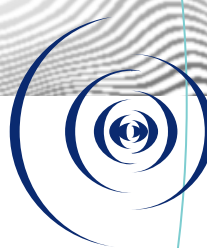
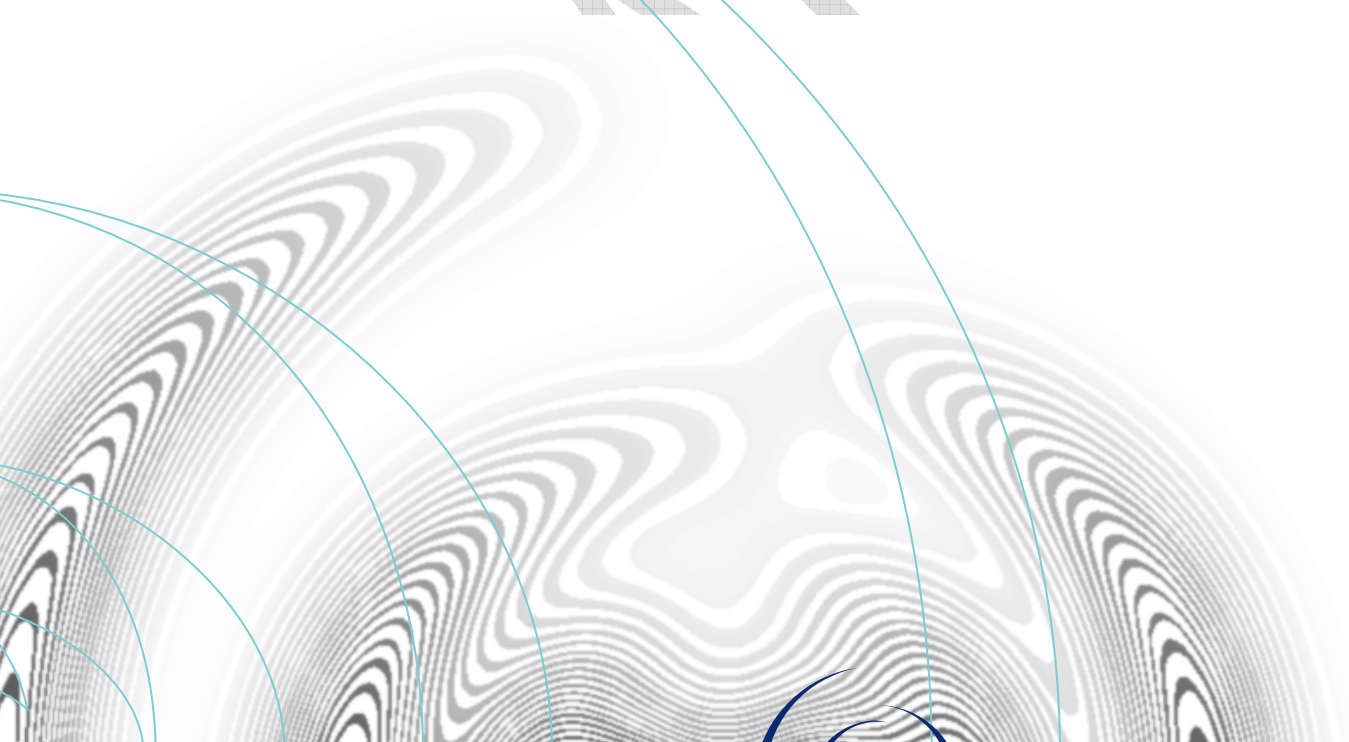
