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4.0 STORMWATER QUALITY BEST MANAGEMENT PRACTICES

4.1 BACKGROUND

The principal objective of this Chapter is to provide guidance with respect to the selection of appropriate Stormwater Quality Best Management Practices (SQBMPs) for a variety of development types and development phases. For 'low risk' developments, this Chapter will list or provide most of the selection requirements. The term SQBMP refers to a collection of practices and devices that improve stormwater quality through the prevention, minimisation and/or trapping of pollutants. They range from grass swales to gross pollutant traps. For 'high risk' developments, reference will also need to be made to other Chapters of Part C of this document, namely:

- Chapter 5 - Stormwater Quality Improvement Devices; and/or
- Chapter 6 - Lakes, Ponds and Wetlands.

Chapter 4 provides guidance by:

- summarising the types of pollutants that are typically generated by different land uses;
- presenting matrices to help identify acceptable SQBMPs for these land uses; and
- providing a list of detailed references that may be used in designing SQBMPs, or obtaining more information.

Selection of appropriate SQBMPs will assist developments to meet Council requirements for the protection of water quality in the City's waterways. These requirements may be site-specific (eg WQOs for 'high risk' developments), or may relate to best practice (eg for 'low risk' developments). It is important to note that whilst specific SQBMPs have been nominated in this Chapter as being appropriate for specific land uses, the application of new and innovative techniques is encouraged for all sites.

A number of typical development types have been identified for which SQBMPs should be applied. These include:

- subdivisions;
- residential buildings;
- townhouse developments;
- industrial and commercial developments;
- service stations; and
- car parks.

As indicated in Figure C1.4, innovative, 'non-standard' stormwater management practices (ie those not included in this guideline) can still be used to meet the performance criteria in the *City Plan*.

4.1.1 Pollutant Generation

Pollutants that are typically generated by the above mentioned land uses are listed in Tables C4.1 and C4.2. These tables provide a summary of the primary stormwater pollutants generated during the construction and operational phases of development.

Development types not listed in these tables will still require controls, the selection of which should be discussed with the relevant Council development assessment team. Note that land uses classified as Environmentally Relevant Activities under the *Environmental Protection Act 1994* (and supporting regulations) will need to be licensed/approved by either the Environmental Protection Agency or Brisbane City Council. This process may result in specific controls being required.

TABLE C4.1 POLLUTANTS TYPICALLY GENERATED DURING THE CONSTRUCTION PHASE

Pollutant	Sources
Litter	Paper, construction packaging, food packaging, cement bags, off-cuts
Sediment	Unprotected exposed soils and stockpiles during earthworks and building
Hydrocarbons	Fuel and oil spills, leaks from construction equipment
Toxic materials	Cement slurry, asphalt prime, solvents, cleaning agents, washwaters (eg from tile works)
pH altering substances	Acid sulfate soils, cement slurry and washwaters

Measures should be put in place during the construction phase to manage each of the pollutant types nominated in Table C4.1.

TABLE C4.2 POLLUTANTS TYPICALLY GENERATED DURING THE OPERATIONAL (POST CONSTRUCTION) PHASE

Pollutant	Subdivisions	Residential Buildings	Townhouse Devt	Industrial and Commercial Devt#	Service Stations	Car Parks
Litter	yes	yes	Yes	yes	yes	yes
Sediment	yes	yes	Yes	yes	no	yes
Oxygen demanding substances (organic and chemical matter)	possibly	no	No	Possibly	no	no
Nutrients (N & P)	yes	yes	Yes	possibly	possibly	no
Pathogens / Faecal coliforms (bacteria & viruses)	yes	yes	possibly	Possibly	No	no
Hydrocarbons (including oil & grease)	yes	unlikely	possibly	possibly	yes	yes
Heavy metals (often associated with fine sediment)	yes	yes	yes	Possibly	yes	yes
Surfactants (eg detergents from car washing)	yes	yes	yes	possibly	possibly	no
Organochlorines & organophosphates (eg pesticides, herbicides)	unlikely	no	no	Possibly	no	no
Thermal pollution (heat)	yes	yes	yes	yes	yes	yes
pH altering substances##	possibly	no	no	possibly	no	no

Notes:

- Shading denotes the key pollutant to be targeted for trapping.
- # Given the heterogeneity of industrial and commercial developments, site-specific assessment needs to be undertaken to identify key pollutants that need to be targeted.
- ## If acid sulfate soils are present, these should have been dealt with as part of the development's design and construction phase (see Chapter 9 of Part C of this document).

4.1.2 Classification of SQBMPs

SQBMPs may be classified in several ways. The classification scheme used in these guidelines adopts three categories, which are:

- Primary practices/devices (eg trapping of gross pollutants and coarse sediment through processes such as screening).
- Secondary practices/devices (eg trapping of fine sediment through processes such as filtration through grass buffer strips).
- Tertiary practices/devices (eg trapping of nutrients through processes such as biological uptake and adsorption).

