

Water for All Conserve, Value, Enjoy



Active, Beautiful, Clean Waters Programme

ABC Waters at Potong Pasir – A Case Study



Agenda

1. Introduction – Liu Huei Lyn (PUB)

- ABC Waters Programme
- 3P Partnership – Adopters of ABC Waters at Potong Pasir
- Overview of Site at Potong Pasir – Kallang River

2. Design Concept, Engineering Requirements & Lessons Learnt - Kenneth Hew (Worley Parsons)

- Concept Overview & Key Features
- Environmental & Hydrology
- ABC Waters Design Features
- Site Constraints & Lessons Learnt

3. Construction & Maintenance of ABC Waters Design Features - Luke Lee (Nature Landscapes)

- Pre-construction
- Construction step-by-step
- Maintenance



ACTIVE

- New recreational and community spaces



ACTIVE

- New recreational and community spaces

BEAUTIFUL

- Integrating waterbodies and waterways with their urban landscape



ACTIVE

- New recreational and community spaces

BEAUTIFUL

- Integrating waterbodies and waterways with their urban landscape

CLEAN

- Improving water quality



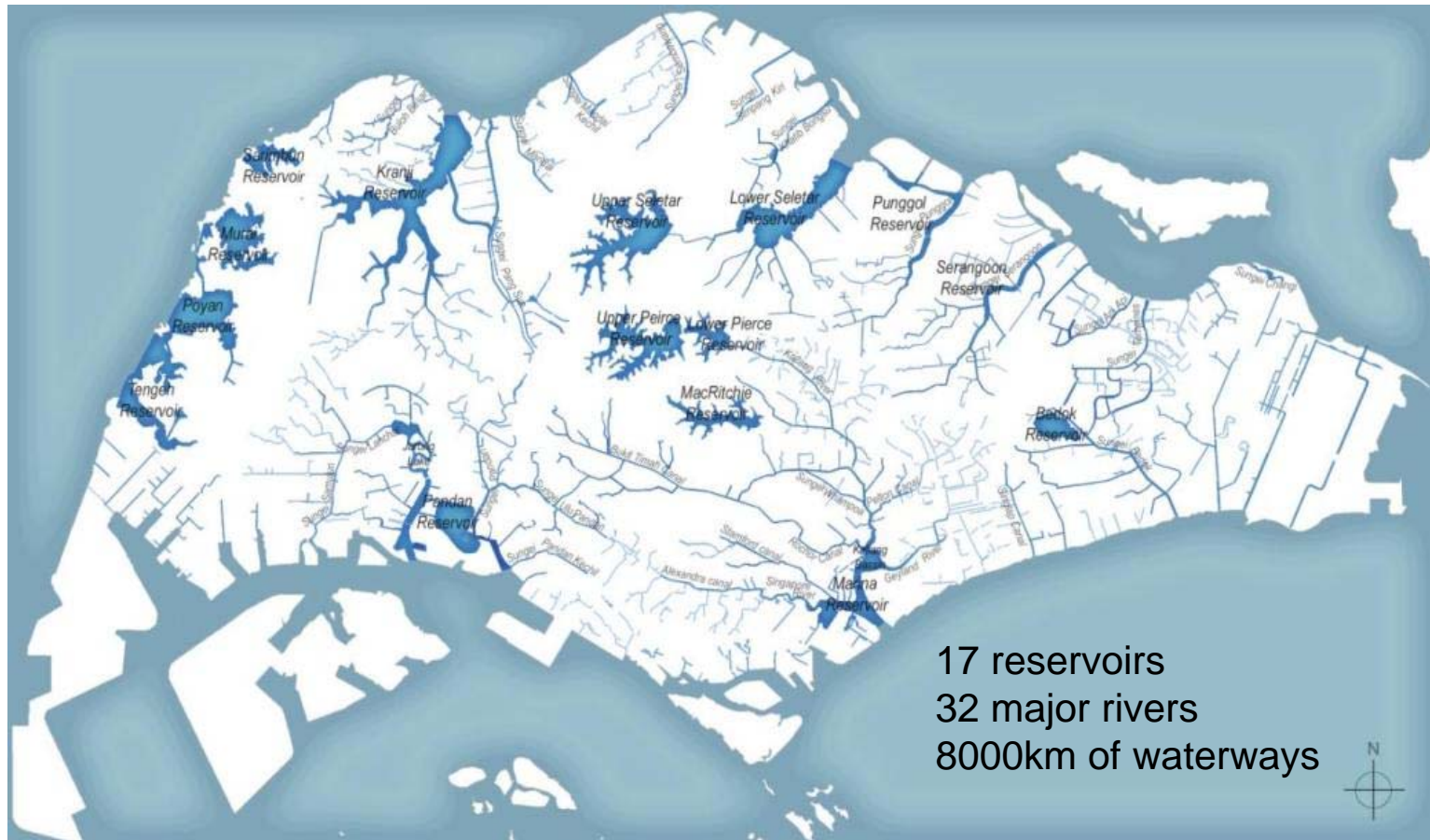
ABC Waters Programme



3 key strategies:

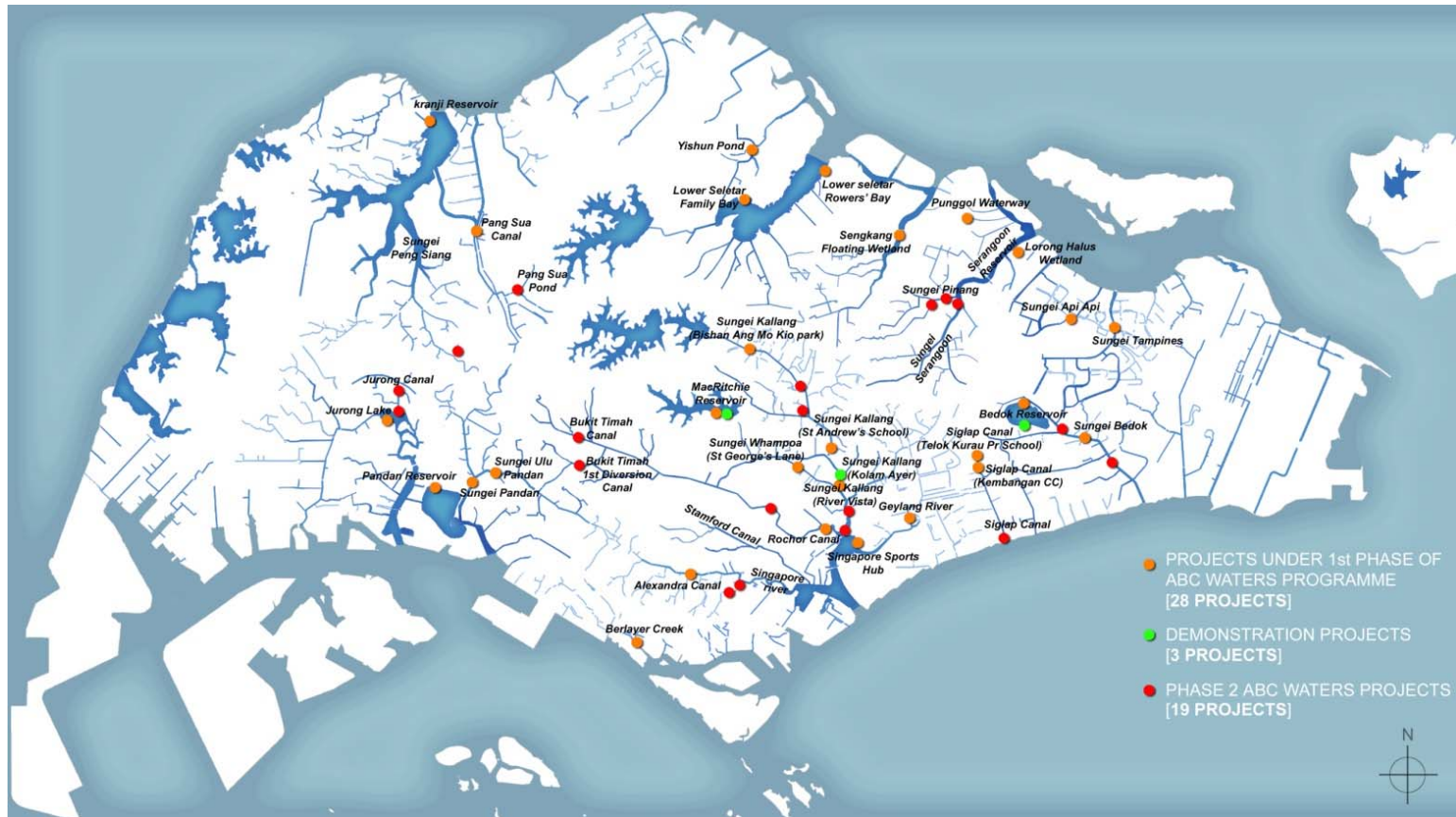
1. Development of ABC Waters Masterplan
 - Implementing 28 projects in Phase 1
 - Implementing 19 projects in Phase 2
2. Promoting adoption of ABC Waters concept
 - Getting the public agencies & private developers to incorporate ABC Waters Design in their projects
3. 3P Partnership Approach
 - Getting community to take ownership of the projects

The Blue Map of Singapore



ABC Waters Programme

The Blue Map with projects islandwide



3P Partnership Approach People Public Private

- Participation in the design process



- Familiarisation Tours

Friends of Water Stewards

To recognise, inspire and encourage community stewardship of Singapore's water resources. 200 of the 267 Friends of Water have adopted ABC Waters sites.