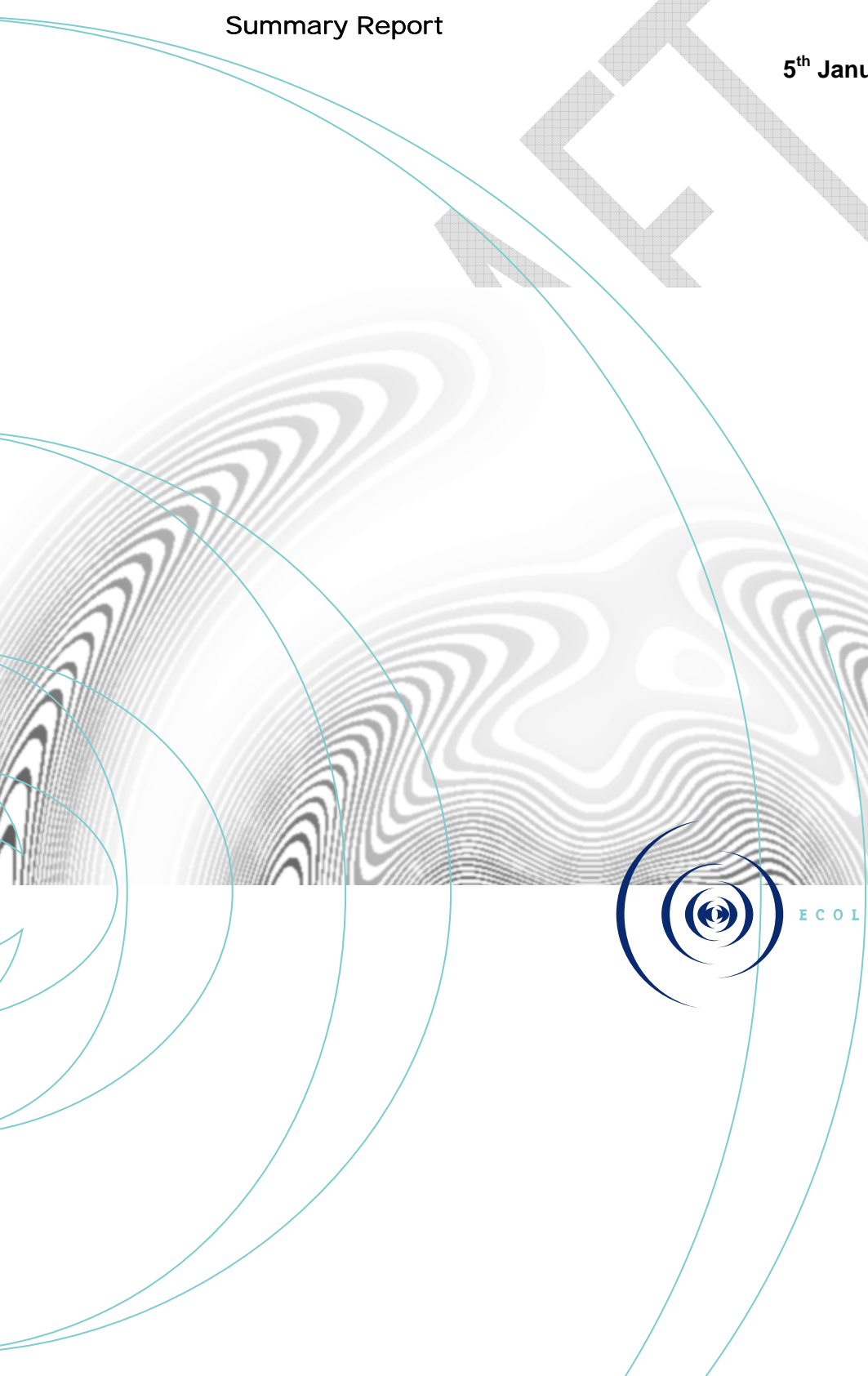
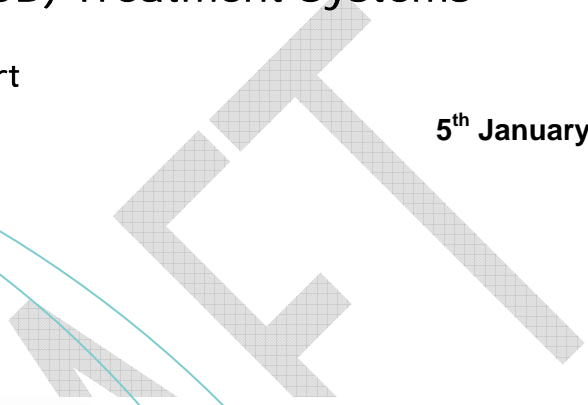