For developments that have a small number of key pollutants, one or two SQBMPs may be sufficient to satisfactorily remove stormwater pollutants. For example, the uncovered areas of a service station may only require a precast oil/water/grit separator to trap coarse sediment and free-phase hydrocarbons before stormwater runoff leaves the site. The provision of litter bins at the fuel bowsers would be an additional source control to minimise the generation of litter.

Selection of such SQBMPs can, in most cases, be achieved through reference to the Tables presented in this Chapter. Where possible, preference should always be given to the selection of *source controls* (rather than end of pipe solutions) and controls with low maintenance costs.

For developments that have a large number of key pollutants (eg an industrial estate), a combination of SQBMPs is likely to be required in accordance with a stormwater 'treatment train' approach. Where larger SQBMPs are required, reference should be made to Chapter 5 of Part C of this document.

Table C4.3 provides a summary of pollutant reduction efficiencies for commonly used SQBMPs. This will aid in the selection of appropriate measures during the process described in the following Section.

4.2 SELECTION OF SQBMPS

4.2.1 Description of Measures

In Australia there is an abundance of literature that describes the strengths, weaknesses, functions, application, constraints, variations, performance, maintenance requirements and design details of many SQBMPs. These references vary in standard and the level of detail provided. In order to assist those selecting and designing SQBMPs, Tables C4.1 to C4.5 have been created using information obtained from a number of the references. These references are given in Section 4.3, and in Appendix 1. Where users of these guidelines experience difficulty in accessing nominated references, Council may to be able to provide assistance through the relevant development assessment team or policy areas.

The term 'Water Sensitive Urban Design' (WSUD) is often used to describe the integration of these SQBMPs as fundamental elements of a development layout in order to minimise adverse impacts upon water quantity and quality. WSUD also looks for opportunities to reuse or recycle water, reducing potable water use, and thus having off-site environmental benefits (eg smaller dams).

At a policy level, Council is committed to encouraging greater use of WSUD elements. However, it is recognised that at an operational level there is sometimes a reluctance to implement (or approve) such measures due to uncertainties on the level of performance, maintenance, etc. While it will take some time to gather information about the effectiveness of WSUD in Brisbane and build confidence in the development industry and Council' own development assessment areas about the widespread use of WSUD, there should be no doubt that WSUD is necessary for the protection of the health of the City's urban waterways and this is the direction Council is moving. Successful implementation of WSUD will require a concerted effort from all stakeholders to re-think long-held paradigms for urban stormwater management that did not consider the impacts that stormwater could have on the health of receiving waters.

4.2.2 Stormwater Recycling

Considerable work is now being undertaken in Queensland to increase the acceptance and adoption of stormwater recycling in an urban context. Potential benefits include reduced use of potable water, reduced volume of urban stormwater, and reduced pollutant loads from urban stormwater that are discharged to waterways.

Options typically integrated into 'water sensitive developments' range from lot scale initiatives (eg use of above or below ground rainwater tanks to irrigate gardens and/or flush toilets) to estate scale measures such as the irrigation of stormwater from wetlands, ponds and lakes.

The Queensland Water Recycling Strategy has recently released its *Stormwater Recycling Background Study* (QWRS & WBM Oceanics, 1999) and will produce a *Queensland Water Recycling Strategy* in mid 2000. Key recommendations from this work to date include:

- Based on extensive research overseas and in Australia, stormwater recycling is a viable option in Queensland.
- No significant impediments exist to increasing the level of stormwater recycling in Queensland.
- Significant environmental benefits may be achieved through greater levels of stormwater recycling.
- There is a need to assess a generic State-wide policy to require all new households to install rainwater tanks.
- There is a need to assess the implications of amending Local Government drainage guidelines so that roof and road drainage are not directly connected to trunk drainage systems (ie they are connected by stormwater recycling units such as rainwater tanks or infiltration devices).

4.2.3 Selection Process

In selecting a SQBMP or suitable combination of SQBMPs, the following process should be followed:

Step 1 – Risk category

Identify whether the proposed development is 'low risk' or 'high risk' (see Glossary and Chapter 2 of Part C of this document).

Step 2 – Pollutant type

Identify the target stormwater pollutants for the proposed land use for the construction and operational phases using Tables C4.1 and C4.2, as well as knowledge of proposed activities on the site.

Step 3 – Construction phase

Determine which SQBMPs are commonly used for the *construction* phase of the project. The primary contaminant of concern will usually be sediment (and to a lesser extent litter). To identify SQBMPs for erosion and sediment control, refer to Chapter 12 of Part C of this document and *Soil Erosion and Sediment Control – Engineering Guidelines for Queensland Construction Sites (IEAust, 1996)* for large developments. Note also that some of the SBSMPs in Table C4.3 can be used during the construction phase as well as operational phase (eg filter strips and water quality ponds).

Step 4(a) – Operational phase ('low risk')

If the development is 'low risk', Water Quality Objectives (WQOs) need not be identified. Use Table C4.3 to select which types of practices will be appropriate for the identified pollutant type. Tables C4.4 and C4.5 may then be used to assist in sizing appropriate SQBMPs. Table C4.4 provides an indication of adequate sizing (based on design flow rates) for some commonly used proprietary 'primary practices/devices', with information relating to secondary devices contained in Table C4.5. Additional references can be used to provide more detailed information. These are included in Section 4.3. A particularly useful reference is Hunter (1999).