Bishan North Watch Group



Friends of Kallang River @ Bishan-AMK Park



**St. Andrews Secondary School planting of Rain garden
ABC Waters at Potong Pasir**



**Sony and Commonwealth Sec Sch launching
Floating wetlands into Pandan Reservoir**

ABC Waters Learning Trail

Targeted at secondary school students, educating them about water related issues and encouraging them to conserve water, keep our waterways clean and adopt water safety habits



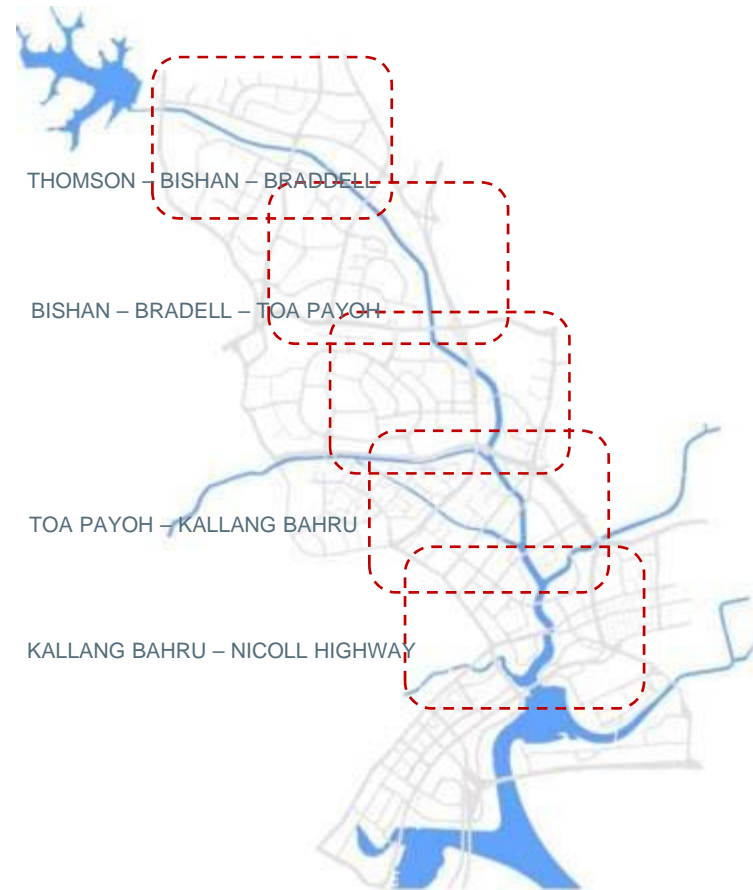
St Andrew's Village



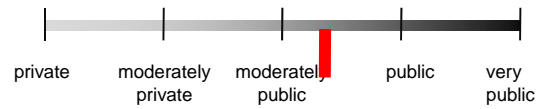
- Friends of Water since 2005
- St Andrew's Junior School
Site visits to Kallang River
- St Andrew's Secondary
Regular Clean Ups at Kallang River
River Studies into Science curriculum
Water Quality tests for Geography students
- St Andrews Junior College
Regular Clean Ups at Kallang River
- Developing a community learning trail at
ABC Waters @ Kallang River (Potong Pasir)



Kallang River



Kallang River



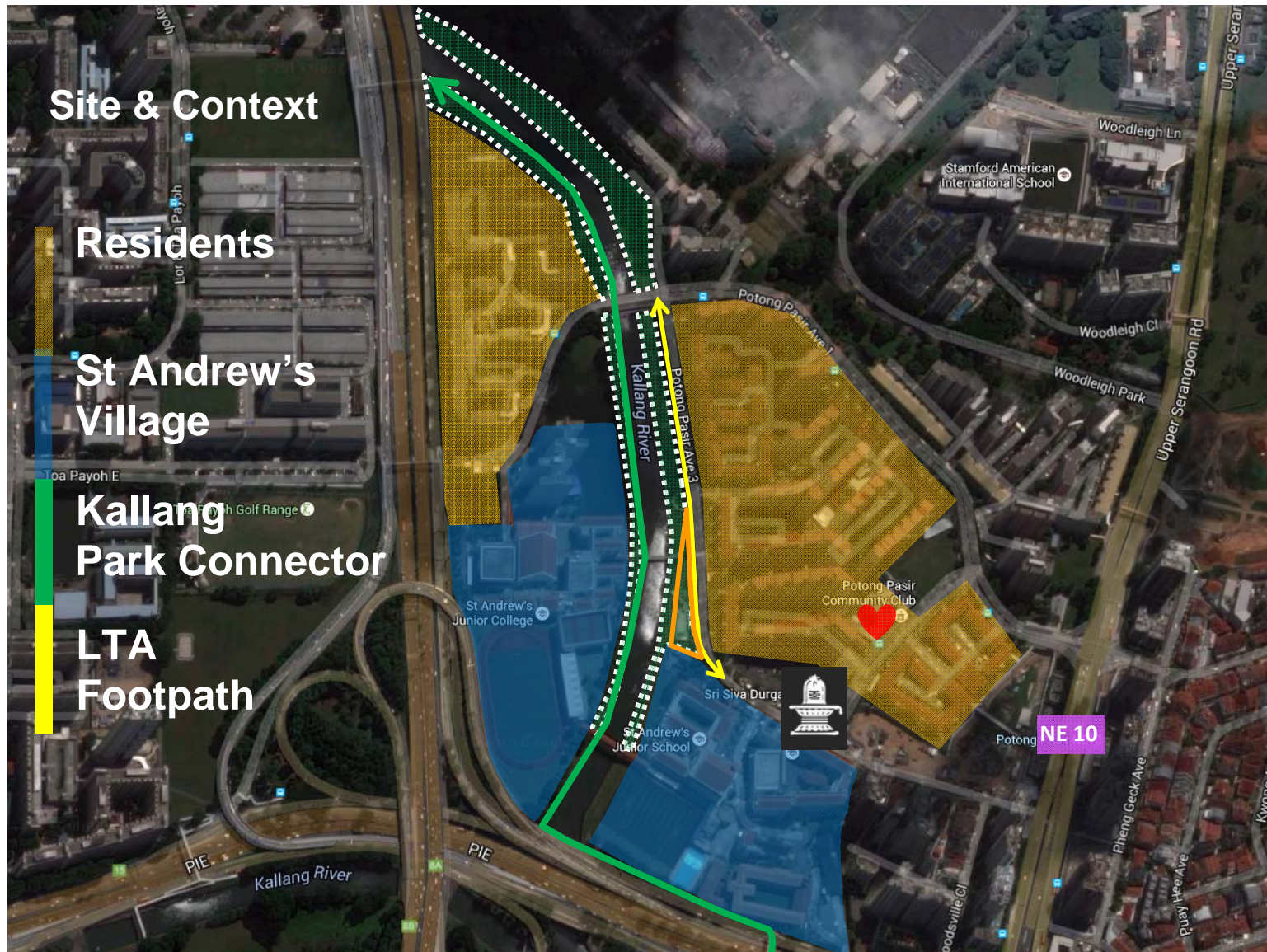
Areas immediately adjacent to /
fronting river:

>50% residential

>30% educational

Mid-scale – river width: 27-35 m





Community Engagement

Bringing people
closer to the water

Community
Open Space

Education
ABC Waters
Design Features



Site Photos



Site Photos



Overview of Project & Concept



- 1 - OPEN PLAZA WITH SEATS (1)
- 2 - CANOPY WITH SEATS (2)
- 3 - ENTRANCE (10)
- 4 - LOOK-OUT DECK (4)
- 5 - GABION WALL (4)

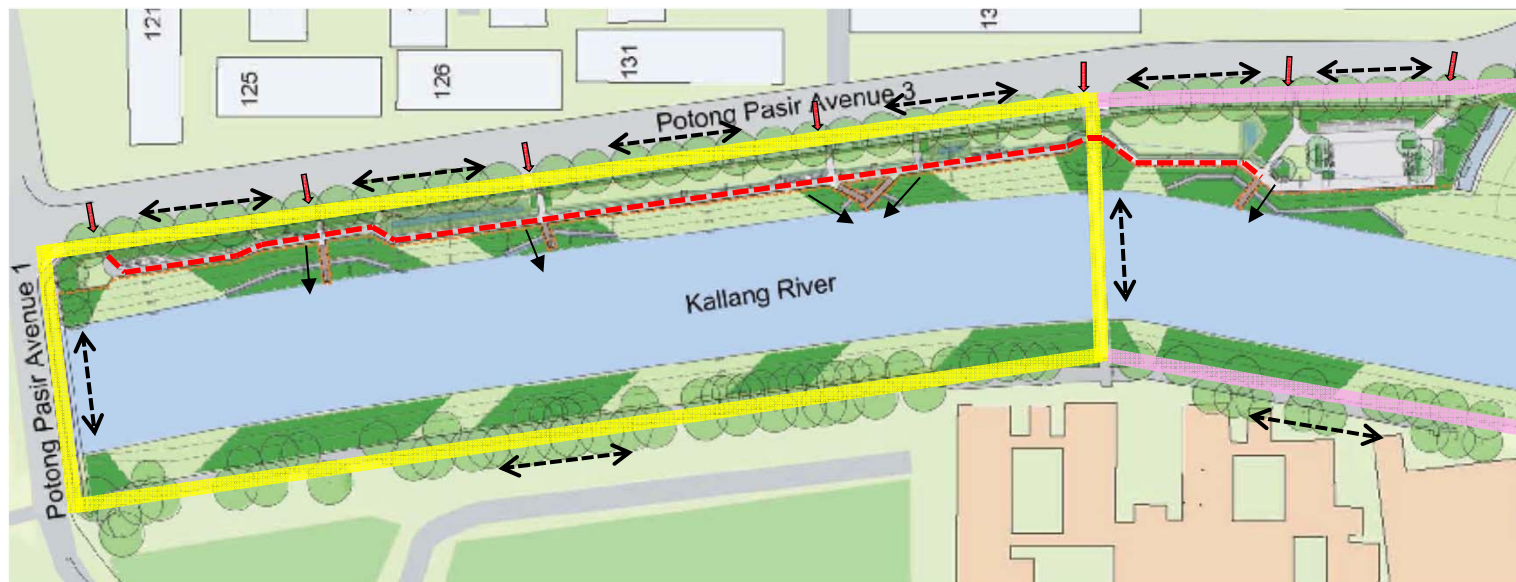
- 6 - RAIN GARDEN (3)
- 7 - FOOTPATH WITH SAFETY RAILING (1)
- 8 - REST AREA WITH SEATS (5)
- 9 - VEGETATED SWALES (5)






Design Concept



- 1) Concept provides the community a waterside park experience with a good balance between hard and soft scapes.
- 2) Plaza area encourages interaction within the community, community activities and students activities.
- 3) Footpath provided allows a through public access and circulation along the waterway.
- 4) Look-out decks encourages community to be closer to the waterway.
- 6) Gabions walls provide a rustic and natural outlook of the waterway.
- 7) Plants of various outlook, colour and functions are planted along the river banks enhances the natural beauty of the waterway
- 8) Rain gardens and vegetated swales collects, treat and convey the surface runoff before discharging into the waterway.