Life Cycle Costs of Water Sensitive Urban Design (WSUD) Treatment Systems

Summary Report

5th January 2007



ECOLOGICAL ENGINEERING

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1 Introduction

The utilisation of water sensitive urban design (WSUD) systems to treat stormwater runoff is becoming increasingly widespread throughout South East Queensland. Stormwater treatment designers, developers and councils need to understand the life cycle costs associated with the different treatment systems so as to make informed decisions regarding the appropriate application of WSUD technology. In response to the need for life cycle cost information, Brisbane City Council's (BCC) City Design group engaged Ecological Engineering to undertake the 'Life Cycle Costs of Water Sensitive Urban Design (WSUD) Treatment Systems' project.

1.1 Project Objectives

The project is a data collection and reporting exercise with the overall objective being the provision of a high quality data set that will guide Council, designers and developers in the selection and design of WSUD treatment systems. The project aimed to collect useful life cycle cost information for the following types of WSUD systems:

- Swales
- Bioretention Swales
- Bioretention Basins
- Bioretention Pods
- Sedimentation Basins
- Constructed Wetlands
- Infiltration Measures
- Sand Filters

The life cycle cost information was to be presented in a Microsoft Excel spreadsheet in a format that can be readily updated with future data.

1.2 Report Structure

This report summarises the work undertaken for this project and presents the results life cycle costs in the following sections:

- Section 2 outlines the methodology utilised to undertake the project.
- Section 3 describes the project outcomes and deliverables.
- Section 4 summarises the life cycle cost data and presents recommendations for the use of the collected data.
- Section 5 outlines some of the key observations and recommendations relating to the recording of life cycle cost data for WSUD treatment systems.



2 Methodology

The tasks undertaken to collect the life cycle cost information are outlined in the following sections.

Task 1 – Formulation of List of Potential WSUD Treatment Systems

The purpose of this task was to formulate a list of WSUD treatment systems that were to be considered for inclusion in the life cycle cost analysis. The intention was to identify a range of WSUD treatment systems covering each of the specified types, including systems that had been designed and constructed by the private sector in addition to those designed and constructed by Council. Although the list of potential WSUD treatment systems was mostly completed as part of this initial phase of the project, additional systems were added to the list throughout the course of the project as they were identified.

The following tasks were undertaken in order to identify potential WSUD treatment systems:

- Project meetings with City Design representatives to confirm the project objectives and obtain relevant life cycle cost information yielded by previous data collection exercises.
- Email and phone correspondence with personnel from the following sections of Council: i. City Design; ii. Water Resources; iii. Local Asset Services (LAS); iv. Vegetation & Pest Services (VPS); v. Development & Regulatory Services (DRS).
- Meetings with personnel from the Northern, Central, Southern and Eastern regions of Local Asset Services (LAS).
- Meetings and email/phone correspondence with personnel from the following consulting firms: i. ETS Group; ii. WBM Oceanics Australia; iii. Bligh Tanner; iv. Ecological Engineering.
- Site visits to visually assess potential WSUD treatment systems.

Task 2 – Development of WSUD Treatment System Shortlist

A brief assessment of each of the WSUD treatment systems identified in Task 1 was undertaken to determine its suitability for inclusion in the detailed life cycle cost assessment. Preference was given to WSUD treatment systems that best satisfy the following criteria:

- WSUD treatment system is a good example of best-practice design, as presented in BCC's WSUD Engineering Guidelines: Stormwater.
- Initial inquiries indicated that cost information is available and accessible.



- WSUD treatment system is representative of a 'typical' system, particularly with respect to its overall size, treatment function and position in a stormwater treatment 'train'.
- WSUD treatment system was constructed prior to 2006, so that some maintenance cost data is available.