Step 4(b) – Operational phase ('high risk')

If the development is 'high risk', WQOs will need to be identified (as per Chapter 2 of Part C of this document) and SQBMPs must be selected to enable the development to meet the relevant set of WQOs where possible (refer also Section 3.5 of Part C of this document). Table C4.3 may be used to determine the appropriate types of devices, but detailed analysis will also be required, as specified in Chapter 3 of Part C of this document and below. Tables C4.4 and C4.5 can be utilised to provide preliminary sizing information and design considerations, respectively.

For 'high risk' developments, structural SQBMPs (like constructed wetlands and gross pollutant traps) need to be carefully sized in accordance with appropriate design guidelines (see references below). For further information on structural SQBMPs (also known as Stormwater Quality Improvement Devices or SQIDs) refer to Chapter 5 of Part C of this document. Ponds, lakes and wetlands are specifically addressed in Chapter 6 of Part C of this document.

Note that for 'high risk' development, pollutant export modelling would usually be required to demonstrate to Council that the combination of SQBMPs would produce stormwater with a quality that meets relevant WQOs for receiving waters. Such modelling allows a variety of SQBMPs combinations to be considered so that costs can be minimised while performance can be maximised[1].

Step 5 – Structural SQBMPs

Where structural SQBMPs (or SQIDs) are selected as one of the appropriate measures for the site (ie part of the treatment train), a Maintenance Plan will be required (see Chapter 14 of Part C of this document). In cases where responsibility for the asset will be transferred to Council, Developers will need to follow the asset hand-over guidelines outlined in Chapter 15 of Part C of this document.

Step 6 – Water Quality Monitoring

For some 'high risk' developments, a water quality monitoring program may be required by Council to demonstrate that WQOs are being met. This monitoring will also give an indication as to whether the design predictions were accurate, the pollutant removal performance of SQBMPs and whether alternative or additional stormwater quality management practices need to be employed.

Chapter 13 of Part C of this document outlines when a water quality monitoring program would normally be required and what type of program would typically be required.

Step 7 – Documentation

Describe in the site's Site Based Stormwater Management Plan (see Chapter 3 of Part C of this document) the SQBMPs that have been selected, their location, the timing for installation, the maintenance regime, and their performance evaluation program (where relevant).

4.3 REFERENCES

A number of detailed design references have been identified below. Each of these has been classified as 'preferred' or 'additional'. Preferred guidelines should suffice for the majority of developments. Note that as Stormwater Quality Best Management Practices evolve, the guidelines nominated below would also need to be updated.

Preferred (P) Design Guidelines

1. Cooperative Research Centre for Catchment Hydrology, 1997. *Best Practice Environmental Management Guidelines for Urban Stormwater (Report 97/7).* Cooperative Research Centre for Catchment Hydrology, Melbourne.
2. Cooperative Research Centre for Catchment Hydrology, 1995. *A Review of Urban Stormwater Quality Processes: Report 95/5.* Cooperative Research Centre for Catchment Hydrology, Melbourne.
3. Victoria Stormwater Committee, 1999. *Urban Stormwater: Best Practice Environmental Management Guidelines.* CSIRO, Melbourne.
4. NSW EPA, 1997. *Treatment Techniques: Managing Urban Stormwater.* NSW EPA, NSW.

[1] It is acknowledged that there is a lack of high quality performance data for some types of SQBMP, due to the immaturity of the research. This data will continue to build with time. In the interim, modelling will need to draw upon the best available data (see references), but clearly flag areas of uncertainty (eg where performance criteria have been estimated due to lack of credible data).

5. Sara Harbidge, GHD, 1996. *Review of Stormwater Quality Best Management Practices for Use with Subdivision Developments.* GHD, Brisbane.

6. Hunter, G.J. April 1999. *Evaluation of Some Readily Available Stormwater Quality Control Technologies.* Waterfall Journal: p.16. Stormwater Industry Association Inc., Sydney.

7. Hunter, G.J., 1999. *Stormwater Treatment Devices.* Workshop Proceedings, 8th International Conference on Urban Stormwater Drainage. Stormwater Industry Association Inc., Sydney.

8. For guidelines relating to lakes, ponds and wetlands, refer to Chapter 6 of Part C of this document.

Additional (A) Design Guidelines

1. Brisbane City Council, 1997. *Stormwater Quality Management: Recommended Treatment Techniques.* Brisbane City Council, Brisbane.

2. Brisbane City Council, 1997. *Stormwater Quality Management: Service Stations.* Brisbane City Council, Brisbane.

3. Brisbane City Council, 1997. *Stormwater Quality Management: Car Parks.* Brisbane City Council, Brisbane.

4. Cooperative Research Centre for Catchment Hydrology, 1997. *Urban Stormwater Pollution: Industry Report 97/5.* Cooperative Research Centre for Catchment Hydrology, Melbourne.

5. Stormwater Industry Association Inc., 1995. *Better Management Practices for Urban Stormwater.* Stormwater Industry Association Inc., Sydney.

