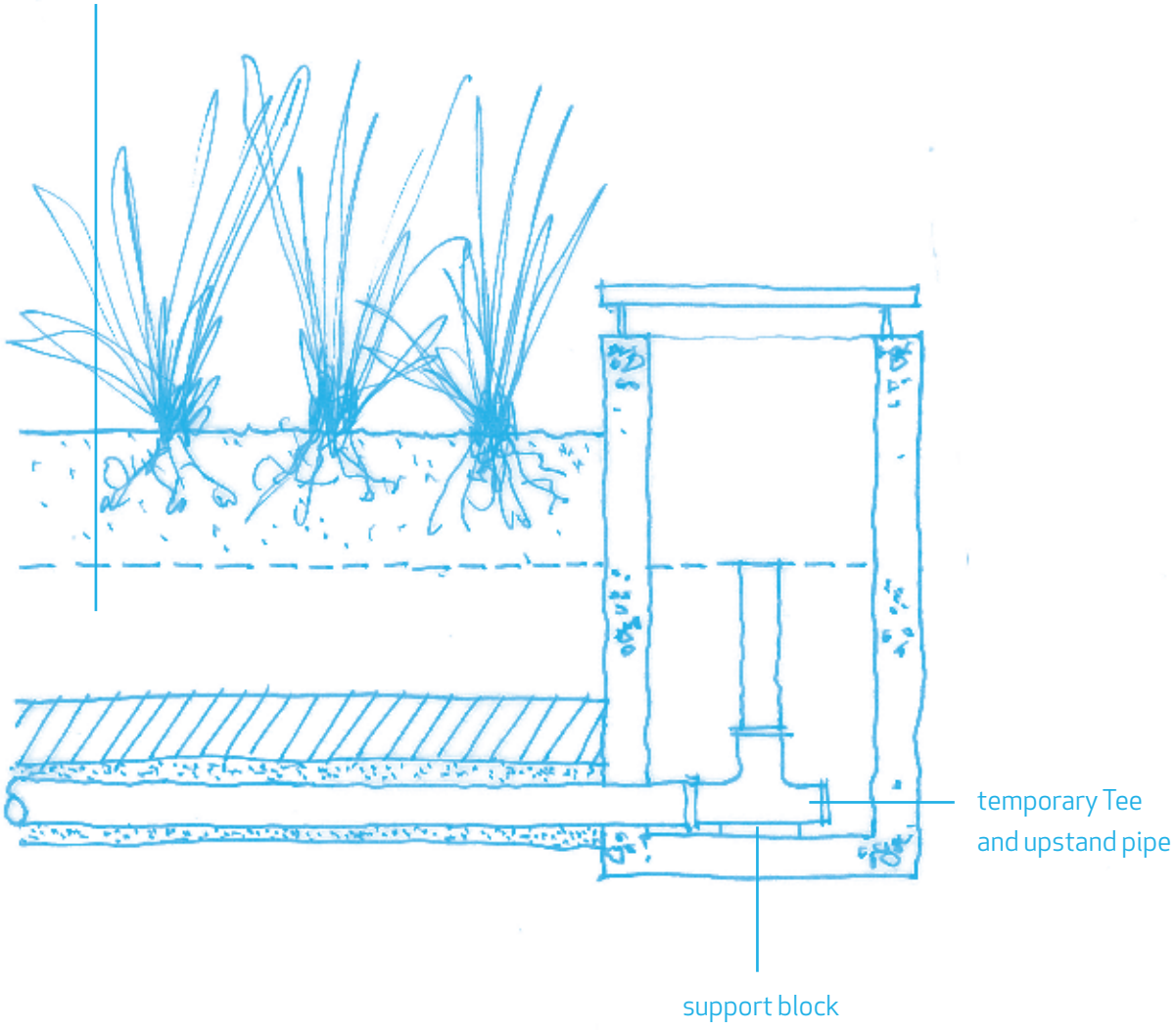
advantage:

- provides temporary watertable for establishing plants
- faster plant establishment

note: potential to leach nutrients if left for long period
idea (sourced or via): Shaun Leinster - DesignFlow

Efficient Maintenance

Visual Impact


temporary
water source for
establishing plants
temporary Tee
and upstand pipe
support block

Surface Clogging

application: bioretention systems with surface blinding

advantage:

- low cost rectification

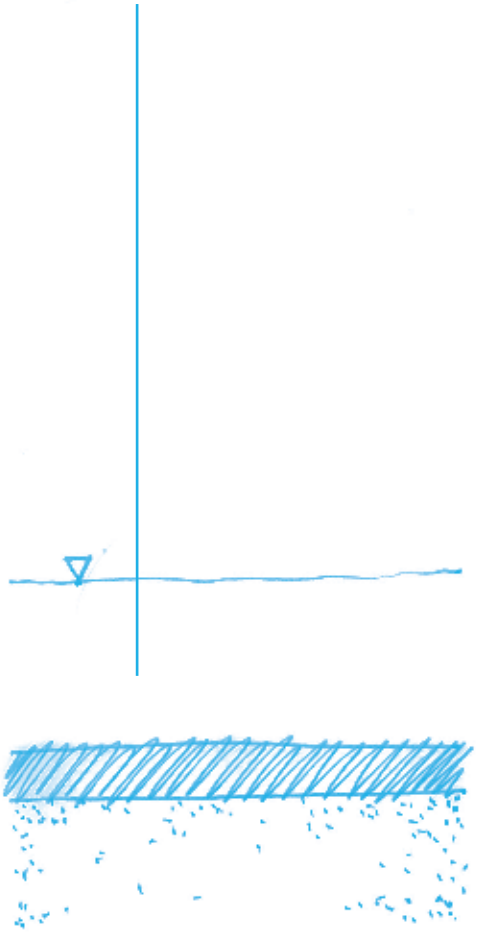
note: consider use of of grasses, sedges, shrubs and trees / hand removal of weeds can further break up filter media surface / additional works may be required if clogging layer is thick

idea (sourced or via): Jack Mullaly – Logan City Council

Efficient Maintenance

Resource Efficient

surface clogging causing water to be permanently ponded - plants drowned



densely replant with aquatic and riparian plants to breakup surface clogging and lower water level