Based on this assessment, a shortlist of suitable WSUD treatment systems was developed and presented to City Design. In collaboration with Ecological Engineering, City Design then determined which of the WSUD treatment systems were to be included in the life cycle cost assessment.

As specified in the Brief, the aim was to collect cost information for at least two (2) examples of each type of WSUD treatment system.

Task 2a – Refinement of List of WSUD Treatment Systems

As outlined above, a shortlist of suitable WSUD treatment systems was presented to City Design and a decision was made as to which of these systems would be included in the life cycle cost assessment. Subsequent to this decision, it was determined that cost data for some of the selected systems was not as accessible as originally thought. Therefore, the list of WSUD treatment systems to be assessed was refined and some substitutions were made. For example, ETS Group advised that construction cost information for the Daintree Dr Wetland at Parkinson was not easily accessible. Therefore, this wetland was replaced by the Kayannie St Wetland, which is similar in design.

Task 3 – Collection of Cost Data for WSUD Treatment Systems

Life cycle cost data was collected for each of the selected WSUD treatment systems. For the purposes of this project, WSUD treatment systems are considered to include all functional elements of the system as well as any landscaped areas directly surrounding the system. For example, a constructed wetland is considered to consist of the following elements (if they form part of the system):

- Gross Pollutant Trap (e.g. trash rack)
- Inlet Pond
- Macrophyte Zone
- High Flow Bypass Channel
- Islands, Internal Bunds, Ephemeral Zones
- Landscaped Areas Directly Surrounding Wetland (e.g. adjacent batter slopes)

Similarly, if a bioretention basin is formed by constructing an earthen bund to enclose a treatment zone, the bund itself and any terrestrial vegetation planted on the batter slopes is considered part of the basin.



The life cycle cost data was collected by the following methods:

- Visits to LAS offices to review LAS hard-copy files and digital spreadsheets and extract relevant cost data.
- Extracting data from spreadsheets compiled as part of previous data collection exercises.
- Meetings with maintenance staff to determine maintenance costs of specific WSUD treatment systems, based on time allocation and hourly rates.
- Reviewing design files for WSUD treatment systems.
- Email/phone correspondence with relevant personnel to obtain specific cost data.
- Engaging consulting firms to provide cost data for WSUD treatment systems they designed.
- Where practical, a site visit was undertaken to each of the selected WSUD treatment systems.

As required by the Brief, the data collection framework was based on that developed by Taylor (2003) and the collated data included:

- Commonly used name for the WSUD system / treatment measure
- Design / type of WSUD system / treatment measure
- Unusual characteristics (e.g. unusual construction costs or disposal costs)
- Expected life cycle / span
- Catchment area
- Area of treatment zone
- Surrounding land use and proportion of directly connected impervious area
- Cost elements
- How cost elements vary over time (e.g. maintenance)
- Corrective maintenance costs/ renewal and adaptation costs
- Assessment on the quality of the data collected

Separation of Establishment Maintenance Period from Ongoing Maintenance Period

Ecological Engineering's experience in the design and delivery of WSUD treatment systems throughout South East Queensland indicates there are three critical stages in the delivery and operation of these systems:



Functional Installation - Construction of the functional infrastructure elements of the WSUD treatment system (e.g. earthworks, pits/pipes, planting of vegetation). 'Acquisition Costs' are incurred at this stage.

Establishment Period - The WSUD treatment system is commissioned in accordance with the design intent (i.e. the system is planted in accordance with the design and the vegetation is established). This requires a substantial amount of care and attention to ensure successful establishment of the vegetation (i.e. weeding, watering to ensure vegetation matures). This can take up to 3 years and is when the 'Establishment Maintenance Costs' are incurred.

Ongoing Operation - Once the vegetation in the WSUD treatment system is established, it can be fully commissioned and commences operation. The ongoing maintenance costs associated with operation of the system are substantially less than those incurred during the establishment period. Costs are limited to the 'Ongoing Maintenance Costs' and infrequent 'Renewal & Adaptation Costs'.