6. Department of Planning and Urban Development, Water Authority of Western Australia & EPA, 1994. *Planning and Management Guidelines for Water Sensitive Urban (Residential) Design*. Whelans & Halpern Glick Maunsell.

Preferred Construction Phase References (erosion and sediment control)

1. Brisbane City Council, 1999. *Erosion and Sediment Control Standard (version 8 or later version).* Brisbane City Council, Brisbane.

2. The Institution of Engineers, Australia (Qld), 1996, or later version. *Soil Erosion and Sediment Control – Engineering Guidelines for Queensland Construction Sites*. IEAust, Brisbane.

3. NSW EPA, 1996. *Managing Urban Stormwater: Construction Activities (Draft).* EPA, NSW.

Preferred Stormwater Recycling References

1. Queensland Water Recycling Strategy and WBM Oceanics Pty Ltd, 1999. *Stormwater Recycling Background Study*. Queensland Government Printer, Brisbane.

TABLE C4.3 POLLUTANT REDUCTION EFFICIENCIES FOR DIFFERENT STORMWATER QUALITY BEST MANAGEMENT PRACTICES

Stormwater Quality Best Management Practice	Litter	Coarse Sediment	Fine Sediment (suspended solids)	Nutrients (N & P)[1]	Oxygen Demanding Substances	Hydrocarbons[2]	Pathogens	Heavy Metals[3]
Source Controls								
Street Sweeping	**H-M**	**M**	**-**	**-**	**L (S)**	**-**	**-**	**L**
Rubbish Bins	**H-M**	**-**	**-**	**-**	**L (S)**	**-**	**-**	**-**
Education[4]	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**
Primary Treatments								
Small Scale Devices								
Litter Baskets	**L-M**	**-**	**-**	**-**	**L**	**-**	**-**	**-**
Grates and Entrance Screens	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Side Entry Pit Traps	**L-M**	**L**	**-**	**-**	**L**	**-**	**-**	**-**
Baffle Pits	**L**	**L-M**	**L**	**-**	**L**	**-**	**-**	**L**
Catch Pits	**L**	**L-M**	**L**	**-**	**L**	**-**	**-**	**L**
Oil and Grit Separators	**L**	**L-M**	**L**	**-**	**L**	**L-M**	**L**	**L**
Nets	**H**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Medium Scale Devices								
Litter and Trash Racks	**M**	**L**	**-**	**-**	**L**	**-**	**-**	**-**
Downwardly inclined screens	**H**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Floating Litter Booms	**L-M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
In-ground GPTs	**H-VH**	**H**	**L**	**L**	**L-M**	**L**	**-**	**L**
In-line Separators	**M**	**L-M**	**-**	**-**	**-**	**-**	**-**	**-**
Large Scale Devices								
Open Gross Pollutant Traps	**M-H**	**H**	**L**	**L**	**L**	**L**	**L**	**L**
Sediment Traps	**L**	**H**	**L**	**L**	**L**	**L**	**L**	**L**
Hydraulically Operated Trash Racks	**H**	**L-M**	**-**	**-**	**-**	**-**	**-**	**-**
Secondary Treatments								
Filter Strips	**M**	**H**	**M**	**L-M**	**L**	**L (S)**	**M (S)**	**L**
Grass Swales	**L-M**	**M-H**	**M**	**L-M**	**L**	**L**	**M (S)**	**M**
Sand Filters	**-**	**M-H**	**M-H**	**M**	**M**	**M**	**M**	**M**
Infiltration Trench / Basin	**-**	**M-H**	**M**	**M**	**M**	**M**	**M**	**M-H**
Porous Pavements	**-**	**H**	**M-H**	**M**	**M**	**M**	**H**	**M-H**
Extended Detention Basins	**-**	**M-H**	**L-M**	**L**	**L**	**L**	**M**	**L**
Tertiary Treatments								
Water Quality Ponds (with pre-treatment)	**M-VH**	**H**	**L-M**	**L-M**	**L**	**L**	**L**	**L-M**
Constructed Wetlands (with pre-treatment)	**M-VH**	**H**	**M**	**M**	**L**	**M**	**M (S)**	**H**

Legend:

- = Negligible benefit.
L = 10-30% Pollutant reduction efficiency.
M = 30-50% Pollutant reduction efficiency.
H = 50-75% Pollution reduction efficiency.
VH = 75-100% Pollution reduction efficiency.
S = Secondary benefits.
Shading = better performing SQBMPs for the target pollutant.

See next page for accompanying notes. . .

Notes for Table C4.3:

1. May be dissolved or attached to fine sediment.
2. Hydrocarbons vary significantly in terms of density and solubility. Some hydrocarbons will float, others will settle or attach to sediment, whilst others will become soluble.
3. Usually adsorbed to fine sediment.
4. Effectiveness will vary. Cannot be relied on as sole measure.

