

Water sensitive urban design (WSUD) assets

Inspection and maintenance guidelines

# Swales & vegetated buffer strips

August 2024





## Authors

This document was prepared by:

Name, title Mellissa Bradley  
Organisation Water Sensitive SA  
Address PO Box 351, Uraidla SA 5142  
Telephone 0431 828 980  
Email [mellissa@watersensitivesa.com](mailto:mellissa@watersensitivesa.com)

## Version history

Date	Document version	Document revision history	Document author/reviser
15 February 2022		Draft for consideration by Water Sensitive SA Steering Committee 28 February 2022	M Bradley
16 May 2021		Draft for (i) comment by Water Sensitive SA partners and (ii) consideration by Water Sensitive SA Steering Committee 30 May 2022	M Bradley
22 August 2022		Final draft approved by Water Sensitive SA Steering Committee 22 August 2022	M Bradley
16 August 2024	1.0	Final for Water Sensitive SA Steering Committee 26 August 2024	M Bradley

## Approvals

Date	Document version	Approver name and title	Approver signature
26 August 2024	1.0	Elsie Mann, Chair, Water Sensitive SA	

## Acknowledgements

Cover image source: Adelaide City Council

This guideline has been adapted from:

- Blacktown City Council (2019) *Water sensitive urban design (WSUD) inspection and maintenance guidelines*. Developed with assistance from E2Designlab Pty Ltd. A previous version was developed with assistance from Alluvium Consulting Australia Pty Ltd.
- Melbourne Water (2013) *WSUD maintenance guidelines*. A guide for asset managers.

## Disclaimer

Water Sensitive SA takes no responsibility for the selective application or interpretation by third parties of the information that constitutes the document. This document and its associated materials have been produced in good faith with all information contained deemed to be correct at time of production. Water Sensitive SA, the authors, reviewers and contributors take no responsibility, legally or financially, for loss/damage to property/persons/projects resulting directly/indirectly from the document in whole or part, its associated materials, or the interpretation thereof. Water Sensitive SA makes no claim as to the accuracy or authenticity of the content of this document, and does not accept liability for loss or damages incurred as a result of reliance placed upon it.

This guide is of a general nature only. Advice from a suitably qualified professional should be sought for your particular circumstances. Depending on each unique situation, there may be occasions where compliance is not achieved.

Water Sensitive SA welcomes feedback on improvements to these guidelines, particularly WSUD assets images in differing conditions for the *Condition assessment audit visual reference sheets*.



## Contents

1	Asset description and functional components .....	1
	Swales .....	1
	Vegetated buffer strips .....	1
	Functional components .....	2
	Expertise required.....	3
2	Inspection and maintenance forms and activities .....	4
	Trouble shooting .....	4
	01: Inspection & maintenance sheet   Swales and vegetated buffer strips – routine (proactive).....	5
	02: Condition assessment audit – descriptive reference sheet   Swales and vegetated buffer strips.....	8



## 1 Asset description and functional components

Inspection and maintenance guidelines of swales and vegetated buffer strips must be read in conjunction with *Water sensitive urban design (WSUD) assets: Inspection and maintenance guidelines | Overview*

### Swales

A conventional swale is a vegetated, formed depression or trapezoidal channel that utilises overland flow and mild slopes to convey stormwater runoff from impervious areas slowly downstream. They are typically linear, shallow and wide with a defined base and batters, and can be used in combination with conventional piped drainage.

Swales provide a means of disconnecting impervious areas from downstream waterways, which assists in protecting waterways from damage by frequent storm events by reducing flow velocity, compared with piped systems, because of their increased hydraulic roughness. During flood events, stormwater flows exceeding the swale treatment capacity drain into pits connected to the underground stormwater pipe network.

Swales can add amenity and biodiversity values to a landscape, require minimal maintenance once established, and are hardy enough to withstand large flows.