The data collection exercise specifically targeted information required to generate an understanding of the difference between the 'Establishment Maintenance Costs' and the 'Ongoing Maintenance Costs'.

Task 4 - Analysis of Cost Data and Generation of Life Cycle Cost Spreadsheet

Initially, the life cycle cost data was analysed to ensure that the information was accurate and appropriate. Cost elements that appeared to be spurious were investigated and confirmed. Once this initial audit process was completed, the life cycle cost data was entered into a Microsoft Excel spreadsheet, using a modified template based on that developed by Taylor (2003).



3 Outcomes

3.1 List of Potential WSUD Treatment Systems

As outlined in Section 2 - Task 1, meetings and email/phone correspondence with relevant personnel enabled the formulation of a list of WSUD treatment systems that were considered for inclusion in the life cycle cost analysis. This list is presented in Appendix A.

3.2 Shortlist of WSUD Treatment Systems

As described in Section 2 - Task 2, the WSUD treatment systems listed in Appendix A were assessed for their suitability for inclusion in the detailed life cycle cost assessment. Based on this initial assessment, a shortlist of suitable WSUD treatment systems was developed and this shortlist is presented in Appendix B.

The majority of the WSUD treatment systems identified as part of Task 1 are roadside swales and it is clear that this is the dominant type of system throughout South East Queensland. The only suitable example of a bioretention basin identified within the Brisbane City Council LGA is the Hoyland St (Bracken Ridge) system, which was designed and constructed by BCC. Similarly, the only suitable bioretention pods that were identified are those designed and constructed by BCC at Streisand Dr (McDowell), Saturn Ct (Bridgeman Downs) and Melbourne St (South Brisbane).

It was not possible to achieve the objective of including two (2) examples of each of the WSUD treatment systems listed in Section 1.1, because no suitable 'infiltration measures' or 'sand filters' were identified.

3.3 Life Cycle Cost Data for WSUD Treatment Systems

The shortlist of suitable WSUD treatment systems was presented to City Design and a decision was made as to which of these systems would be included in the life cycle cost assessment. Subsequent to this decision, it was determined that cost data for some of the selected systems was not as accessible as originally thought. Therefore, the list of WSUD treatment systems to be assessed was refined and some substitutions were made. The final list of WSUD treatment systems for which life cycle cost data was collected is presented in Appendix C.

The life cycle cost data was entered into a Microsoft Excel spreadsheet and a print-out of this spreadsheet is contained in Appendix D. There are some data gaps in the spreadsheet, because not all cost information was readily available for each of the WSUD treatment systems. The life cycle costs spreadsheet has been provided to Council in digital form. It is intended that additional WSUD treatment systems be added to this spreadsheet in the future. Also, the maintenance costs should be refined as more detailed, long-term maintenance information becomes available.



Two bioretention basins from the Coomera Waters residential development are included in the spreadsheet; Rainbow Cct Bioretention Basin and Slipstream Rd Bioretention Basin. More than a dozen bioretention basins have been constructed at Coomera Waters and it is noted that the life cycle costs for all of the basins are similar to those of the two presented.

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4 Summary of Data & Recommendations for Use

The WSUD treatment systems that were analysed represent a variety of types, sizes and styles. As such, there is considerable variation in the life cycle costs. The total acquisition costs range from \$40,000 for the roadside bioretention pods recently constructed by Council in the northern suburbs to \$3.6M for the Bowie's Flat Wetland. The average annual maintenance costs range from \$1,500 for the smaller, established bioretention systems to \$30,000 for the larger wetlands that incorporate GPTs. The scale of these systems and the associated stormwater treatment capacity is drastically different and this is reflected in the life cycle costs.