Surface Ponding

application: bioretention systems with surface blinding

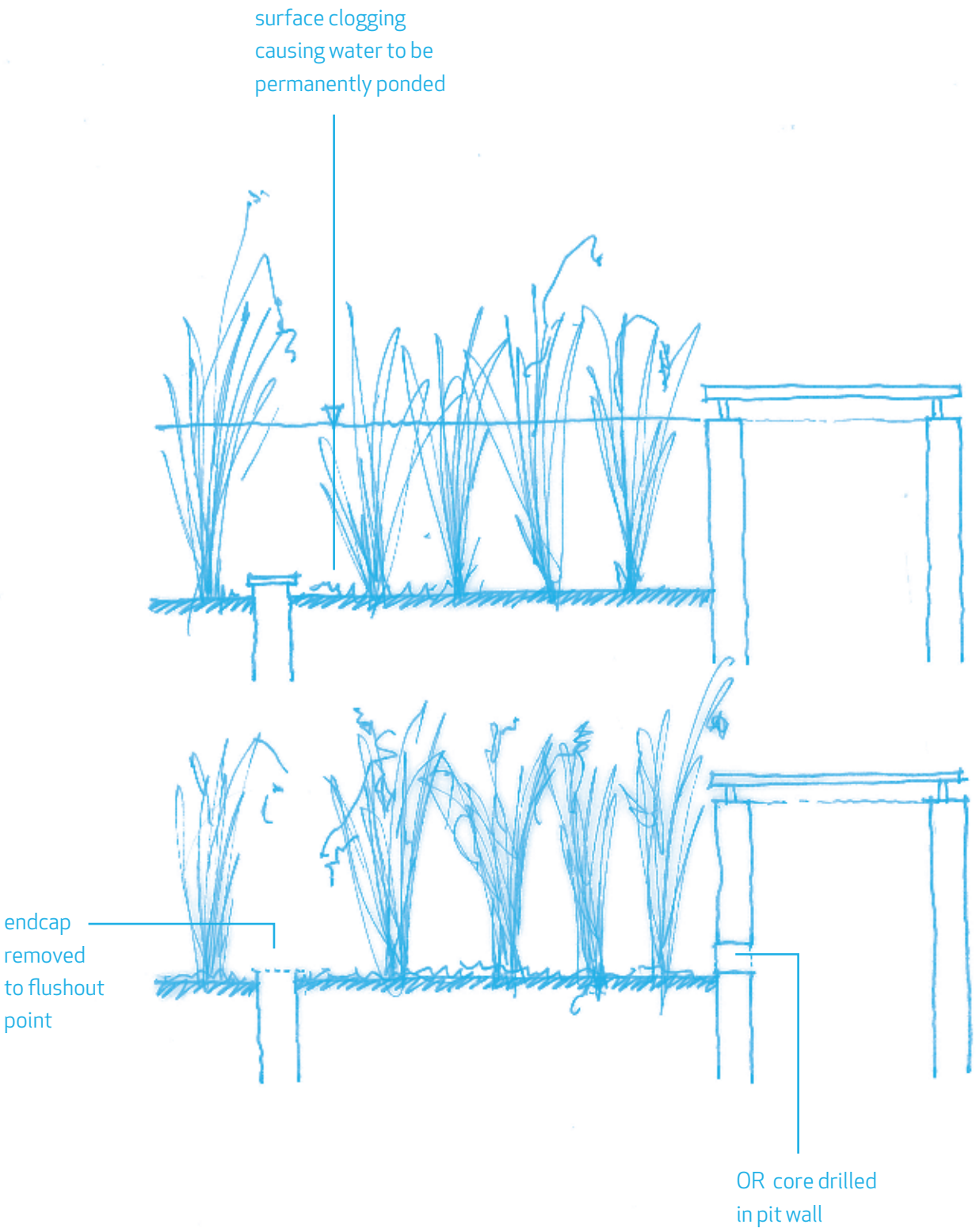
advantage:

- low cost rectification
- maintain plant health

note: water quality impacts of short circuiting
idea (sourced or via): Jack Mullaly – Logan City Council

Efficient Maintenance

Resource Efficient


surface clogging causing water to be permanently ponded
endcap removed to flushout point
OR core drilled in pit wall