Access & Circulation



-  All-round circulation path
-  Dual-way access
-  Entrance to footpath
-  Footpath
-  Look-out deck

Water Levels

Flow profiles along affected Kallang River

- 1) Parameters assumed in flow profile analysis:
 - Q = ranges from 300 m³/s to 600 m³/s
 - Tailwater at downstream ranges from $Q = 300$ m³/s and $Q = 600$ m³/s
 - Manning n of lined main channel = 0.015
 - Manning n of un-lined banks = 0.035
- 2) The proposed ABC features along the affected section of Kallang river has insignificant effect on the flow back-up along the river. This is mainly because the proposed features are located outside the main waterway where the bulk of flood flow is conveyed.
- 3) Flow velocity along the banks could reach 0.76 m/s during peak flood flow of 600 m³/s

Environmental & Hydrology

Water quality improvement

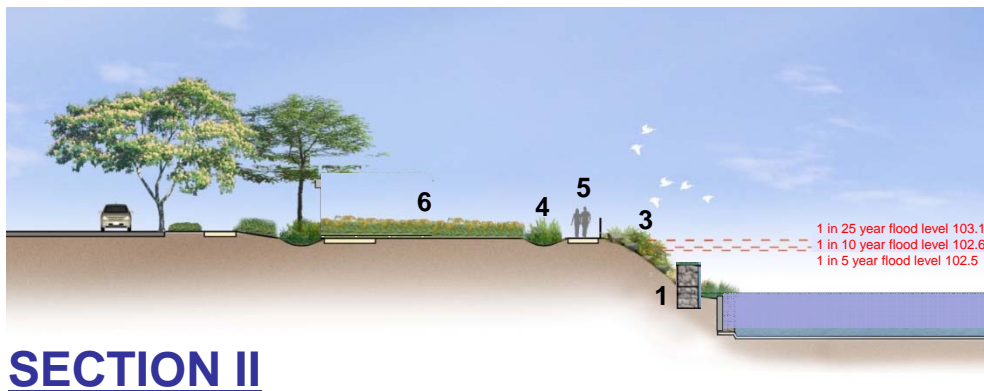
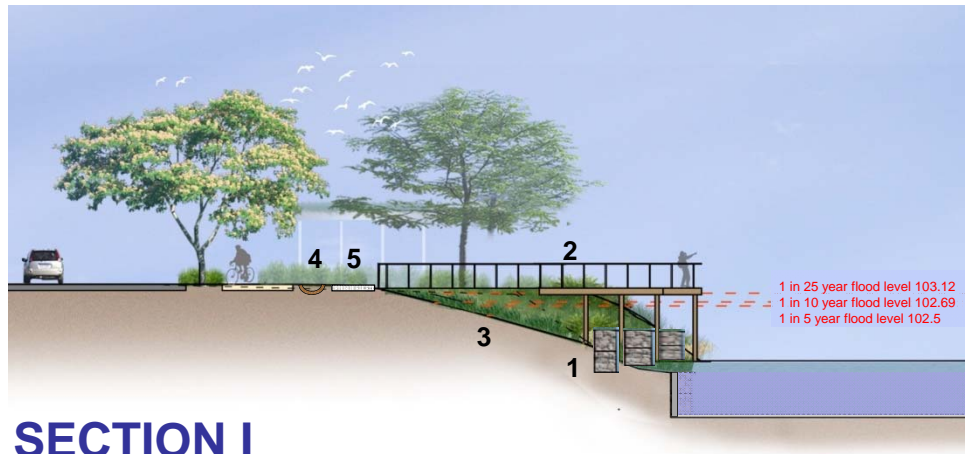
Treatment of storm water runoff is provided by passing water through the rain gardens prior to discharge.

Nutrient & Metalloid uptake is carried out by water edge plantings.

Bio-engineered banks

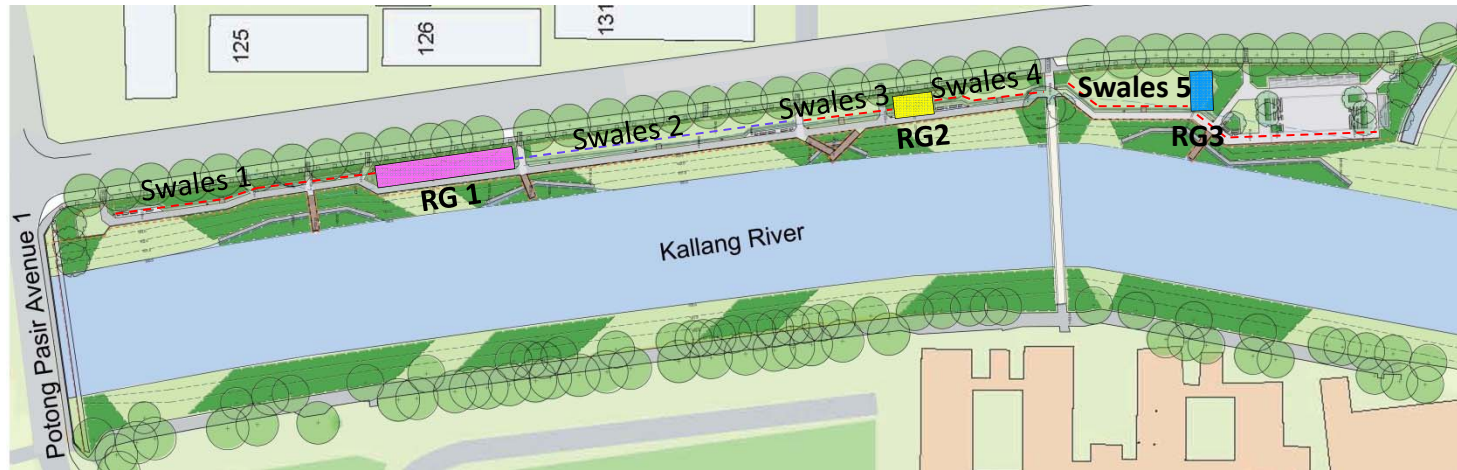
Gabion walls with layers of brush planting provided along the slopes of waterway.

Sections



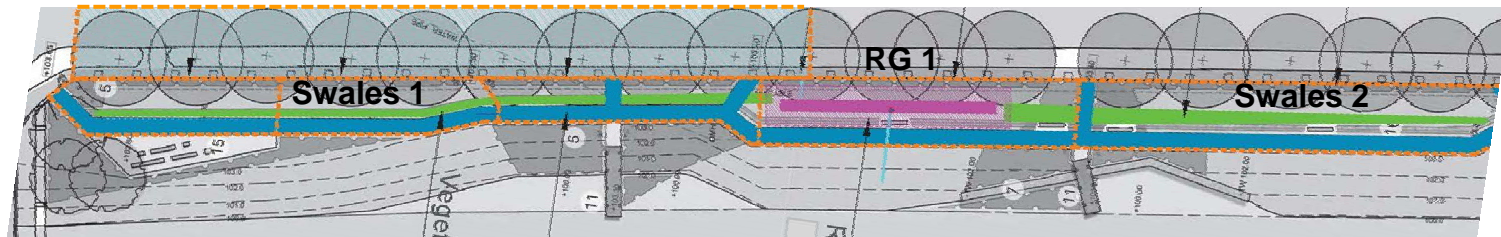
1. Gabions
2. Look-out Deck
3. Bioengineered bank with wetland planting
4. Vegetated swales leading to rain gardens
5. Footpath
6. Softscape planting

ABC Waters Design Features – Swales & Raingardens

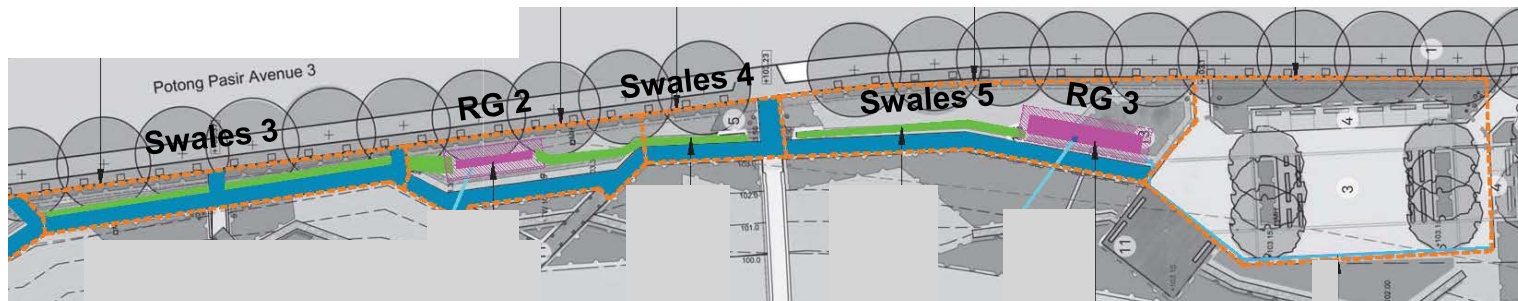


Site Plan

ABC Waters Design Features – Swales & Raingardens



Runoff Catchment plan (1)



Runoff Catchment plan (2)



ABC Waters Design Features – Swales & Raingardens

Design Methodology

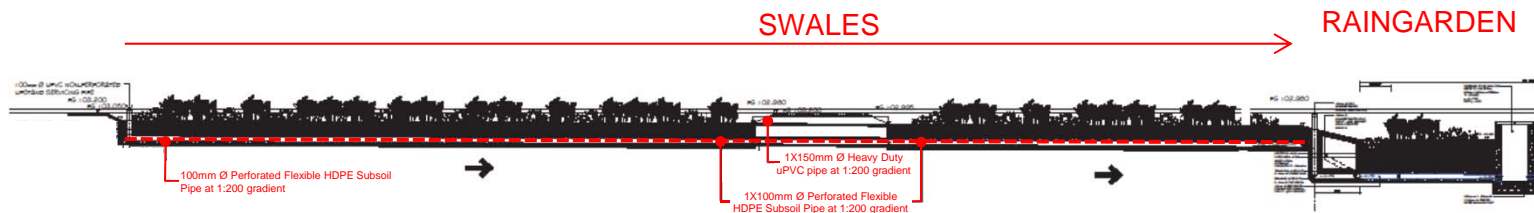
- The 3 rain gardens installed will treat storm water runoff within the site catchments and water from the nearby roadside drain to improve the quality of water within the wider catchment.
- Design assumptions for the Raingarden 1 :-
 - a) 3 month ARI with 10mins time of concentration : 72mm/hr
 - b) Max filtration rate : 3.2L/s
 - c) The extended detention depth in Rain Garden : 300mm
 - d) The ratio of treatment surface area to impervious area : 3%
 - e) Filter media saturated hydraulic conductivity : 180 mm/hr
 - f) Filter Media Depth : 0.6m
 - g) The expected pollutant reductions are 88%, 75% and 46% for Total Suspended Solid, Total Phosphorus and Total Nitrogen respectively.
 - h) Discharge pipe size : 150mm dia