Stormwater managers and designers of WSUD treatment systems are likely to be interested in the acquisition costs and maintenance costs presented as \$/m² unit rates. The total acquisition costs for bioretention swales, bioretention basins and constructed wetlands in greenfield situations range from \$100/m² to \$350/m². In some retrofit situations (e.g. Besline St Bioretention Swale, Bowie's Flat Wetland), these unit rates increase by up to \$300/m². The total acquisition costs for the Streisand Dr and Saturn Ct Bioretention Pods equate to \$2,000/m². One would expect the unit rates for small-scale systems such as these to be higher. However, the costs of these pods were unusually high because of the fact that they were some of the first pods to be retrofitted into an existing Brisbane streetscape and also they were specially designed to incorporate monitoring facilities. City Design has advised the likely unit rate cost of subsequent systems would be about 50% lower (i.e. \$1,000/m²).

The average annual maintenance costs during the establishment period for bioretention swales, bioretention basins and constructed wetlands range from \$7/m² to \$35/m². This reduces to an average annual cost of \$2/m² to \$12/m² for ongoing maintenance.

4.1 Using Collected Data to Predict Life Cycle Costs of Proposed WSUD Treatment Systems

This project assessed the life cycle costs of a relatively small sample of WSUD treatment systems. Only a few examples of each type of WSUD treatment system were included (e.g. 4 bioretention basins) and the systems were intentionally selected to represent contrasting examples within each of those types (e.g. a wetland constructed by the private sector in a greenfield development and a retrofit wetland constructed by Council in a constrained urban drainage corridor). Due to the small sample size and the intentional variety of WSUD treatment systems within the sample, one must be cautious about using the data to estimate the life cycle costs of a proposed WSUD treatment system. Despite this, the life cycle spreadsheet provides a starting point and should prove to be a useful guide. The usefulness of the life cycle cost spreadsheet will improve as more examples are added and the costs are refined based on more detailed information.



When using the spreadsheet to estimate the life cycle costs of a proposed WSUD treatment system, the recommended approach is to determine which system(s) in the spreadsheet best represents the proposed system and extract the relevant cost data. For example, if the proposed WSUD treatment system is a 1,500m² wetland located within a new greenfield residential development, the life cycle costs for the Kayannie St Wetland, the Daintree Dr Wetland and the Syzygium Grove Wetland would provide a good guide. However, the life cycle costs for the Bowie's Flat and Keith Boden Wetlands may be misleading because they represent systems that were retrofitted into existing urban drainage corridors.

4.2 Factors Affecting the Applicability of Collected Life Cycle Cost Data

The implementation of water sensitive urban design (WSUD) and the associated construction of WSUD treatment systems is a recent development. As such, there are relatively few examples of well-designed WSUD treatment systems in South East Queensland. This is an obvious constraint when endeavouring to undertake a life cycle cost assessment of the full range of WSUD treatment systems.

The intention was to select WSUD treatment systems that are good examples of best-practice design (as presented in BCC's WSUD Engineering Guidelines: Stormwater) and are representative of 'typical' systems, particularly with respect to their overall size and design. However, the pool of WSUD treatment systems from which to draw suitable examples is limited and some of the systems that have been included in the project are not entirely suitable. The following notes should be taken into consideration when utilising the life cycle cost spreadsheet:

- The WSUD treatment systems contained in the spreadsheet represent some of the first examples of their kind constructed in South East Queensland. In most instances, the designers, construction contractors and maintenance contractors have had to negotiate relatively steep learning curves with regard to WSUD treatment systems. As with any new technology, there are inherent inefficiencies that are likely to have influenced the life cycle costs presented in the spreadsheet. Over the past few years, there have been improvements in the approach to the design, construction and maintenance of WSUD treatment systems that should lead to cost reductions.
- The acquisition costs for Bowie's Flat Wetland are somewhat misleading due to the fact that they include landscape embellishments that are not critical aspects of the WSUD treatment system. For the purposes of this project, WSUD treatment systems are considered to include all functional elements of the system as well as any landscaped areas directly surrounding the system. Ideally, additional landscape embellishments, such as viewing platforms, boardwalks and signage, should not be included in the acquisition costs. For the Bowie's Flat Wetland, it was not possible to separate out the costs associated with these items.