- As there are many different designs of SQBMPs on the market (especially for Gross Pollutant Traps), this table should only be used as a broad assessment tool.
- The above SQBMPs are mainly used during the operational phase, but some can be used during both the construction and operation phase (eg wet basins and filter strips).
- Performance/efficiency ratings assume the SQBMPs are not being bypassed in a major storm event (ie they are appropriately sized) and that maintenance is sound.
- This list is not exhaustive, it only covers some commonly used SQBMPs (see references at the end of Chapter 4 of Part C of this document for more information).
- It is common to link SQBMPs to form a 'stormwater treatment train' (eg combining a trash rack with a sediment trap) to improve the overall efficiency of the system.
- The '% pollutant reduction efficiencies' for many of the SQBMPs are more conservative than in some other reference materials from inter-state, due to uncertainties about the performance of SQBMPs in Brisbane.

References Used to Construct Table C4.3:

Advice from Brisbane Consultants, internal experts (BCC), and gross pollutant trap product suppliers.

- CRC for Catchment Hydrology, 1997. *Best Practice Environmental Management Guidelines for Urban Stormwater* (Report 97/7). Cooperative Research Centre for Catchment Hydrology, Melbourne.
- NSW EPA, 1997. *Treatment Techniques: Managing Urban Stormwater.* EPA, NSW.
- Victoria Stormwater Committee, 2000. *Urban Stormwater: Best Practice Environmental Management Guidelines.* CSIRO, Vic.
- Hunter, G.J. Waterfall Journal: p16, April 1999. *Evaluation of Some Readily Available Stormwater Quality Control Technologies*. Stormwater Industry Association Inc.

For Additional Information on:

- The management of sewage overflows, see Chapter 7 of Part C of this document.
- On-site sewage treatment and effluent reuse, see Chapter 8 of Part C of this document.
- The management of acidic run-off from acid sulfate soils, see Chapter 9 of Part C of this document.
- The management of rubbish bins and car washing areas, see Chapter 10 of Part C of this document.
- Suitable SQBMPs for swimming pool water, see Chapter 11 of Part C of this document.
- The management of erosion and sediment control, see Chapter 12 of Part C of this document.

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TABLE C4.4 SIZING DETAILS FOR COMMONLY USED PRIMARY STORMWATER QUALITY BEST MANAGEMENT PRACTICES/DEVICES

Stormwater Quality Management Practice/Device				Maximum Flow Rate [L/s] For The Design Event (eg $Q_{3months}$)																							
		Target Pollutants	Size Criteria	20	30	50	70	100	150	200	250	300	350	400	450	500	600	700	800	1000	1250	1500	1750	2000	2500	3000	4000
In-ground GPT																											
Humes	Humeguard In-line Gross Pollutant Trap	litter, sediments	Model No.	HG18, HG24, HG30, HG35, HG35A, HG40, HG40A, HG40B, HG45, HG45A - Contact CSR Humes for sizing information																							
Ecosol	In-line / End of line Solid Pollutant Filter RSF 4000		Flow [L/s]	300φ					450φ	600φ		750φ				900φ			1050φ		1200φ		1350φ	1500φ		1800φ	
Ecosol	In-line / End of line Solid Pollutant Filter RSF 6000		Flow [L/s]	450φ						600φ		750φ				900φ			1050φ		1200φ		1350φ	1500φ		1800φ	
Rocla	CleansAll		Inlet Dia [mm]	CL375				CL600					CL900							CL1350						CL1800	
Rocla	Downstream Defender [1]		Flow [L/s]	DD1200			DD1800			DD2400				DD3000													
Baramy	In-line and low profile units		Inlet Dia [mm]											300 - 1300φ													
CDS	Continuous Deflection Separator (CDS Unit)		Flow [L/s]		F0908				P1512				P1516		P2018			P2028					P3024		* Combinations		
Oil and Grit Separators																											
Humes	Humeceptor STC	hydrocarbons, sediments	Model No.	STC2, STC3, STC5, STC7, STC9, STC14, STC18, STC23, STC27 - Contact CSR Humes for sizing information																							
Ecosol	Oil and Grease Arrester RSF 5000		Flow [L]	300φ					450φ	600φ		750φ				900φ			1050φ		1200φ		1350φ	1500φ		1800φ	
CDS	Continuous Deflection Separator (CDS Unit)		Flow [L/s]	F0908				P1512				P2018					* Sized on flow, capacity and/or maintenance costs										
Grease Traps																											
Everhard	Grease Traps [2]	hydrocarbons	Trap Capacity [L]	250-10,000 L Traps [3]																							
Open GPT																											
Baramy	Universal and Direct Flow Units	litter, sediment	Inlet Dia [mm]											300 - 1500φ													
Baramy	Channel GPT	litter	Unit Size [m]	Treatable Flow = 40% of channel depth																							
End of Pipe Litter Nets																											
Stormwater Systems	Pratten Trap - PT 2000	litter	Inlet Dia [mm]	PT2000																							
Net Tech	Gross Pollutant Interceptor		Inlet Dia [mm]	All																							
Litter Baskets																											
Ecosol	End of Line Solid Pollutant Filter RSF 1000	litter, coarse sediments	Unit Dia [mm]		300φ			450φ		600φ																	
Side Entry Trap																											
Ecosol	At Source Solid Pollutant Filter RSF 100 & RSF GSP	litter, coarse sediments	Gully trap size	* Standard single/double/triple gully pit and pavement grated inlets.																							
Sediment Trap																											
Hydro	Storm King Overflow [4]	coarse sediments	Unit Size [m]		3.0φ x 2.57					3.66φ x 3.0m		5.0φ x 3.59m					6.0φ x 4.13m										
Hydro	Grit King [4]		Unit Dia [m]		1.4φ		2.6φ					3.4φ			4.1φ					*Indicative sizes (designed for 10 – 1000L/s)							
Swales & Filter Strips																											
	Grass swales and filter strips	sediments, nutrients, metals, litter	Hydraulic residence time	* See Table C4.5 for design considerations to achieve a hydraulic residence time of at least 9 minutes.																							