ABC Waters Design Features – Swales & Raingardens

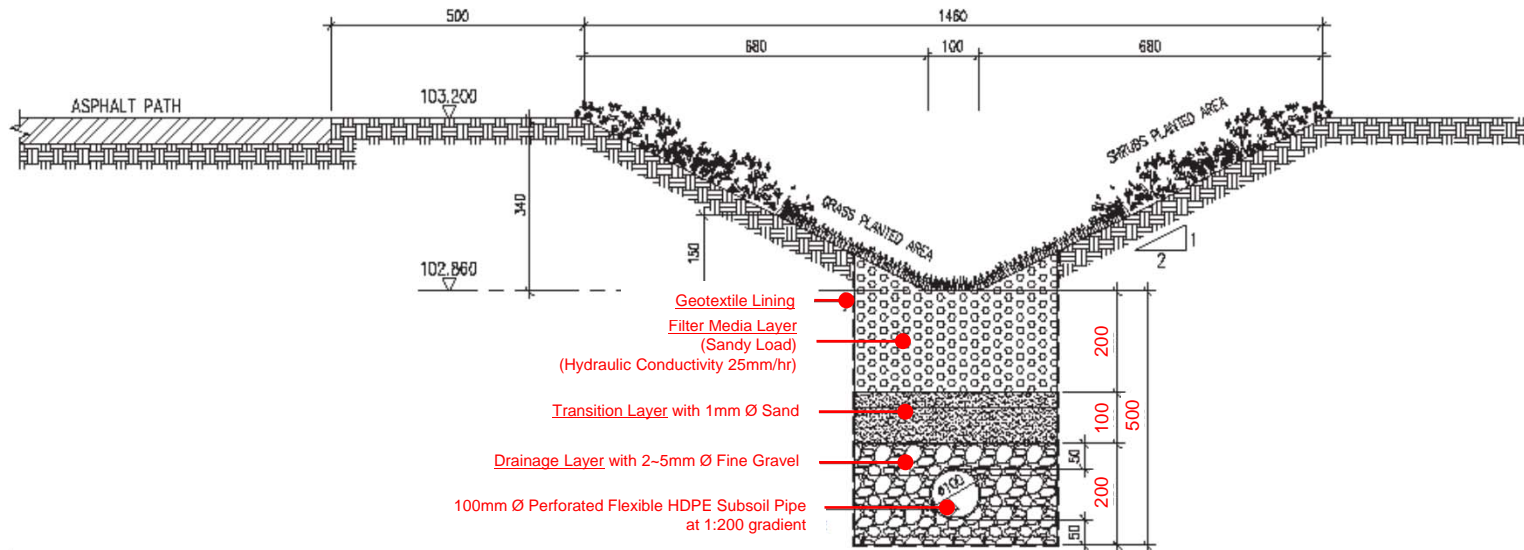
Design Methodology

- Design assumptions for the Vegetated Swales :-
 - a) Side slope of the swale : 1 in 2
 - b) Longitudinal Slope : 1 in 200
 - c) Base width of the swale : 100mm
 - d) Maximum vegetation height : 100mm
 - e) Manning's n : 0.04