- The Ragamuffin Dr West Bioretention Swale, Rainbow Cct Bioretention Basin, Slipstream Rd Bioretention Basin, and Syzygium Grove Wetland are located within the Coomera Waters residential development. It is important to note that this development has a relatively high level of landscape maintenance. The Coomera Waters Body Corporate is responsible for landscape maintenance and they employ a permanent on-site landscape maintenance contractor. Landscapes throughout the development are inspected on a daily basis and most are subject to weekly scheduled maintenance. In addition, remedial maintenance is undertaken when required. Such a high level of landscape maintenance is only likely to exist in similar masterplanned residential communities or iconic public park areas.
- In the case of retrofit projects, particularly those constructed in constrained sites (e.g. Bowie's Flat Wetland), it is important to understand the nature of the project and identify elements of the design that may have resulted in unusually high costs.
- The maintenance costs associated with a WSUD treatment system are influenced by whether the system incorporates a gross pollutant trap (GPT).
- Maintenance costs may be reduced when there are several WSUD systems in the same general location. For example, the four wetlands at Ridgewood Estate (Parkinson) are in close proximity to each other, which provides an opportunity to lump the systems in the same maintenance 'run'. Also, it may be possible to share the cost associated with bringing in specialised equipment (e.g. for de-silting or weed harvesting) between the four wetlands.
- Similarly, acquisition costs may be reduced if several WSUD treatment systems are constructed in close proximity to each other. In this instance, there would be economy of scale associated with hiring or commissioning plant/machinery.



5 Recording of Costs for WSUD Treatment Systems

5.1 Observations

Maintenance costs are a critical component of the life cycle cost of a WSUD treatment system. Uncertainty surrounding the ongoing maintenance costs of WSUD treatment systems is a common concern amongst asset managers and, as such, the collation of maintenance costs for existing systems is a key outcome of this project. Unfortunately, the collection of accurate, representative maintenance cost data is compromised by the incomplete, inconsistent and non-specific maintenance records for some WSUD treatment systems.

During the course of the project, the following observations were made regarding the way in which the life cycle costs, in particular maintenance costs, associated with WSUD treatment systems are recorded.

- The maintenance of landscapes within privately developed residential estates (e.g. Ridgewood Estate) is typically undertaken by a landscape contractor during the 'on maintenance' period prior to the handover of the landscapes to Council. In the case of developments that are managed by a Body Corporate (e.g. Coomera Waters), the landscapes may never get handed over to Council and the landscape contractor continues to maintain the landscapes. The landscape contractor is typically responsible for all landscapes, including road verges, garden beds, local parks and WSUD treatment systems. As such, they usually don't have itemised maintenance records and it is difficult to determine the costs associated with maintaining an individual WSUD treatment system.
- In the case of WSUD treatment systems that are maintained by Local Asset Services (LAS), the maintenance costs associated with various elements of a single system are often recorded separately. In the case of a wetland, the cost records for cleaning the GPT (trash rack) are often kept in a separate file to the cost records for maintaining the vegetation or de-silting the inlet pond. This is primarily due to the organisation of the budgets for maintaining WSUD treatment systems. For example, in the case of the Keith Boden Wetland, cleaning the GPT (trash rack) and litter removal fall within the Stormwater Quality Improvement Device (SQID) budget, but weed removal comes under the Open Drains budget.
- There is a lack of standard procedures and forms for recording the maintenance costs associated with WSUD treatment systems.
- Maintenance manuals for WSUD treatment systems that are designed and constructed by the private sector often do not get handed over from Development & Regulatory Services (DRS) to LAS. In general, there appears



to be a lack of adequate handover of WSUD treatment systems between these departments.