A second type of swale, the bioretention swale (bio-swales) comprise a channel with vegetation, layers of filter media and slotted drainage pipes (underdrain) arranged in a similar layout to a raingarden. Bio-swales facilitate more infiltration than conventional swales and therefore provide a higher level of treatment. For more guidance on how to maintain a biofilters/bio-swales refer to *Inspection and maintenance guidelines | Biofilters*.

### Vegetated buffer strips

Vegetated buffer strips, also known as filter strips, are typically grassed (or planted) areas that are level or have a minor grade, that receive shallow runoff from impervious areas as distributed or sheet flow. These vegetated areas treat shallow overland flow before it enters the drainage network (or a discharge point).

During low intensity rainfall events, swales and vegetated buffer strips also filter the flow and capture coarse sediment, and encourage infiltration, thereby providing some water treatment functionality.

## Functional components

### Swales

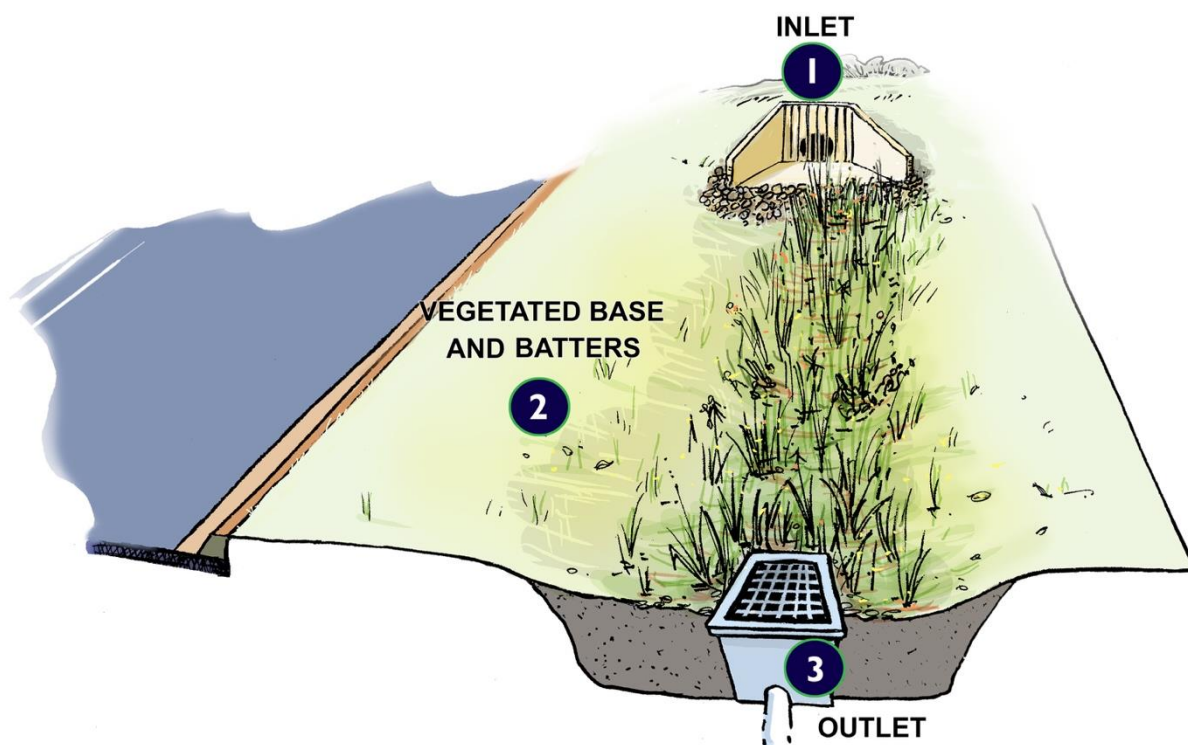


Figure 1.1 Schematic of conventional swale showing functional components

### Vegetated buffer strips

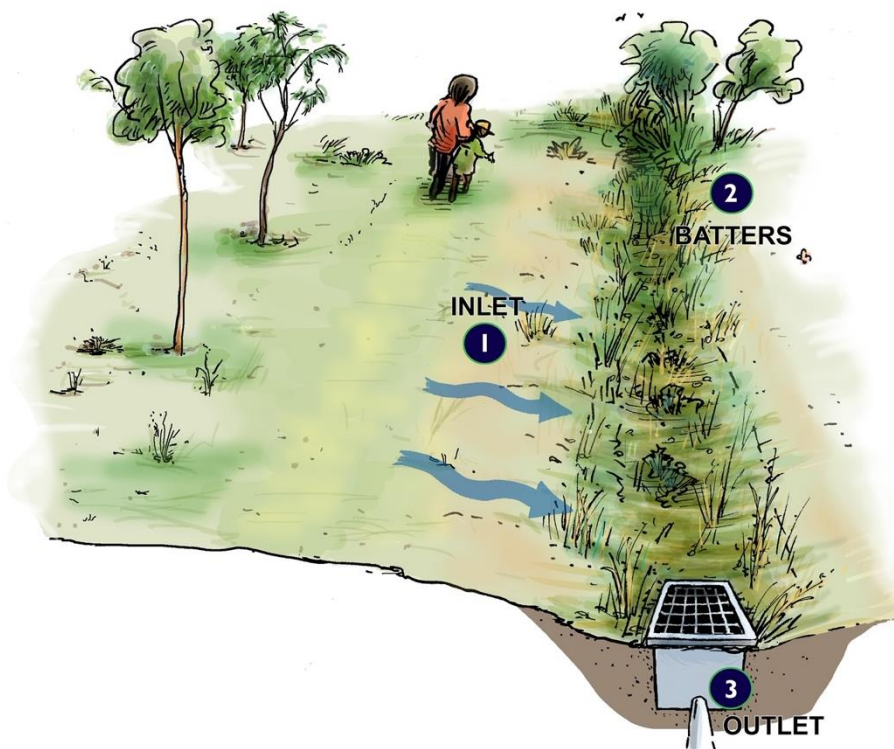


Figure 1.2 The functional components of a vegetated buffer strip and swale

Swales and vegetated buffer strips comprise three functional components (Figure 1.1 and Figure 1.2):

1. **Inlet** The inlet to a swale or vegetated buffer strip can simply be the area where water first flows into the asset. Often, buffer strips are used on the side of roads or driveways where the boundary between the paved area and the vegetated buffer strip would make up the “inlet”. A swale transfers stormwater down a channel and can have a traditional piped inlet or a simple buffer-style distributed inlet.