ABC Waters Design Features – Swales & Raingardens

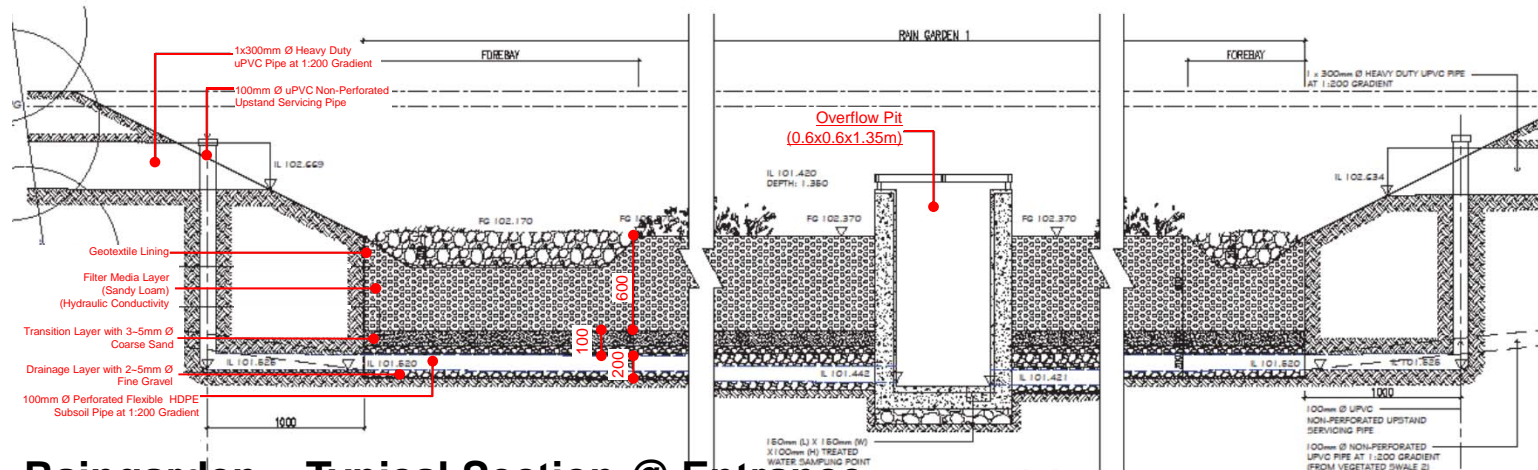


Swale – Typical Longitudinal Section

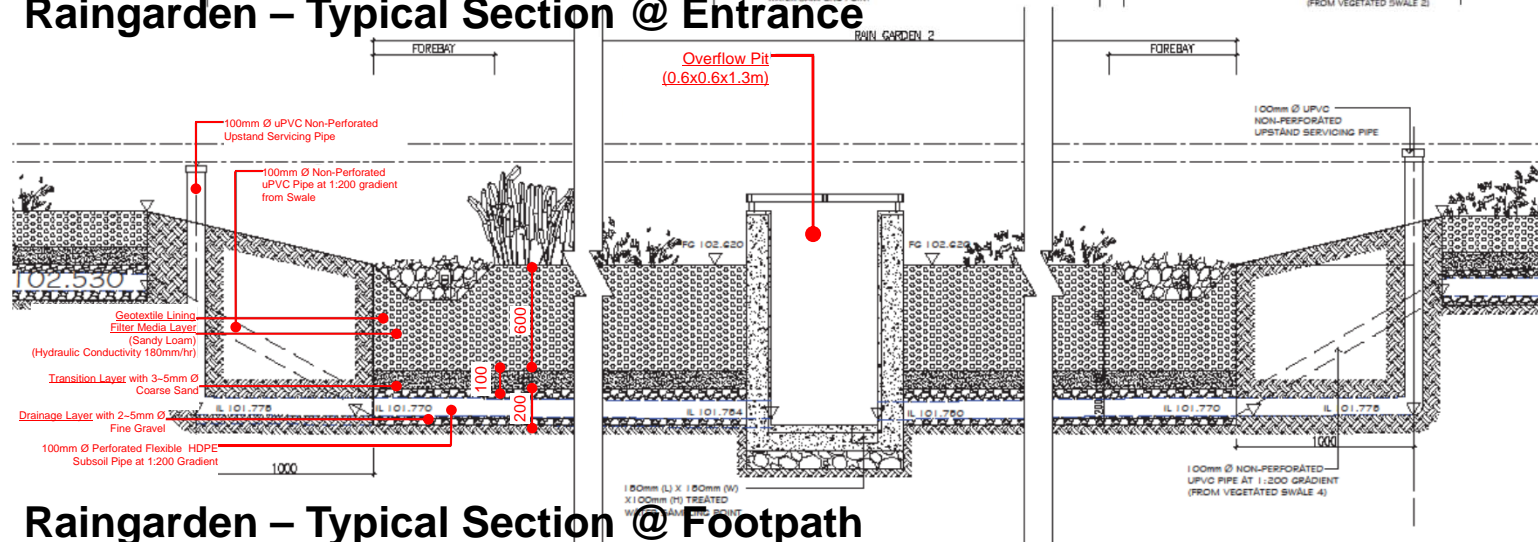


Swale – Typical Cross Section

ABC Waters Design Features – Swales & Raingardens

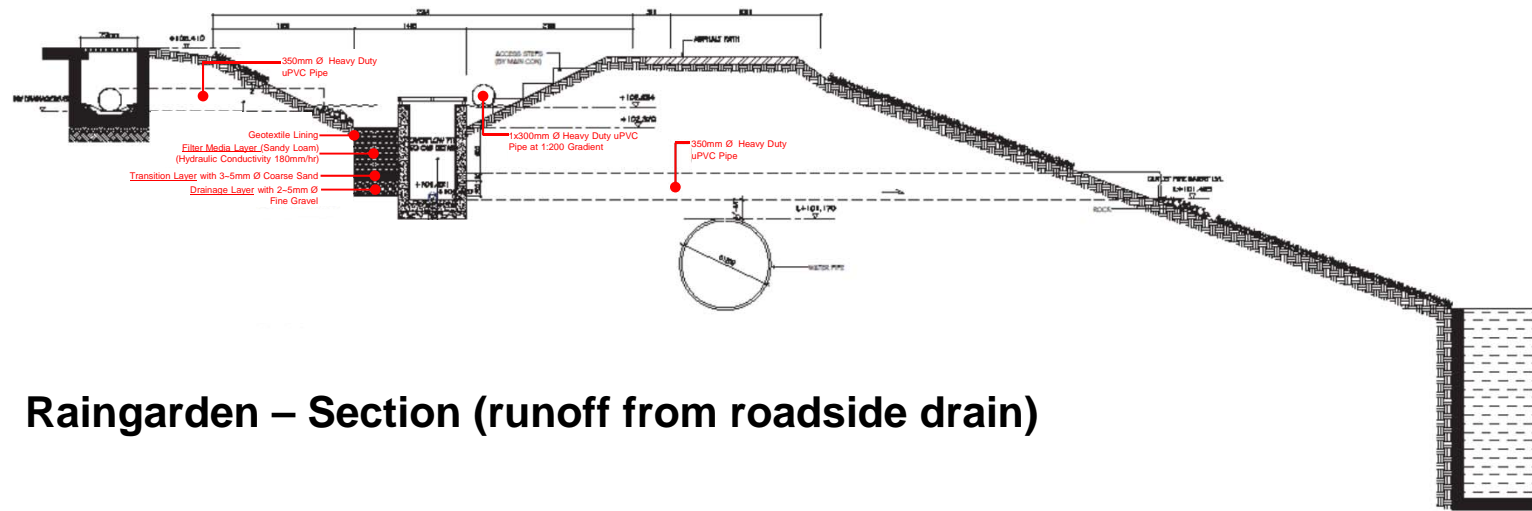


Raingarden – Typical Section @ Entrance



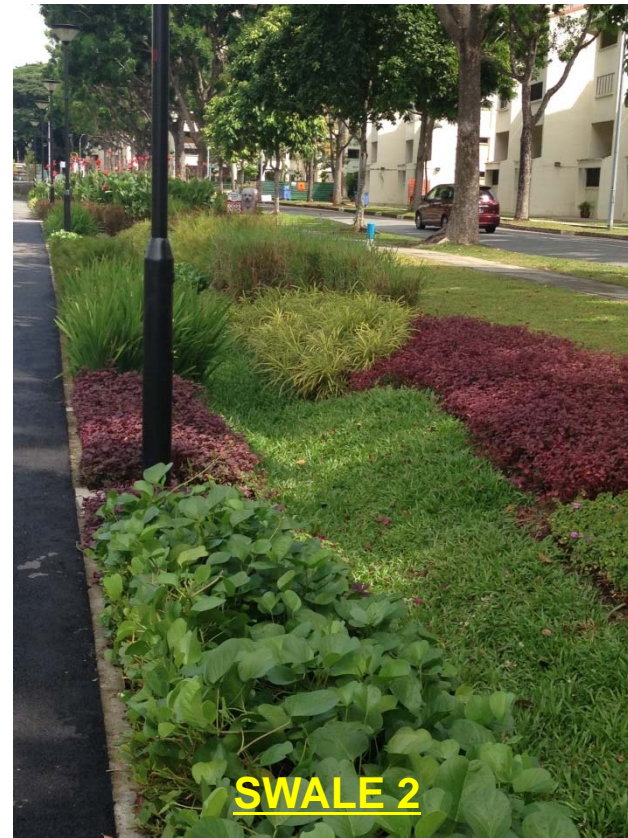
Raingarden – Typical Section @ Footpath

ABC Waters Design Features – Swales & Raingardens



Raingarden – Section (runoff from roadside drain)

ABC Waters Design Features – Swales & Raingardens

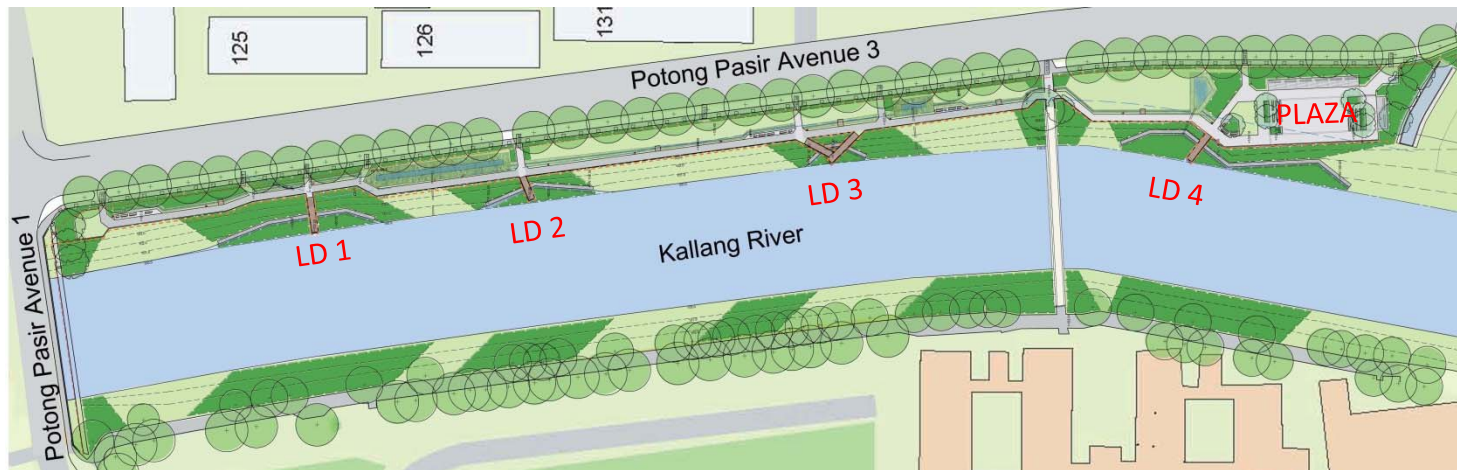




ABC Waters Design Features – Swales & Raingardens



ABC Waters Design Features – Look-out Decks & Plaza



Site Plan





OPEN PLAZA

ABC Waters Design Features



Landscape Planting







GABION WALLS

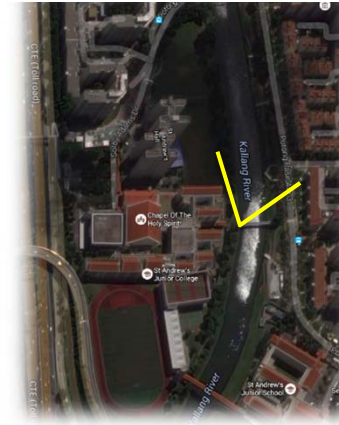


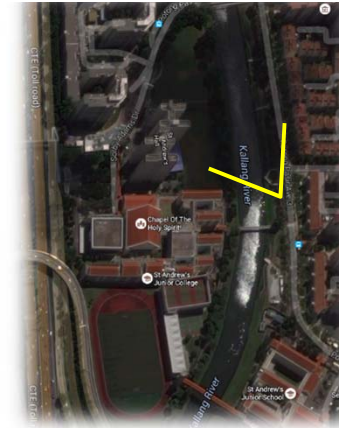
Construction – Site Constraints

- 1) Existing tree roots affecting construction works
- 2) Limited access into site affecting construction sequence
- 3) Existing precast concrete pavers slope protection system affecting planting works
- 4) Difficulty of construction works on existing slope
- 5) Construction works over existing water main

Construction – Lessons Learnt

- 1) Conduct trial trenches, arborist assessment and consultation with NParks during design stage to resolve trees roots issues
- 2) Early consultation with LTA on allowable construction accesses
- 3) Selection of suitable plant species (eg sun or shade loving or wetland plants) based on site conditions
- 4) Closer spacing of plants to ensure a more lush landscape
- 5) Adequate establishment period for plants (min. 3 months)





Construction & Maintenance of ABC Waters Design Features

- 1) Pre-construction
- 2) Construction
- 3) Maintenance

Pre-construction

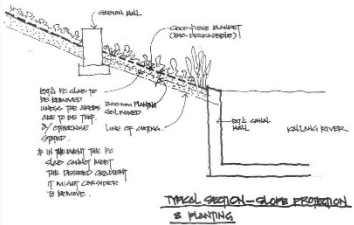

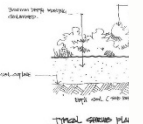

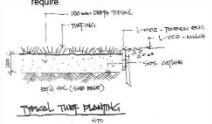
- 1) Shop Drawings/Submission
- 2) Method Statement
- 3) Risk Assessment
- 4) Material submission
- 5) Lab Test
- 6) Procurement
- 7) Programme/Construction sequence

Pre-construction



Shop Drawings/Submission

Pre-construction

<p>PROJECT TITLE: ABC WATERS AT POTONG PASIR (Kallang River/ St. Andrew's School) – R2</p> <p>PROJECT TITLE: ABC WATERS AT POTONG PASIR (Kallang River/ St. Andrew's School) – R2</p> <p>Method Statement of Water Edge Planting</p> <p>Upon completion of water edge profiling work with all planting media;</p> <ol style="list-style-type: none">1. Installation of coco-fibre blanket with stainless steel 'J' pins to stabilized the slope2. Installation of rocks/ boulders edge3. Installation of small tree/ feature shrubs; dig planting pit according to prescribed size and construct a compacted subgrade at root ball zone and backfill with planting soil mix. Once planted, follow by 50mm thick mulch4. Immediate watering new planted small trees/ feature shrubs/ shrubs/ groundcovers5. Installation of shrubs/ aquatic plants in between rocks/ boulders; all root ball to have coco mesh to protect the erosion of root ball due to moving water6. LA to inspect all planting <ul style="list-style-type: none">• Existing PC slab on site to be removed unless those areas to be completed with new turfing and or the existing gradient is not of the desired angle• During soil profiling works, soil erosion silt-screen must be in place at all time to prevent siltation form in existing water body during rain event.• During the installation, photos of each stage will be taken for record• Join inspection with SO at all stages if necessary  <p>NATURE LANDSCAPES PTE LTD 15, JOUR TOWN, #15-17 PIA MARKET, Singapore 368015 Tel: (65) 657 8887 Fax: (65) 657 8887 www.naturelandscapes.com</p> <p>..bringing Nature closer to you!</p> <p>Prepared by Luke Lee</p> 	<p>PROJECT TITLE: ABC WATERS AT POTONG PASIR (Kallang River/ St. Andrew's School) – R2</p> <p>PROJECT TITLE: ABC WATERS AT POTONG PASIR (Kallang River/ St. Andrew's School) – R2</p> <p>CONSTRUCTION</p> <p>PROJECT TITLE: ABC WATERS AT POTONG PASIR (Kallang River/ St. Andrew's School) – R2</p> <p>Method Statement for Installation of Shrubs and Groundcovers</p> <ol style="list-style-type: none">1. Profiling the ground to desired gradient with a minimum 300mm depth cut into existing earth for mass silt-screen and recontouring to minimum 10% down slope cut into existing earth for fit2. Installation of coco-fibre blanket3. Before planting a container if it has become root-bound4. To loosen the roots of a root ball, wherever it5. To avoid excessive settling to the punch in removing a6. To achieve a controlled set<ul style="list-style-type: none">• Tamp the soil as you place• Watering the soil lightly als7. After filling the hole, the soil level, to promote good drainage, the rule of thumb mentioned should be less than that of the base of the shrub's trunk. The resulting poor drainage  <ol style="list-style-type: none">8. LA to inspect all planting• During the installation, photos of each stage will be taken for record• Join inspection with SO at all stages if necessary <p>NATURE LANDSCAPES PTE LTD 15, JOUR TOWN, #15-17 PIA MARKET, Singapore 368015 Tel: (65) 657 8887 Fax: (65) 657 8887 www.naturelandscapes.com</p> <p>..bringing Nature closer to you!</p> <p>Prepared by Luke Lee</p>  <p>NATURE LANDSCAPES PTE LTD 15, JOUR TOWN, #15-17 PIA MARKET, Singapore 368015 Tel: (65) 657 8887 Fax: (65) 657 8887 www.naturelandscapes.com</p> <p>..bringing Nature closer to you!</p> <p>Prepared by Luke Lee</p> 
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Method Statement