Subsurface Ponding

application: bioretention systems with ponding

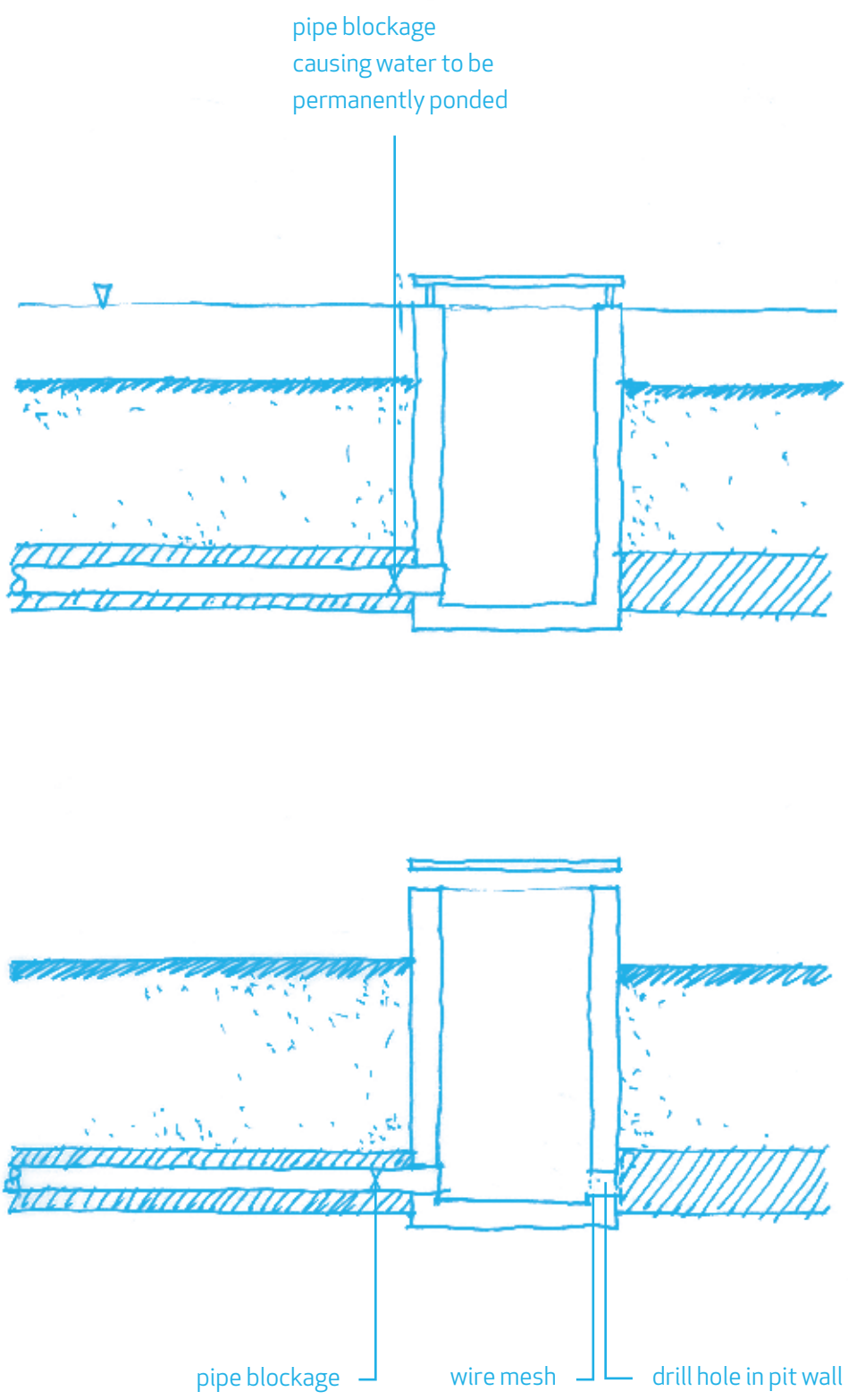
advantage:

- low cost rectification

note: short circuiting
idea (sourced or via): Jack Mullaly

Efficient Maintenance

Resource Efficient


pipe blockage
causing water to be
permanently ponded
pipe blockage
wire mesh
drill hole in pit wall

In our efforts to move towards long-term sustainabilty, our choice of materials needs to consider environmental impact, renewability and energy inputs.

Material Sustainability

Material Sustainability

Materials selection is often a balance of competing benefits and disadvantages as well as consideration of costs and functionality. Sustainable design should seek to protect receiving ecosystems while reducing regional water demands for irrigation. The sourcing of locally available filter media and plant species is also of importance to reduce transportation and support local provenance species.

Material Sustainability

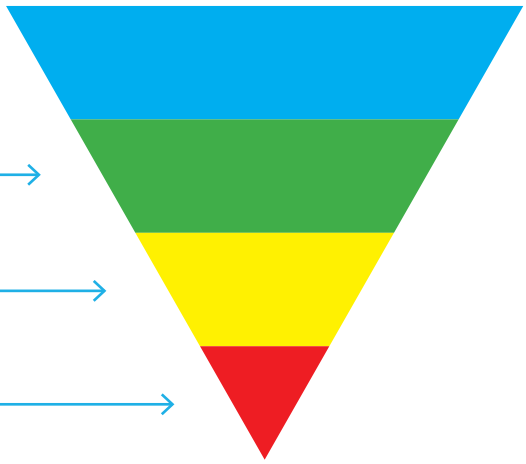
Broad principles for sustainable selection of materials are outlined below:

Avoid

Reduce

Reuse

Recycle



Low impact
- low energy / carbon
- local source
- extraction damage minimised
- non-renewables avoided

Durability – appropriate length of lifecycle

Reasonable costs, functionality and maintenance requirements

Item	Sustainable Options
Earthworks	Reduce – modify cell size, shape and orientation to minimise earthworks volume (e.g. align long axis of basin parallel with contours) Reduce import / export - balance earthworks on site to avoid extra cut and fill Low impact – limit area of disturbance Low impact – avoid exposure of PASS, AASS and sodic soils
Drainage aggregate	Low impact – avoid extraction from rivers or creeks Durability – non degrading Substitution – use washed recycled concrete
Filter media	Local sourcing Low impact extraction Durability – non degrading
Transition layer	Avoid – through careful selection of drainage and filtermedia satisfying the bridging criteria Local sourcing Low impact extraction Substitution – use an appropriate recycled crushed glass product
Underdrainage pipes	Avoid – can an infiltration basin be used? Reuse – offcuts, abandoned pipes Recycle – use recycled plastic
Inlet / outlet pipes	Reduce – encourage upstream infiltration (where appropriate) to reduce pipe size Reduce – optimise hydraulics to reduce pipe size, use at-source bioretention on flat sites Low carbon – low embodied energy for plastic pipes Low carbon – use fly ash cement for RCP
Topsoil for batters	Reuse – Save and reuse topsoil layer from site Local sourcing – if insitu soil not suitable Low impact – free of weeds / fireants

Item	Sustainable Options
Liner	Avoid – can this be eliminated from the design Substitute – can insitu clay be used instead of plastic
Concrete Weirs	Reduce – optimise hydraulics to reduce weir length Substitute – can rock protection be used instead Substitute – low carbon fly ash cement
Concrete Pits	Reduce – optimise hydraulics to reduce pit size Substitute – low carbon fly ash cement
Headwalls	Substitute – can rock armouring be used instead? Substitute – low carbon fly ash cement or recycled plastic
Sediment forebay	Avoid or reduce – through careful design Substitute – low carbon fly ash cement
Access Tracks	Reduce – through careful design Substitute – use reinforced turf / garden (gravel base + topsoil + low groundcover)
Retaining Walls	Avoid – through careful design Substitute – use boulder walls, low impact extraction, local sourcing Substitute – use low carbon fly ash cement
Rock Protection	Avoid – can velocities be reduced to avoid need? Low impact – Avoid extraction from rivers or creeks Avoid material that could pollute or change the pH of the water (e.g. AMD)
Plants	Local provenance – grown from local seed by local growers Organic – grown without pesticides and artificial fertilizers Durability – use hardy plants to limit dieoff and replanting Multiuse – carbon sequestration, productive landscapes, biodiverse, fauna friendly
Irrigation Water	Avoid – timing of establishment period with seasonal rain Avoid – use drought tolerant plant species Substitute - use suitable alternative water source Low impact – minimise release of pollutants to environment

Filter Media Layering

application: alternatives to standard profile

advantage:

- less resource consumption
- reduce filter media costs

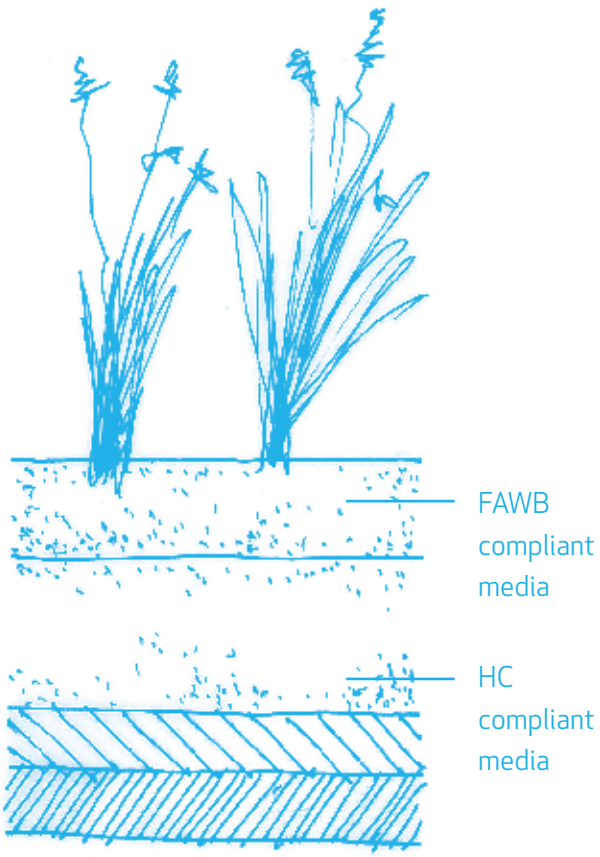
Alernative Profile 1
note: use only if hydraulic conductivity (HC) unaffected & plants can completely establish (root depth may be shortened)
idea (sourced or via): Southern Pacific Sands

Alernative Profile 2
note: use only if bridging criteria is satisfied
idea (sourced or via): River Sands

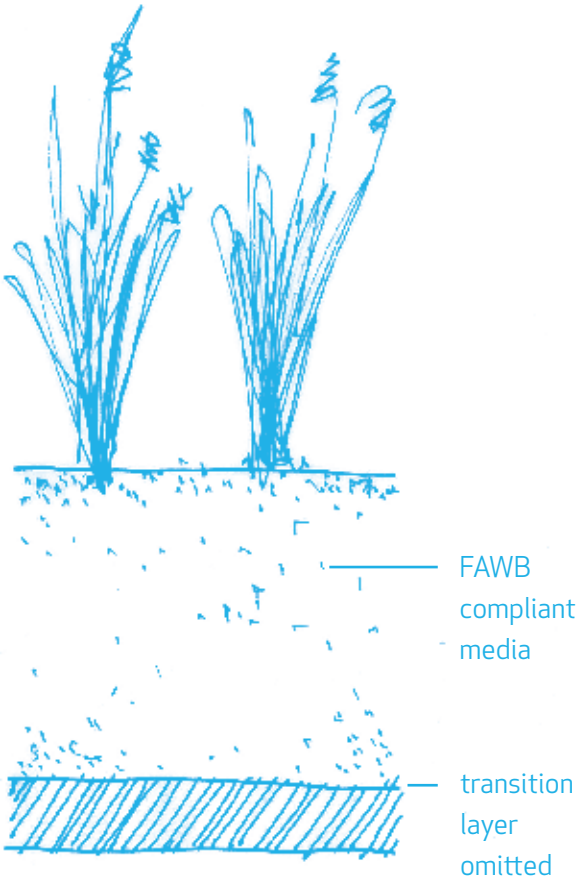
Material Sustainability

Resource Efficient

ALTERNATIVE PROFILE 1



ALTERNATIVE PROFILE 2



Filter Media Additives

application: to enhance filter media properties

advantage:

- improved plant establishment

idea (sourced or via): Sally Boer - E2Designlab and Simon Leake - SESL

Material Sustainability

Low nutrient organic matter:

- Composted garden waste
- Composted pine bark
- Coconut coir
- Composted wood chip fines
- Sugar cane bagasse
- Composted saw dust

Mineral additives:

- Diatomaceous earth
- Zeolites
- Scoria
- Perlite
- Power station ash
- Crushed brick and tile