2. **Vegetated base and/or batters** are the surface areas of the swale or vegetated buffer strip with planted turf (grass) or vegetation (small shrubs). Vegetation is vital to avoid soil erosion. Swale and vegetated buffer strips must have an even grade to allow all water to eventually drain, to avoid ponding and boggy conditions.

The batters are designed to contain high flows within the swale, and are normally vegetated and with a low slope to assist with mowing and erosion control.

Vegetation is an important factor in the reduction of stormwater flow velocities, removal of suspended solids and sediments, and stabilisation of the channel base and batters.

3. **Outlet** The outlet of a swale or vegetated buffer strip is the point at which stormwater finishes running over the surface. This is usually a pit, but buffer strips can also flow directly into swales, overland flow paths or biofilters. A swale usually has a defined outlet with a pit at the downstream end.

### Expertise required

Swale and vegetated buffer strip condition inspections can be undertaken by an asset owner, as specialised equipment to access and view the system is generally not required.

During the establishment period, the vegetated components should be inspected more frequently than indicated in sheet *02: Condition assessment audit – reference sheet | Swales and vegetated buffer strips*, as additional maintenance may be required, e.g. supplementary watering.

## 2 Inspection and maintenance forms and activities

### Routine inspection requirements typically involve:

- Check for sediment and debris build-up in inlets and outlets
- Check for sediment accumulation in the vegetated base
- Check for permanent bogging/pooled areas following rainfall events
- Check for evidence of erosion
- Check for evidence of preferential flow paths
- Check plant health
- Monitor weed growth within the batters and base/channel.