Pre-construction

Nature Landscapes Pte Ltd		WSH Form 02-2 Revision: 01 Sheet: Page 1 of 22 Dated:	
Risk Assessment for the (work activity) <u>LANDSCAPING WORKS</u>			

Revision	01	Signature	01	Signature	02	Signature
Date	23/08/2014					
Originated by	Zakaria					
Approved by	Luke Lee					

RISK ASSESSMENT FOR KALLANG ABC WATER PROJECT

Nature Landscapes Pte Ltd		WSH Form 02-2 Revision: 01 Sheet: Page 2 of 22 Dated:	
Risk Assessment for the (work activity) <u>LANDSCAPING WORKS</u>			

Risk Matrices

- Assessment of **Severity** – with the existing risk controls in consideration, each likely severity outcome of the possible injury or ill-health identified: see [Table 1](#)

Severity (S)	Description
(5) Catastrophic	Fatality, fatal diseases or multiple major injuries.
(4) Major	Serious injuries or life-threatening occupational disease (i occupational cancer, acute poisoning).
(3) Moderate	Injury requiring medical treatment or ill-health leading to c dermatitis, deafness, and work-related upper limb disorder
(2) Minor	Injury or ill-health requiring first-aid only (includes minor c
(1) Negligible	Not likely to cause injury or ill-health

- Assessment of **Likelihood** – with the existing risk controls in consideration, each likelihood hazard that may cause the possible injury or ill-health: see [Table 2](#) b

Likelihood (L)	Description
(1) Rare	Not expected to occur but still possible.
(2) Remote	Not likely to occur under normal circumstances.
(3) Occasional	Possible or known to occur.
(4) Frequent	Common occurrence.
(5) Almost Certain	Continual or repeating experience.

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Risk Assessment for the (work activity)

- Risk Matrix** provides the useful framework to classify risks ident

Table 3

Severity (S)	Likelihood (L)				
	(1) Rare	(2) Remote	(3) Occasional	(4) Frequent	(5) Almost Certain
(5) Catastrophic	(5) Medium	(10) Medium	(15) High	(20) High	(25) High
(4) Major	(4) Medium	(8) Medium	(12) Medium	(18) High	(20) High
(3) Moderate	(3) Low	(6) Medium	(9) Medium	(12) Medium	(15) High
(2) Minor	(2) Low	(4) Medium	(6) Medium	(9) Medium	(10) Medium
(1) Negligible	(1) Low	(2) Low	(3) Low	(4) Medium	(5) Medium

[Risk Level: H = High Risk (15 ~ 25), M = Medium Risk (4 ~ 14), L = Low Risk (1 ~ 3)]

- Action for **Risk Level** – the following actions are to be implemented based on the current Risk Level, as shown in [Table 4](#) below.

Table 4

Risk Level	Risk Acceptability	Recommended Actions
Low Risk	Acceptable	<ul style="list-style-type: none"> No additional risk control measures may be needed. Frequent review and monitoring of hazards are required to ensure that the risk level assigned is accurate and does not increase over time.
Medium Risk	Tolerable	<ul style="list-style-type: none"> A careful evaluation of the hazards should be carried out to ensure that the risk level is reduced to as low as reasonably practicable (ALARP) within a defined time period. Interim risk control measures, such as administrative controls or PPE, may be implemented while longer term measures are being established. Management attention is required.
High Risk	Not acceptable	<ul style="list-style-type: none"> High Risk level must be reduced to at least Medium Risk before work commences. There should not be any interim risk control measures. Risk control measures should not be overly dependent on PPE or appliances. If practicable, the hazard should be eliminated before work commences. Management review is required before work commences.

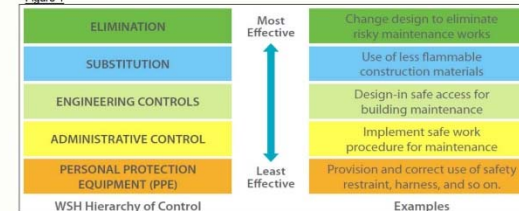
Nature Landscapes Pte Ltd		WSH Form 02-2 Revision: 01 Sheet: Page 4 of 22 Dated:	
Risk Assessment for the (work activity) <u>LANDSCAPING WORKS</u>			

Risk Control

Hierarchy of Control

The control of hazards and reduction of risks can be accomplished by following the WSH Hierarchy of Control (see Figure 1). These control measures are not usually mutually exclusive. Generally, it may be more effective to use multiple control measures, for example, engineering controls work better with administrative controls like training and Safe Work Procedures.

Figure 1



Risk Assessment

Pre-construction



Sample Board



Sieving Test & Report



Material Submission & Test Reports

Pre-construction

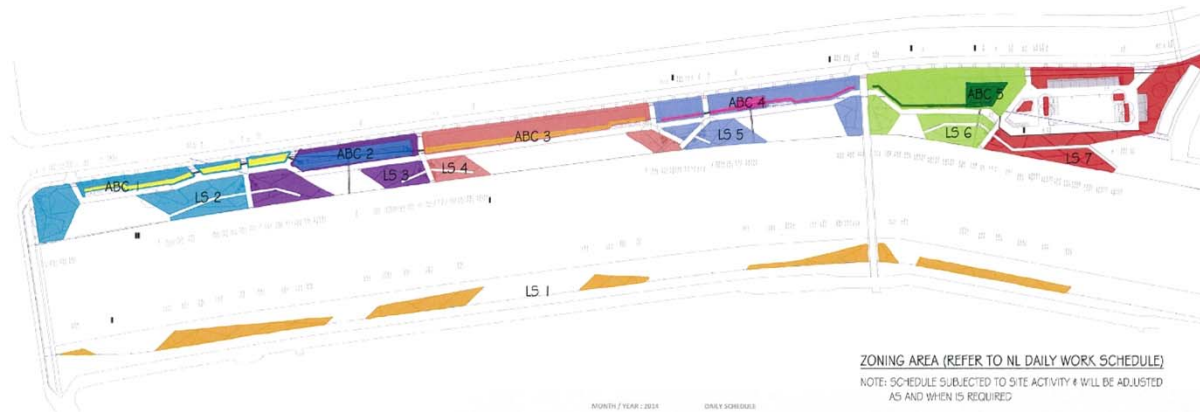
PROJECT TITLE: ABC FEATURE WORKS AT KALLANG RIVER - ST ANDREW'S SCHOOL
REF: G5LE-CL03192118 - LS-R2 CONTRACTOR: SWEE BUILDERS PTE LTD
DATE: 07/11/2014 OWNER: PUB
LANDSCAPE CONSULTANT: NATURE LAN