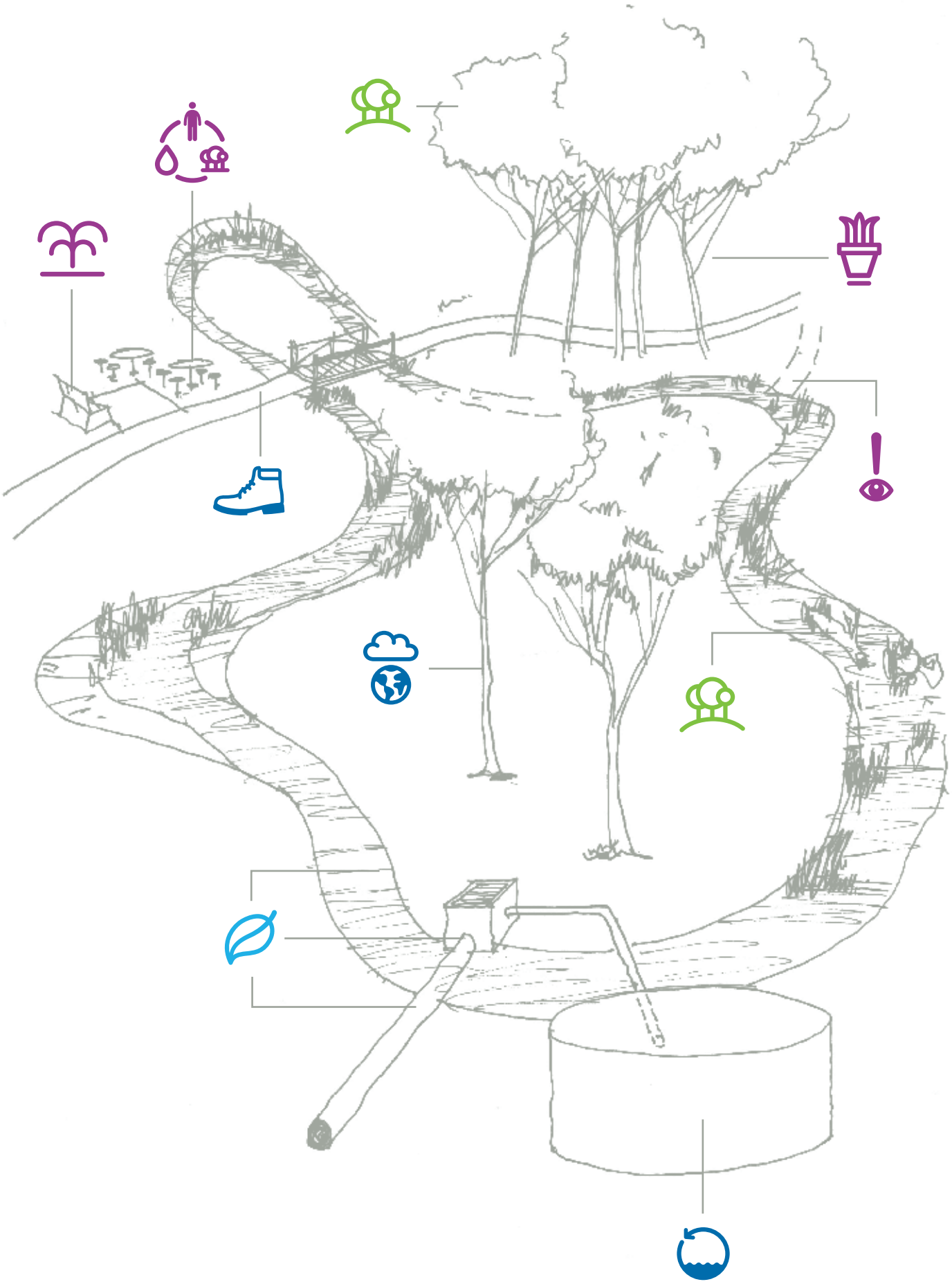
Other additives to support plant establishment:

- Water retention polymers (water holding crystals) (1-2% by weight)
- Slow release fertiliser (10g/plant)
- Silica, calcined clay and cellulose based water holding agents.

How Does Your System Rate?

Discover the new Living Waterways scoring system at **www.waterbydesign.com.au**

Submit your own ideas at **info@waterbydesign.com.au**




Healthy
Waterways
ONE CLEAR VISION


Australian Government