Notes for Table C4.4:

1. Also a sediment trap.
2. Many grease traps are not designed to be stormwater quality controls.
3. Maximum flow rate = 0.07 – 0.6 L/s.
4. Designed for sewage treatment, hence large diameters and high rate of removal.

Design Notes for Table C4.4:

- Devices cannot be selected on the basis of size alone. All relevant design criteria must be taken into account when selecting a device.
- Other relevant criteria include pollutant characteristics, maintenance issues, hydraulic head, pipe gradient, tidal influence, health (mosquitoes & odours), safety, aesthetics, etc.

See next page for more notes. . .

Caveats for Table C4.4:

- This Table is not exhaustive, that is, it does not cover all of the devices on the market.
- Other effective devices will exist for which BCC does not have any sizing details.
- This Table should not be interpreted as a list of 'BCC preferred devices'.
- New designs are emerging every year, care is needed to ensure that users of this guideline are accessing up-to-date information (when in doubt contact suppliers).

Reference can be made to the manufacturer of the device, and also to:

- CRC for Catchment Hydrology, 1997. *Best Practice Environmental Management Guidelines for Urban Stormwater* (Report 97/7). Cooperative Research Centre for Catchment Hydrology, Melbourne.
- NSW EPA, 1997. *Treatment Techniques: Managing Urban Stormwater.* EPA, NSW.
- Vic. EPA, Melbourne Water, Department of Natural Resources, et al, 1999. *Best Practice Environmental Management Guidelines for Urban Stormwater. EPA, Vic.*
- Brisbane City Council, 1999. *Draft SQID Design Guidelines.* Brisbane City Council, Brisbane.

TABLE C4.5 DESIGN CONSIDERATIONS FOR SOME SECONDARY STORMWATER QUALITY BEST MANAGEMENT PRACTICES/DEVICES

Design Parameter	Secondary SQBMPs					
	Grass Swales	**Filter Strips**	**Sand Filters**	**Infiltration Trench / Basin**	**Porous Pavements**	**Extended Detention Basins**
Description	Grass lined channels for conveying runoff. Mechanisms = settling, filtration and infiltration into the subsoil.	Grassed or vegetated areas that treat overland (sheet) flow. Mechanisms = settling, filtration and infiltration into the subsoil.	Pass runoff through bed of sand or similar medium overlying an underdrain system. Mechanisms = sedimentation and infiltration.	Trench - Shallow, excavated trench filled with gravel through which runoff drains to subsoil. Basin - Excavated basin designed to infiltrate runoff through the basin floor. Mechanisms = soil infiltration.	Coarse (open) graded concrete / asphalt pavement or open modular paving to facilitate infiltration to underlying soil. Mechanisms = soil infiltration.	Basin designed to store runoff for 1-2 days and release through low flow outlet structure. Mechanisms = sedimentation.
Soil Type	Variable, but permeable soil types preferred. Consideration should be given to installing subsoil drainage to ensure effective drainage and infiltration where slopes are <2%.	Variable.	Generally housed within a formal concrete structure. Characteristics of inflow sediment will significantly affect performance of the filter.	Typical subsoil percolation rates = > 0.8-1.3 mm/hr (R11) or > 15 mm/hr (R7) or > 7mm/hr (R10). Soil should not have more than 30% clay or 40% combined clay and silt. Generally only loams, sandy loams and loamy sands are suitable. Bed of facility should be at least 1.0-1.5 m above water table or impermeable layer.	Moderate soil infiltration rates are required. Soil types similar to those for infiltration trenches and basins are deemed suitable. Bed of facility should be at least 1.0-1.5 m above the water table or any impermeable layer.	Appropriate for all soil types, can be operated wet or dry.
Gradient / Velocities	Non scouring velocities should be maintained. Slopes should be up to 4% (dependent on vegetation), preferably with a uniform grade. For larger slopes (up to 6%) small check dams can be incorporated every 15 to 30m to reduce velocities and enhance residence time. High flow bypass recommended to prevent erosion. Also, see comments above for subsoil drainage where slopes are <2%.	Uniform slope and cross section desirable. Slopes up to 5% (dependent on vegetation). For slopes below 2%, installation of subsoil drainage should be considered. High flow bypass recommended to prevent erosion.	Energy dissipator recommended at inlet. High head loss and relatively low flow rates through filter. Velocities to minimise resuspension (<0.3 m/s). Pre-treatment settling basin to achieve 60-75% suspended solids retention (ie coarse sediment). Sand media filtration time of approximately 16-24 hours.	Suitable only on slopes < 15%. Not suitable in areas of geotechnical instability. Filtration times of 24-72 hours recommended. Infiltration period related to inter-event period with the aim of minimising anaerobic conditions underground and the growth of algae.	Slope of porous pavement should generally not exceed 5%.	Applicable for all catchment slopes, although the basin site is itself unsuitable on steep or unstable slopes. Sedimentation optimised at low velocities hence energy dissipators at inflow may be appropriate (design velocity < 0.3 m/s). Optimum detention time is usually between 24-40 hours.