S/No:	Description	BQ Qty	BQ Unit	Unit Rate		REVISED BQ Qty	BQ Unit	SELECTED		DELIVERY ORDER (AS OF 4 NOV 2014)				NOT YET ARRIVE IN NATURE NURSERY AS OF 4 NOV 2014
				MS	TOTAL BUDGET (RM)			SUPPLIER	COST (RM)	DO	DO DATE	REMAN	REMARKS	
A VEGETATED SWALES														
6.2	Ruellia equisetiformis (Firecracker plant)	762	NOS	3.00	2,286.00	762	NOS	SF	3.50	762	21-Oct-14	OK		
6.3	Dissotis rotundifolia (Spanish show)	762	NOS	1.50	1,143.00	762	NOS	CKK	1.00	762	-	OK		
6.4	Ipomoea pes-caprae (Beach Morning Glory)	762	NOS	2.50	1,905.00	762	NOS	CKK	1.00	762	-	OK		
6.5	Pandanus pygmaeus (Small screw pine)	762	NOS	1.50	1,143.00	762	NOS	SF	1.20			-762	Supplier cannot provide	762
6.6	Cyathula prostrata (Hook weed)	762	NOS	1.20	914.40	762	NOS	SF	1.00			-762	Supplier cannot provide: take CKK purple leaves	762
6.7	Pontederia cordata var lanceolata	762	NOS	30.00	22,860.00	762	NOS	CKK	18.00			-762	CKK no stock, buy from Jakarta	762
6.8	Neomarica longifolia	762	NOS	3.00	2,286.00	762	NOS	SF	1.30			-762	Not yet arrive	762
6.9	Pennisetum setaceum (Rubrum)	762	NOS	4.00	3,048.00	762	NOS	LM	2.50	300	11-Oct-14	-462	Supplier cannot provide the balance (no stock)	462
B RAIN GARDEN														
4.1	Pandanus tectorius	3	NOS	100.00	300.00	3	NOS	LM	45.00	3	11-Oct-14	OK		
4.2	Cyperus alternifolius (Umbrella sedge)	870	NOS	7.00	6,090.00	870	NOS	LM	3.00	870	11-Oct-14	OK		
4.3	Typha angustifolia (Cattail)	870	NOS	10.00	8,700.00	870	NOS	SF	9.00	870	09/11/2014	OK		
4.4	Thalia geniculata (Alligator Flag)	870	NOS	8.00	6,960.00	870	NOS	LM	7.50			-870	Supplier cannot provide: CKK 500 nos	870
4.5	Pandanus pygmaeus (small screw pine)	870	NOS	1.50	1,305.00	870	NOS	SF	1.20	870	28-Oct-14	OK		
4.6	Pennisetum alopecuroides Hakem (Dwarf fountain grass)	870	NOS	4.00	3,480.00	870	NOS	LM	4.50			-870	Supplier cannot provide	870
C TO SUPPLY TREES														
1	Browea coccinea	20	NOS	848.90	12,978.00	11	NOS	SF	150.00	20	21-Oct-14	OK		
2	Coelrus gremus	9	NOS	250.00	2,250.00	9	NOS	SF	140.00	9	21-Oct-14	OK		
D TO SUPPLY RIVER BANK MIX														
1	Hymenocallis speciosa	2103	NOS	1.50	3,154.50	0	NOS	SF	2.50	2020	28/10/2014	2020		
2	Pandanus pygmaeus	1429	NOS	1.50	2,143.50	1656	NOS	SF	1.20	1191	23-Oct-14	-465	SF Supplier cannot provide: only purple, take from CKK	465
3	Ruellia brittoniana dwarf white	804	NOS	3.00	2,412.00	804	NOS	SF	1.50			-804		804
E TO SUPPLY LOW MIX														
1					1.50	4,158.00	0	NOS	SF	1.00	2770	26/10/2014	2770	
2					1.00	3,585.00	3070	NOS	CKK	1.00	3070	-	OK	
3					3.00	4,847.80	2904	NOS	SF	3.50	730	23-Oct-14	-2184	SF
4					3.00	13,962.00	2908	NOS	SF	2.50			-3908	Supplier cannot provide
5					6.00	4,440.00	1075	NOS	SF	2.80	615	21-Oct-14	-460	SF
6					4.50	5,751.00	1124	NOS	CKK	1.00	1124	-	OK	
7					6.00	7,050.00	849	NOS	SF	2.80	850	28-Oct-14	110	
8					5.00	185.00	11	NOS	LM	2.40	11	11-Oct-14	OK	
9					8.00	80.00	10	NOS	LM	8.50	10	11-Oct-14	OK	
10					5.00	150.00	10	NOS	LM	8.50			-10	Supplier cannot provide
11					4.00	84.00	758	NOS	LM	2.20			-758	Supplier cannot provide
12					6.00	72.00	12	NOS	SF	2.80			-12	take from CKK \$1
13					0.00	2,100.00	14	NOS	LM	85.00	14	11-Oct-14	OK	
14					0.00	180.00	6	NOS	SF	28.00	6	21-Oct-14	OK	
15					8.00	10,575.00	908	NOS	SF	4.50			-908	Supplier cannot provide
16					6.50	591.55	82	NOS	LM	6.50	91	11-Oct-14	9	
17					5.00	425.00	78	NOS	to change				-78	Supplier cannot provide
18					6.00	7,050.00	864	NOS	LM	4.50	1175	11-Oct-14	311	
19					3.00	2,280.00	786	NOS	LM	3.20	788	11-Oct-14	-20	Propagation
20					5.00	1,710.00	1135	NOS	LM	2.20			-1135	Supplier cannot provide

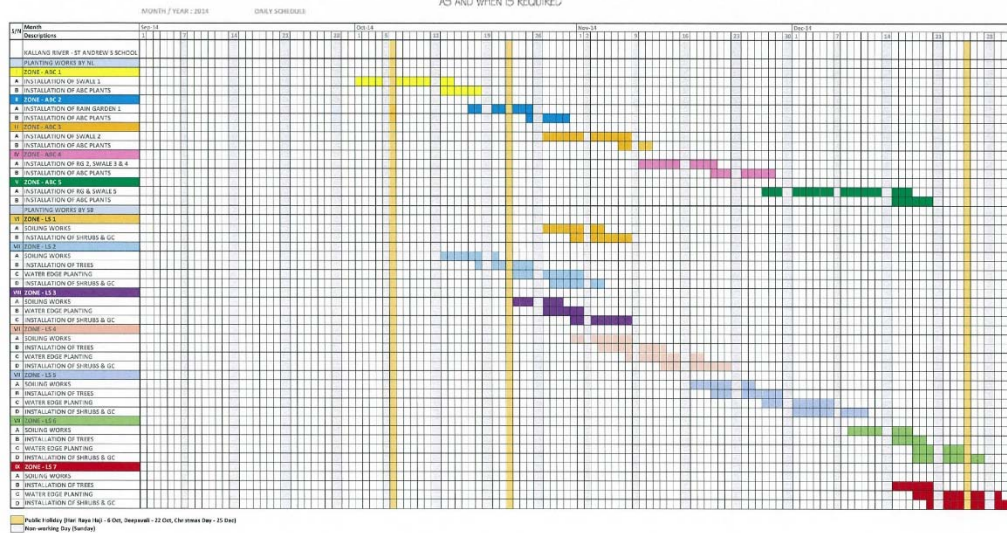
No	DESCRIPTION	FINAL CONCLUSION (NOS)									
	LOCATION	RG1	RG2	RG3	S1	S2	S3	S4	S5	TOTAL	
	SWALE	NOS									
1	Axonopus compressus										
2	Cyathula prostrata				82	279	52	143	206	762	
3	Dissotis rotundifolia				144	106	22	144	346	762	
4	Ipomoea pes-caprae				121	211	103	136	191	762	
5	Neomarica longifolia				256	282		202	22	762	
6	Pandanus pygmaeus				80	348	156	156	22	762	
7	Pennisetum setaceum Rubrum				148	325	77	100	112	762	
8	Pontederia cordata var lanceolata	180	19	37	76	53	17	160	220	762	
9	Ruellia equisetiformis				113	144	60	81	364	762	
	RAIN GARDEN										
10	Cyperus alternifolius (870)	506	56	149	86		26	18	29	870	
11	Pandanus pygmaeus	314	90	180				95	191	870	
12	Pandanus tectorius	1	1	1						3	
13	Pennisetum alopecuroides 'Hameln'	224	105	141		332		68		870	
14	Thalia geniculata	490	64	264		52				870	
15	Typha angustifolia	358	85	260		167				870	

Procurement, Material List, Delivery/Logistics

Pre-construction



ZONING AREA (REFER TO NL DAILY WORK SCHEDULE)
NOTE: SCHEDULE SUBJECT TO SITE ACTIVITY & WILL BE ADJUSTED
AS AND WHEN IS REQUIRED



Programme & Construction Sequence

Pre-construction

Site Protection/ Safety Hoarding



Construction of cut off drain



Site Preparation

Construction

- 1) Site Preparation Works
- 2) Construction of ABC Waters Design Features
- 3) Planting Works

Construction

Site Preparation

- Site Storage – convenient access to during construction
- Tools – All relevant tools
- Machinery – excavation and transportation within site
- Site Clearance
- Survey levels – use correct equipment and tools
- Setting and staking – location of elements, inlet, outlet etc.



Construction

Site Storage

- No obstruction during construction
- Sequence of work
- Constant checks to avoid stagnant water



Construction

Sequence of Works

- Excavation using mini-excavator, changkol and spade for fine shaping and profiling the trench according to the drawing specification.
Temporary placement of geotextile to prevent erosion into trench and PE Plastic sheet canvas for protection during rain.
- Install drainage and overflow pipes
- Install leveling sand layer – to provide a bedding layer for receiving drainage layer
- Install drainage layer (Fine gravel with a diameter of 2 – 5 mm), it will be a 2 steps process, before subsoil drainage pipe installation
- Install perforated flexible sub-soil drainage pipes and non-perforated up-stand servicing pipe

Construction

Sequence of Works (continued)

- Complete installation of subsoil drainage pipe; continue with drainage layer (Fine gravel with a diameter of 2 – 5 mm) over the sub-soil drainage pipes
- Installation of transition layer (Coarse sand with diameter of 1 – 2 mm) once completed the drainage layer
- Install sandy loam filtration layer (planting media); no any form of compaction
Sandy loam filtration layer hydraulic flow rate
- Installation of plant materials according to specification
- Watering
- Top up sandy loam layer if necessary

Construction



Excavation using mini-excavator and, changkol and spade for fine shaping and profiling the trench according to the drawing specification. Temporary placement of geotextile to prevent erosion into trench and PE Plastic sheet canvas for protection during rain.

Excavation

Construction



Construction of overflow drainage
pipe and RC overflow sump

Overflow & Drainage

Construction

Install drainage and overflow pipes

Install leveling sand layer – to provide a bedding layer for receiving drainage layer

Install geotextile liner

Install drainage layer (Fine gravel with a diameter of 2 – 5 mm), it will be a 2 steps process, before laying of subsoil drainage pipe and after laying of subsoil drainage pipe



Drainage Layer Installation

Construction



Installation of perforated flexible sub-soil drainage pipes and non-perforated up-stand servicing pipe

Check gradient at every 6m interval to ensure subsoil drainage pipe are laid according to the design intent



Drainage Layer Installation

Construction



Installation of non perforated flexible upstand servicing pipes



Connection of subsoil pipe to collection sump with gradient towards the overflow/ collection sump



Drainage Layer Installation

Construction



Installation of non perforated PVC drainage pipe underneath the location of footpath



Completed inlet scour protection with granite rock



Drainage Layer Installation

Construction



Completed installation of subsoil drainage pipe; continue with drainage layer (Fine gravel with a diameter of 2 – 5 mm) over the sub-soil drainage pipes

Constantly check on the covering to ensure achievement of consistence drainage layer



Drainage Layer Installation

Construction



Installation of transition layer (Coarse sand with diameter of 1 – 2 mm)



Constantly check to ensure consistent transition layer coverage

Transition Layer Installation

Construction



Install sandy loam filter media layer

During installation of drainage, transition and filtration layers, no compaction is allowed



Filter Media Layer Installation

Construction



Fine tune level and profile of bioswale; check interface between filter media layer and side slopes of the bioswale.