### Routine (proactive) maintenance requirements typically involve:

Activity	Frequency
• Clean blocked inlets and outlets	After significant rain events
▪ Remove sediment from base/channel	As required
▪ Replace soil and re-profile eroded areas	As required
▪ Prune plants	Every 8 weeks during high-growth season <sup>1</sup>
▪ Replant eroded areas	As required
▪ Weed removal/targeted use of herbicide	Every 2-3 weeks during high-growth season <sup>1</sup>
• Mow/slash grass	Monthly during high-growth season <sup>1</sup>

<sup>1</sup> Fortnightly during high-growth season for high amenity sites

Details of the routine inspection and maintenance activity to maintain the amenity of swales and vegetated buffer strips can be found in form

*01: Inspection and maintenance sheet | Swales and vegetated buffer strips – Routine (proactive)*

Routine inspections include the performance of a condition assessment audit to inform asset management planning. The condition assessment score matrices are detailed in form

*02: Condition assessment audit – descriptive reference sheet | Swales and vegetated buffer strips*

### Trouble shooting

**Erosion** Persistent erosion problems within swales may indicate excessive flow velocities, incorrect vegetation cover, excessive batter slopes, or the development of preferential flow paths, and may require further investigation and potentially rectification.

**Sediment accumulation** Areas of standing water and/or boggy conditions are generally indicative of accumulated sediment. Accumulated sediment should only be removed from a swale if the function of the swale is being impeded. The installation of upstream sediment traps may need to be considered if excessive sedimentation persists.

**Vegetation** The vegetation structure (size and shape) influences the flow of stormwater through the swale. High profile vegetation (e.g. tall grasses and sedges, shrubs and trees) may inhibit stormwater flow, leading to retardation of flows and the unintentional discharge of stormwater from the edges of the swale.

Date	_____	<b>Purpose of visit</b>	<b>Rainfall conditions</b>
Location	_____	<input type="checkbox"/> Routine inspection	<input type="checkbox"/> Rainfall today (____mm)
Asset name	_____	<input type="checkbox"/> Response to complaint	<input type="checkbox"/> Rainfall in last 3 days (____mm)
Asset ID	_____	<input type="checkbox"/> Other (specify)	<input type="checkbox"/> No recent rainfall
Inspected by (name /company)			

### INSTRUCTIONS

Prior to maintenance activities occurring, rate asset functional component condition score (from 0 to 5) as per the scoring system below and circle the relevant score.

If score = 0, generate Works Request to refer matter to relevant Council team to decommission the asset or investigate further.

If score = 1, no action is required.

If score = 2, action may be required in some circumstances.

If score = 3, undertake the necessary maintenance and record action taken in right hand side column.

If score = 4 or 5, generate Works Request to refer matter to relevant Council team for rectification works.

### Scoring

0 – Asset has been decommissioned, no longer exists or was not able to be rated due to serviceability issues

1 – As new

2 – Working well, PI met

3 – Routine (proactive) maintenance required

4 – Major maintenance/minor rectification works required

5 – Major rectification required

### Actions

If further action is required, raise a Works Request for relevant department.

Provide reason for 0 rating/not rated.

Functional component		Performance indicator (PI)	Existing condition score and action(s)						
<b>1</b>		<b>Inlet</b>							
1a	Blockage	Limited blockage Limited amount of standing water	0	1	2	3	4	5	
			<input type="checkbox"/> Clear accumulated sediment or debris from inlet <input type="checkbox"/> Other (provide details):						
1b	Damage	Limited damage	0	1	2	3	4	5	
			<input type="checkbox"/> Repair damaged inlet structure <input type="checkbox"/> Replace damaged inlet structure <input type="checkbox"/> Other (provide details):						
1c	Erosion	Limited and localised erosion	0	1	2	3	4	5	
			<input type="checkbox"/> Re-profile or reinforce eroded areas <input type="checkbox"/> Replant eroded areas <b>Information:</b> Only use approved plant species, refer to original design specifications. <input type="checkbox"/> Other (provide details):						
<b>2</b>		<b>Vegetated base and batters</b>							
2a	Erosion	Limited and localised erosion	0	1	2	3	4	5	
			<input type="checkbox"/> Re-profile or reinforce eroded areas <input type="checkbox"/> Place and suitably compact fill in minor erosion areas (requiring <1m <sup>3</sup> soil) and re-profile affected area						