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TABLE C4.5 DESIGN CONSIDERATIONS FOR SOME SECONDARY STORMWATER QUALITY BEST MANAGEMENT PRACTICES/DEVICES (CONT.)

Design Parameter	**Secondary SQBMPs**					
	Grass Swales	**Filter Strips**	**Sand Filters**	**Infiltration Trench / Basin**	**Porous Pavements**	**Extended Detention Basins**
Vegetation	Vegetation must be maintained all year and prolonged shading should be avoided. Vegetation choice dependant on soil type and climatic conditions. Pollutant uptake by grass is negligible. Grass to be dense to maximise residence time, filtration and infiltration as well as minimise erosion.	Vegetation must be maintained all year. Requires adequate sunlight, with prolonged shading to be avoided. Vegetation choice dependant on soil type, climatic conditions and the adjacent ecology (ie existing waterway corridor vegetation may need to be protected from possible 'weed invasion' from the buffer zone). Pollutant uptake by grass is negligible. Grass to be dense to maximise filtration and minimise erosion.	Large configuration sand filters can have topsoil and grass cover. Vegetation largely irrelevant for sand filtration process.	Trenches – not applicable. Although pre-treatment is mandatory for infiltration devices to prevent clogging due to sedimentation. Basin - provision of grassed basin.	Not applicable, although pre-treatment is recommended in order to minimise sediment load and reduce the likelihood of clogging of pavement.	Vegetative cover (designed to filter sediment and minimise erosion impacts) is desirable. Grass species tolerant to frequent inundation in base of basin are recommended.
Water Depth	1/3 to ½ of the grass height, up to maximum of 75 mm (for regularly mowed swales). Reduced effectiveness for concentrated flows and high flow depths.	Sheet flow required. Maximum depth of flow = 12 mm. Reduced effectiveness for concentrated flows and high flow depths.	Dictated by filtration and pre-treatment detention times (See Gradients and Velocities).	Contingent on runoff volume and infiltration rate.	Contingent on runoff volume and infiltration rate.	Contingent on runoff, basin dimension and detention time. Sedimentation enhanced by shallow depths, average depth of 1-2m recommended.
Maintenance Requirements	Maintenance of a dense vegetative cover. Prevent ponding for extended periods (as it may damage the grass cover). Remediation of erosion and channelisation. Prevent vehicular access and associated ruts. Removal of sediment associated with check dams (used where gradients are 4-6%).	Maintenance of vegetative cover. Remediation of erosion and channelisation. Prevent vehicular access.	Performance can be deleteriously affected by poor maintenance of filter media. High maintenance demand to prevent filter clogging. Cleaning, drying, replacement of sand to maintain optimum filter capability.	Removal and washing of clogged media and replacement of geotextile to relieve clogging in trenches. Removal of deposited sediment, tilling to enhance infiltration rates and grass mowing and maintenance in basins.	High number of reported failures of porous pavements due to limited infiltration attributable to pavement clogging. High suction vacuum sweeping and / or high-pressure jet hosing to maintain porosity. Repair of potholing and cracking. Replacement of clogged pavement areas.	Removal of accumulated debris / rubbish. Removal of accumulated sediment. Remediation of erosion damage. Unclogging of outlet structure. Grass mowing.
Monitoring	Regular inspection recommended especially during vegetation establishment period and after large storm events.	Regular inspection recommended especially during vegetation establishment period and after large storm events.	Regular inspection recommended after large storm events.	Regular inspections recommended every 6 months and after every large storm event.	Regular inspection recommended after large storm events.	Regular inspection particularly after large storm events.
Catchment Area	Generally apply to catchment < 2ha. The critical design issue however is hydraulic residence time (need 9 minutes or greater).	Generally apply to catchment < 2ha. The critical design issue however is hydraulic residence time (need 9 minutes or greater).	Generally apply to catchment < 2-5 ha.	Infiltration trench < 2 ha. Infiltration basin 2-5 ha.	Generally applicable to catchments 0.1-4 ha.	Generally applicable to catchments > 5 ha.

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TABLE C4.5 DESIGN CONSIDERATIONS FOR SOME SECONDARY STORMWATER QUALITY BEST MANAGEMENT PRACTICES/DEVICES (CONT.)