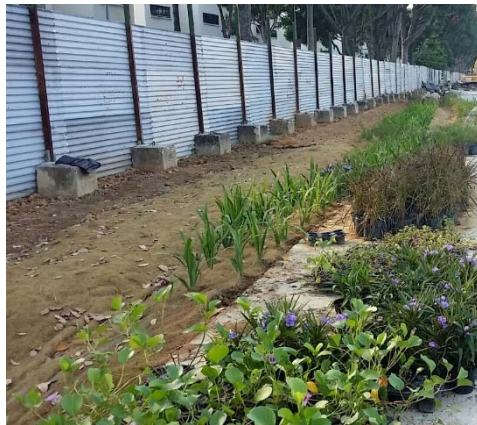


Coco-fibre erosion control mat laid over after completion of installation prior to planting works. All completed features to be protected with barricade to prevent compaction by surrounding activities (including foot traffic and storage of materials on site)



Fine Grading & Site Protection

Construction



Planting work in progress

Constant watering to plant during plant establishment

Planting Works

Construction

Operation & Maintenance Manual
ABC Waters Features and Landscapes at Kallang River/ St. Andrew's School



c. Field Testing

Method Statement for ABC Water Feature Testing

The filtration of stormwater runoff through the filter layer is a key treatment process for bioretention systems. In addition to ensuring healthy vegetation growth to maintain the porosity of the filter layer, regular monitoring of the time taken for stormwater runoff to infiltrate through the filter layer should be undertaken. During the plants establishment period (first two years), it is the most intensive period for maintenance to ensuring a healthy well functioned ABC water feature. The checking process will be follow the flow as below:

1. Inspection of the swale profile and identify any areas of obvious increase sediment deposition, scouring of the swale invert from storm flows, fill erosion of the swale batters from lateral inflows or damage to the swale.
2. Inspection of the inlet points, discharge sump pits and identify any blockage, appears of litter and areas of scour.
3. Remove all the litters and debris from the swale to prevent further blockage and water pollution, follow with proper disposal or recycle of removed wastes.
4. Remove all the sediment where it is reforming the swale or rain-garden to the shape which is undesirable from the original design, follow up with proper disposal or recycle of the removed sediments.
5. Re-profiling and re-vegetating to original design specification if necessary (in the event of too much removal and disturbs happen on site).
6. Repairing damage of the swale and pond from erosion and any unforeseen events, or re-profiling and re-vegetating to original design specification if necessary.
7. Clearing of blockages of all inlets, outlets, pipes and overflow sump pits.
8. Infilling of water (non-portable water) at the inlets to testify the above mentioned works has done properly.
9. Closing all the inlets of the overflow sump pits to increase the speed rate of infilling water (non-portable water) in the next stage.
10. Infilling water (non-portable water) from the inlets points, and open the inlets of the overflow sump pits, which been mentioned in the above step, when the infilling water (non-portable water) has reach the overflow level, stop infilling simultaneously and start to calculate the timing until there is no water remain on the surface of the swale or rain-garden.
11. Calculating of the existing penetration rate based on above mentioned steps results and compare with the requirements.

Field testing of Hydraulic conductivity is to be carried out yearly. The hydraulic conductivity of bioretention basin range value preferably be within 100 – 300mm/hr. and should not be more then 500mm/hr.

*** All maintenance work done shall be completed with report for submission

NATURE LANDSCAPES PTE LTD 15 Joon Road, #102-2 PISA Nursery, Singapore 286689 Tel: (65) 6252 8862 Fax: (65) 6252 8861 www.naturelandscapes.com
...bringing Nature closer to you!

Method Statement

PROJECT TITLE: ABC WATERS AT KALLANG RIVER - ST ANDREW'S SCHOOL
ABC WATER FIELD REPORT 10th July 2015

PROJECT SITE: KALLANG RIVER - ST ANDREW'S SCHOOL

Prepared By: Tony Xu

Date: 10 July 2015

SNO	LOCATION / DATE	IMAGE	ACTION TAKEN	REMARKS
1.	Rain Garden 2		Check all inlet valves the overflow sump pit. The process of filling the retention Basin.	

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E: info@naturelandscapes.com | www.naturelandscapes.com



Report

Field test to be conducted to check the Hydraulic performance after completion of system installation

Ponding Test

Maintenance

Scope of Works

- Horticulture Maintenance
- ABC Waters Design Features Maintenance

Maintenance

No	FREQUENCY	OPERATION
1	Daily Works	<ul style="list-style-type: none"> ▪ Watering to all planting bed ▪ Picking up rubbish at planting bed
2	Weekly Works	<ul style="list-style-type: none"> ▪ Inspect general cleanliness, physical defect, organic fouling in planting bed ▪ Observation, report, pulled from ground self-seeding and wild growth ▪ Treatment of invasive weed infestations ▪ Removal of dead plants or dying plants not in a vigorous thriving condition as and when necessary, Replacement shall be the same species and size as planted originally and not chargeable, except for damage due to vandalism, termites, incurable Gamoderma Fungal disease, acts of God and damaged by others ▪ Trimming overgrown turf, shrubs and groundcovers ▪ Tree trimming and protection work, including adjusting tree staking as and when if necessary ▪ Proper disposal of horticulture waste ▪ Repairing of turf as it becomes evident that certain lawns and groundcovers have not uniformly or properly established, except for damage due to negligence, vandalism and damaged by others. We will not be responsible for turf in areas where the vegetation has matured or are shaded out by building, structure or where they receive insufficient light. .
3	Monthly Works	<ul style="list-style-type: none"> ▪ Pest control (Limited to planting bed only), no chemical pesticide, fungicide to be used due to water sensitivity area ▪ Grass cutting ▪ Inspection of remedial works
4	Quarterly Works	<ul style="list-style-type: none"> ▪ Mulching. Limited to organic composting materials ▪ Fertilizing. No chemical fertilizer to be used due to water sensitivity area
5	Half yearly Works	<ul style="list-style-type: none"> ▪ Pruning of tree once every six months for major pruning of trees & tall palms beyond 3m and to be charged separately

Routine horticultural work schedule for shrub/ groundcover

General Landscaping

Maintenance

ABC Waters Features Maintenance Check List



VEGETATED SWALE/ RAINGARDEN MAINTENANCE CHECKLIST			
Ref. No:			
Project Title:			
Location:			
Description:			
Inspection Frequency:	Daily/ Weekly Works	Date of Visit:	
Site Visited by:		Date of next visit:	
In-charge/ Supervisor:		Signature:	
INSPECTION ITEMS	Yes	No	ACTION REQUIRED (DETAILS)
ABC Systems Maintenance Works			
Check for signs of ponding, especially after a rain event			
Check for Mosquito breeding			
Check for signs of scouring at inlets			
Inspect the inlet and overflow pipes are not choked			
Remove blockage at all inlet and overflow pipes			
Remove litter and debris within vegetated swales to maintain surface porosity			
Horticulture Maintenance Works			
Watering			
Removal of weeds			
Removal of overgrown algae			
Monitor vegetation growth during establishment period			
COMMENTS			

Prepared by:

Date:

ABC Waters Features Maintenance Check List



VEGETATED SWALE/ RAINGARDEN MAINTENANCE CHECKLIST			
Ref. No:			
Project Title:			
Location:			
Description:			
Inspection Frequency:	Monthly Works	Date of Visit:	
Site Visited by:		Date of next visit:	
In-charge/ Supervisor:		Signature:	
INSPECTION ITEMS	Yes	No	ACTION REQUIRED (DETAILS)
ABC Systems Maintenance Works			
Remove sediment accumulation at inflow/ forebay points?			
Remove sediment accumulation at outlet/ overflow pipe?			
Remove sediment accumulation in overflow sump?			
Remove litter and debris within vegetated swales to maintain surface porosity?			
Check erosion at inlet or other key structures (e.g. crossovers)			
Check erosion at sub-catchment			
Traffic damage present?			
Evidence of dumping (e.g. building waste)?			
Infill any holes in vegetated swale surface.			
Inspect after rainfall to check the infiltration or any sign of poor drainage.			
Horticulture Maintenance Works			
Vegetation condition satisfactory?			
Pruning of overgrown plant required?			
Removal of weeds			
Removal of overgrown algae			
Replacement of dead plant required?			
Mowing of turf required?			
Spraying of insecticide (Strictly organic)			
COMMENTS			

Prepared by:

Date:

ABC Waters Design Features

Maintenance

ABC Waters Features Maintenance Check List



VEGETATED SWALE/ RAINGARDEN MAINTENANCE CHECKLIST			
Ref. No:			
Project Title:			
Location:			
Description:			
Inspection Frequency:	Half Yearly Works	Date of Visit:	
Site Visited by:		Date of next visit:	
In-charge/ Supervisor:		Signature:	
INSPECTION ITEMS	Yes	No	ACTION REQUIRED (DETAILS)
ABC Systems Maintenance Works			
Field test on water quality			
Field test on hydraulic flow to ensure flow rate to meet the original design intent			
Inspect after rainfall to check the infiltration or any sign of poor drainage			
Clear blockage and flushing of corrugated and perforated pipes			
COMMENTS			

Prepared by:

Date:

ABC Waters Features Maintenance Check List



VEGETATED SWALE/ RAINGARDEN MAINTENANCE CHECKLIST			
Ref. No:			
Project Title:			
Location:			
Description:			
Inspection Frequency:	Quarterly Year Works	Date of Visit:	
Site Visited by:		Date of next visit:	
In-charge/ Supervisor:		Signature:	
INSPECTION ITEMS	Yes	No	ACTION REQUIRED (DETAILS)
ABC Systems Maintenance Works			
Remove sediment accumulation at inflow/ forebay point?			
Remove sediment accumulation at outlet/ overflow pipe?			
Remove sediment accumulation in overflow sump?			
Remove litter and debris within vegetated swales to maintain surface porosity?			
Check erosion at inlet or other key structures (e.g. crossovers)			
Check erosion at sub-catchment			
Traffic damage present?			
Evidence of dumping (e.g. building waste)?			
Infill any holes in vegetated swale surface			
Racking of filtration media surface to break sediment layer			
Clear blockage and flushing of corrugated and perforated pipes			
Inspect after rainfall to check the infiltration or any sign of poor drainage			
Horticulture Maintenance Works			
Vegetation condition satisfactory?			
Pruning of overgrown plant required?			
Replacement of dead plant required?			
Fertilize of plants (Strictly organic)			
Soil additives or amendments required?			
COMMENTS			

Prepared by:

Date:

ABC Waters Design Features

ABC

Active, Beautiful, Clean
Waters for all



Water for All: Conserve, Value, Enjoy