Functional component		Performance indicator (PI)	Existing condition score and action(s)	
			<input type="checkbox"/> Place and suitably compact fill to remediate moderate or significant erosion areas <input type="checkbox"/> Other (provide details):	
2b	Plant health	Good plant health, free from disease and growing vigorously	0 <span style="background-color: #90EE90;">1</span> <span style="background-color: #ADD8E6;">2</span> <span style="background-color: #FFD700;">3</span> <span style="background-color: #FFA500;">4</span> <span style="background-color: #FF6347;">5</span>	<input type="checkbox"/> Remove dead or diseased vegetation <input type="checkbox"/> Replant bare areas (>10% of total area) <b>Information:</b> Only use approved plant species, refer to original design specifications. <input type="checkbox"/> Irrigate stressed plants during extended dry periods <input type="checkbox"/> Other (provide details):
2c	Plant cover	Good plant cover (80-90%)	0 <span style="background-color: #90EE90;">1</span> <span style="background-color: #ADD8E6;">2</span> <span style="background-color: #FFD700;">3</span> <span style="background-color: #FFA500;">4</span> <span style="background-color: #FF6347;">5</span>	<input type="checkbox"/> Replant bare areas (>10% of total area) <b>Information:</b> Only use approved plant species, refer to original design specifications. <input type="checkbox"/> Irrigate stressed plants during extended dry periods <input type="checkbox"/> Other (provide details):
2d	Weeds	Limited weed cover (<10%) No declared invasive weeds	0 <span style="background-color: #90EE90;">1</span> <span style="background-color: #ADD8E6;">2</span> <span style="background-color: #FFD700;">3</span> <span style="background-color: #FFA500;">4</span> <span style="background-color: #FF6347;">5</span>	<input type="checkbox"/> Treat weeds with steam, and return within a week to remove by hand <input type="checkbox"/> Treat weeds with targeted-use herbicides <b>Information: Herbicides must be approved for use in proximity to waterways.</b> This will minimise potential impact on desirable species and reduce likelihood of chemical residue within soil profile or local waterways. <input type="checkbox"/> Other (provide details):
2e	Litter and/or debris (larger than a soft drink can)	1 piece of litter or debris/50m <sup>2</sup> Limited impact on aesthetics	0 <span style="background-color: #90EE90;">1</span> <span style="background-color: #ADD8E6;">2</span> <span style="background-color: #FFD700;">3</span> <span style="background-color: #FFA500;">4</span> <span style="background-color: #FF6347;">5</span>	<input type="checkbox"/> Remove all litter and/or debris <b>Information:</b> Contact with sharp objects is a risk when removing litter. All workers must follow WHS practices to reduce risk, including wearing personal protective equipment. Forks and tongs may be used to pick up litter. <input type="checkbox"/> Other (provide details):
2f	Accumulated sediment (flow path impacts)	Limited accumulated sediment (<10% of surface)	0 <span style="background-color: #90EE90;">1</span> <span style="background-color: #ADD8E6;">2</span> <span style="background-color: #FFD700;">3</span> <span style="background-color: #FFA500;">4</span> <span style="background-color: #FF6347;">5</span>	<input type="checkbox"/> Remove accumulated sediment on surface by flat shovel, rake treatment surface, and restore design levels <input type="checkbox"/> Mechanically remove excess sediment and restore design levels <input type="checkbox"/> Other (provide details):
2g	Surface levels	Limited number of depressions or mounds	0 <span style="background-color: #90EE90;">1</span> <span style="background-color: #ADD8E6;">2</span> <span style="background-color: #FFD700;">3</span> <span style="background-color: #FFA500;">4</span> <span style="background-color: #FF6347;">5</span>	<input type="checkbox"/> Re-profile minor local depressions or mounds, ensuring swale/buffer strip is as even as possible and sloped towards outlet to allow water to drain <input type="checkbox"/> Re-profile significant depressions, mounds or short-circuiting channels, ensuring swale/buffer strip is as even as possible and sloped towards outlet to allow water to drain <input type="checkbox"/> Other (provide details):
2h	Standing water and/or boggy conditions	Limited standing water and/or boggy conditions after rain events Typically dries out within 12 hours	0 <span style="background-color: #90EE90;">1</span> <span style="background-color: #ADD8E6;">2</span> <span style="background-color: #FFD700;">3</span> <span style="background-color: #FFA500;">4</span> <span style="background-color: #FF6347;">5</span>	<input type="checkbox"/> Re-profile minor local depressions or mounds, ensuring swale/buffer strip is as even as possible and sloped towards outlet to allow water to drain