Design Parameter	Secondary SQBMPs					
	Grass Swales	**Filter Strips**	**Sand Filters**	**Infiltration Trench / Basin**	**Porous Pavements**	**Extended Detention Basins**
General Configuration and Sizing	Recommend swale length of at least 30 m to encourage sheet flow. Trapezoidal cross section with bottom width between 0.6 m and 2.5 m recommended. Uniform slope also desirable, bank slopes generally not to exceed 1:3 without permanent bank stabilisation. In cases where water logging may be a concern (eg slopes <2%), good design practice would be to incorporate subsoil drainage to enhance infiltration. Swales should be remote (>1.8m) from the edge of asphalt (or incorporate subsoil drainage) to prevent infiltration into the road pavement. In Brisbane, swales have been used successfully along the sides of roads that enter subdivisions, where a concrete strip (at ground level) separates the swale from the paved road.	Length of strip generally >6 m to maintain sheet flow. Shorter strips (>3 m) are acceptable for established sheet flow. Optimal hydraulic residence time of 9 minutes (slope/velocity dependant). Uniform slope is desirable and the cross section should be level. *Design steps:* 1. Estimate the design flow for the design storm event. 2. Determine the slope of the filter strip. 3. Set the design's flow depth (<12 mm). 4. Solve Manning's Equation to determine the width of the flow ('n' = 0.2 for mowed strips and 0.24 for natural grasses or infrequently mowed strips). 5. Determine the flow area. 6. Calculate the flow velocity, and adjust the strip's design parameters to ensure v<0.3m/s. 7. Calculate the flow length to achieve a hydraulic residence time of 9 minutes.	Minimum filtration media depth of 400 mm dependent on recommended filtration time (16-24 hours). Typical length to width ratio of at least 3:1 to prevent short circuiting. Energy dissipator at inlet. Two main configurations are common. 1) Large sand filters suitable for catchments up to 25-50 ha, generally including a pre-treatment basin for coarse sediment settling. 2) Smaller sand filters in underground pits / chambers generally applicable for highly impervious catchments up to 2 ha, installed within the piped drainage. Recommended sand grading between 0.1 and 1.0 mm.	Clean washed stone aggregate typically 25-75 mm diameter. Sand or geotextile layer placed in base of trench to prevent upward piping of soils. Trench walls also lined with geotextile to prevent migration of soil into rock media. Grassed basin with side slopes not exceeding 1:4 with a flat basin floor. Provide inflow energy dissipators and spillway to bypass events in excess of design requirements. Subsoil drainage infrastructure may also be considered to enhance infiltration. Care taken during construction of both basins and trenches to minimise compaction of the soil to aid infiltration. Trenches designed typically to capture 1 in 1 month ARI event with provision for overflow to be diverted elsewhere.	Coarse open grade asphalt / concrete pavement (excluding a large proportion of normal fine aggregate) or modular paving. Often underlaid by a deep gravel layer (reservoir), bedded on a sand layer. Runoff usually infiltrates to subgrade.	Usually sized to provide between 24-40 hours detention with a typical length to width ratio of 3:1 to 5:1. Grassed basin with side slope approx 5:1 for mowing, base slope >1-2% to prevent excessive ponding and mosquito breeding. Often a stabilised low flow path included to minimise scouring during frequent events. Outlet structures include weirs or outlet pipes. A minimum orifice diameter of 75 mm is recommended. Care should be taken to prevent blockage of outlet pipe. Energy dissipators at both basin inlet and outlet are desirable to control higher velocities and therefore provide scour protection both within the basin and downstream.

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TABLE C4.5 DESIGN CONSIDERATIONS FOR SOME SECONDARY STORMWATER QUALITY BEST MANAGEMENT PRACTICES/DEVICES (CONT.)

Design Parameter	**Secondary SQBMPs**					
	Grass Swales	**Filter Strips**	**Sand Filters**	**Infiltration Trench / Basin**	**Porous Pavements**	**Extended Detention Basins**
Others	Depth to groundwater to be considered from the perspective of groundwater contamination and vegetative maintenance. Ensuring swales are used in areas where cars will not be parked or driven on them is important (as ruts prevent sheet flow). Note that vegetated swales with extensive subsoil drainage are sometimes called 'bioretention systems').	Depth to groundwater to be considered from the perspective of groundwater contamination and vegetative maintenance.	-	Not generally applicable during the construction phase due to high sediment load. Potential for soil / groundwater contamination.	Porous pavement should be placed after stabilisation of surface drainage area (to prevent premature clogging). Not general suitable for areas with a high volume of traffic or heavy traffic. High failure rate due to clogging reported, apply with caution. Potential for soil / groundwater contamination.	Potential lower efficiencies for events less than the design event. Potential for re-suspension of sediments. Significant attenuation of storm events occurs as result of provision of detention basin. Public safety risks must be identified and managed (eg the risk of drowning due to 1-2m of ponded water).

References used to create table:

- NSW EPA, 1997. *Treatment Techniques: Managing Urban Stormwater.* EPA, NSW.
- Victorian Stormwater Committee, 1999. *Urban Stormwater – Best Practice Environmental Management Guidelines*. CSIRO Publishing, Melbourne.
- Cooperative Research Centre for Catchment Hydrology, 1997. *Best Practice Environmental Management Guidelines for Urban Stormwater (Report 97/7).* Cooperative Research Centre for Catchment Hydrology, Melbourne.