Functional component		Performance indicator (PI)	Existing condition score and action(s)
			<input type="checkbox"/> Re-profile significant depressions, mounds or short-circuiting channels, ensuring swale/buffer strip is as even as possible and sloped towards outlet to allow water to drain <input type="checkbox"/> Other (provide details):
<b>3</b>		<b>Outlet</b>	
3a	Blockage	Limited blockage	0 1 2 3 4 5 <input type="checkbox"/> Unblock outlet pipes <input type="checkbox"/> Remove sediment from outflow areas <input type="checkbox"/> Report damage to outlet or pit <input type="checkbox"/> Other (provide details):
3b	Erosion	Limited and localised erosion	0 1 2 3 4 5 <input type="checkbox"/> Repair base or batter erosion in area surrounding outlet structure <input type="checkbox"/> Repair base or batter erosion caused by flow skirting weir crest <input type="checkbox"/> Other (provide details):
<b>4</b>		<b>Other structures, e.g. handrails, bollards, access ramps</b>	
4a	Damage to or removal of structure/s (Annual)	Limited damage	0 1 2 3 4 5 <input type="checkbox"/> Repair damaged structure/s <input type="checkbox"/> Replace significantly damaged or removed structure/s <input type="checkbox"/> Other (provide details):

#### Waste and soil disposal general

Note: Waste and soil disposal procedures must adhere with South Australian EPA and local authorities' requirements.

Functional component		Inspection frequency (months)	Very good (condition score – 1)	Good – Performance indicator (PI) met (condition score – 2)	Fair (condition score – 3)	Poor (condition score – 4)	Very poor (condition score – 5)
<b>1</b>		<b>Inlet</b>					
1a	Blockage	3 (and after significant rain events)	No blockage	Limited blockage  Limited amount of standing water	Minor blockage causing slight bypass of flows or restricted inflows  Minor amount of standing water	Moderate blockage causing significant bypass of flows or restricted inflows  Moderate amount of standing water	Complete blockage causing total bypass of inflows  Significant amount of standing water
1b	Damage	3 (and after significant rain events)	No damage	Limited damage	Minor damage	Moderate damage  Minor risk to structural integrity of asset, public safety or asset function	Significant damage  Moderate to significant risk to structural integrity of asset, public safety or asset function
1c	Erosion	3 (and after significant rain events)	No erosion	Limited and localised erosion	Minor erosion	Moderate erosion  Minor risk to structural integrity of asset, public safety or asset function	Significant erosion  Moderate to significant risk to structural integrity of asset, public safety or asset function
<b>2</b>		<b>Vegetated base and batters</b>					
2a	Erosion	3	No erosion	Limited and localised erosion	Minor erosion	Moderate erosion (e.g. short circuiting of flows)  Minor risk to structural integrity of asset, public safety or asset function	Significant erosion (e.g. short circuiting of flows)  Moderate to significant risk to structural integrity of asset, public safety or asset function
2b	Plant health	3	Excellent plant health	Good plant health, free from disease and growing vigorously	Fair plant health	Poor plant health	Very poor plant health
					Minor signs of disease and/or pests  Wilting in <10% of turf/plants	Moderate signs of disease and/or pests  Wilting in 10-25% of turf/plants	Significant signs of disease and/or pests  Wilting in >25% of turf/plants

Functional component	Inspection frequency (months)	Very good (condition score – 1)	Good – Performance indicator (PI) met (condition score – 2)	Fair (condition score – 3)	Poor (condition score – 4)	Very poor (condition score – 5)	
2c	Plant cover	3	Excellent plant cover (>90%)	Good plant cover (80-90%)	Fair plant cover (50-80%)	Poor plant cover (30-50%)	Very poor plant cover (<30%)
2d	Weeds	3	No visible weed cover No declared invasive weeds	Limited weed cover (<10%) No declared invasive weeds	Minor weed cover (10-20%) No declared invasive weeds	Moderate weed cover (20-40%) and/or declared invasive weeds present	Significant weed cover (>40%) and/or declared invasive weeds present
2e	Litter and/or debris (larger than a soft drink can)	3	No litter and/or debris	1 piece of litter and/or debris/50m <sup>2</sup> Limited impact on aesthetics	2-3 pieces of litter and/or debris/50m <sup>2</sup> Minor impact on aesthetics	4-5 pieces of litter and/or debris/50m <sup>2</sup> Moderate impact on aesthetics	Significant amount of litter and/or debris/50m <sup>2</sup> Significant impact on aesthetics
2f	Accumulated sediment (flow path impacts)	3	No accumulated sediment	Limited accumulated sediment (<10% of surface)	Minor accumulated sediment (10-25% of surface) Minor redirection of flows through system	Moderate accumulated sediment (25-50% of surface) Moderate redirection of flows through system	Significant accumulated sediment (>50% of surface) Significant redirection of flows through system
2g	Surface levels	3	No surface depressions or mounds  Base is flat with flows evenly distributed through asset surface	Limited surface depressions or mounds  Base is mostly flat with flows evenly distributed through most of asset surface	Minor number/size of surface depressions or mounds.  Minor impact on flows through the asset (e.g. emerging signs of short circuiting)	Moderate number/size of surface depressions or mounds, or preferential flow paths  Moderate impact on flows through asset	Significant number/size of depressions or mounds, or preferential flow paths  Significant impact on flows through asset (e.g. short-circuiting of flows, blocking flows, limited flow distribution)
2h	Standing water and/or boggy conditions	3	Well drained with no standing water or boggy areas	Limited standing water and/or boggy conditions after rain events Typically dries out within 12 hours	Standing water and/or boggy conditions after rain events Typically dries out within 24-48 hours	Standing water and/or boggy conditions after rain events Typically dries out after 2-5 days	Standing water and/or continued boggy conditions for 5+ days, affecting asset performance and ease of maintenance
<b>3</b>	<b>Outlet</b>						
3a	Blockage	3 (and after significant rain events)	No blockage	Limited blockage	Minor blockage causing slight obstruction of outflows	Moderate blockage causing moderate obstruction of outflows	Blockage completely obstructing outflows

Functional component		Inspection frequency (months)	Very good (condition score – 1)	Good – Performance indicator (PI) met (condition score – 2)	Fair (condition score – 3)	Poor (condition score – 4)	Very poor (condition score – 5)
3b	Erosion	3 (and after significant rain events)	No erosion	Limited and localised erosion	Minor erosion	Moderate erosion  Minor risk to structural integrity of asset, public safety or asset function	Significant erosion  Moderate to significant risk to structural integrity of asset, public safety or asset function
<b>4</b>	<b>Other structures, e.g. handrails, bollards, access ramps</b>						
4a	Damage to or removal of structure/s	Annual	No damage	Limited damage	Minor damage	Moderate damage  Minor risk to structural integrity of asset, public safety or asset function	Significant damage  Moderate to significant risk to structural integrity of asset, public safety or asset function