- There seems to be some reluctance to include 'vegetated' stormwater treatment systems (e.g. bioretention basins) on SQID maintenance lists that are currently dominated by 'hard' stormwater treatment systems (e.g. GPTs). In some cases, the maintenance of a GPT that forms part of a constructed wetland is included on the SQID maintenance list, but the general maintenance of the wetland (e.g. pruning vegetation, litter/weed removal) and de-silting of the inlet pond are not.
- Not surprisingly, it proved difficult to collect cost data that was more than a couple of years old. In some instances, the design files containing construction costs needed to be retrieved from archive storage.

5.2 Recommendations

The following recommendations relate to the recording of life cycle costs for WSUD treatment systems:

- If Council is keen to gain a comprehensive understanding of the acquisition costs of WSUD treatment systems, a standard data sheet should be developed that needs to be submitted when the systems are handed over to Council. The data sheet would need to capture basic design information, design costs, construction costs and, if possible, initial maintenance costs.
- The maintenance records and costs of all elements of a WSUD treatment system should be kept in a common file. A WSUD treatment system is considered to include all functional elements of the system as well as any landscaped areas directly surrounding the system. For example, a constructed wetland is considered to consist of the following elements (if they form part of the system): (i) Gross Pollutant Trap (e.g. trash rack); (ii) Inlet Pond; (iii) Macrophyte Zone; (iv) High Flow Bypass Channel; (v) Islands, Internal Bunds, Ephemeral Zones; and (vi) Landscaped Areas Directly Surrounding Wetland (e.g. adjacent batter slopes). It may be possible to simply incorporate maintenance of the entire WSUD treatment system into the SQID maintenance program. For example, in the case of a wetland, it would be appropriate to have separate listings for (1) cleaning the GPT; (2) general maintenance (e.g. litter/weed removal, vegetation maintenance); and (3) sediment removal.



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Appendix A: List of Potential WSUD Treatment Systems

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Name of WSUD System	Type of WSUD System	Description of WSUD System	Scale of WSUD System	Location	BCC LAS Region	Source
Carindale Pines Roadside Swale	swale	roadside turf swale (residential development)	streetscape	Carindale Pines, Carindale (via Wright St)	East	Bill Manners
Surbiton Ct Swale	swale			Surbiton St, Carindale	East	Bill Manners
Habitat Dr Swale	swale			Habitat Dr, Wakerley	East	Bill Manners
Hindes St Swale	swale			Hindes St, Lota	East	LAS - East
Moss Rd Swale	swale			Moss Rd, Wakerley	East	LAS - East
Mozart Pl Swale	swale			Mozart Pl, Mackenzie	East	LAS - East
Stanbrough Rd Swale	swale			Stanbrough Rd, Belmont	East	LAS - East
Whites Rd Swale	swale			Whites Rd, Manly West	East	LAS - East
Woodcrest Estate Swales	swale	swales in road reserve		Woodcrest Estate, Pullenvale	West	Bill Manners
Gunnin St Swales	swale			93 Gunnin St, Fig Tree Pocket	West	Bill Manners
Upper Brookfield Rd Swales	swale			850 Upper Brookfield Rd, Upper Brookfield	West	Bill Manners
Samford Rd Swales	swale			928 Samford Rd, Mitchelton	West	Bill Manners
Payne Rd Swale	swale			170 Payne Rd, The Gap (Parkside Place)	West	Bill Manners
Parkwood Estate Swales	swale			100 Stapylton Rd, Heathwood (Parkwood Estate)	South	Bill Manners
The Sanctuary Swales	swale			Sanctuary Dr, Heathwood (The Sanctuary, Forest Lake)	South	Bill Manners
Edenbrooke Swales	swale			Edenbrooke Dr, Sinnamon Park (Edenbrooke Estate)	South	Bill Manners
Windermere Swales	swale			Brinley Pl, Sinnamon Park (Windermere Estate)	South	Bill Manners



Ridgewood Estate Swales	swale			Wallum Dr, Ridgewood Estate, Parkinson	South	LAS - South
Tallowood Way Roadside Swale	swale	roadside turf swale (residential development)	streetscape	Tallowood Way, Sunnybank Grove, Sunnybank Hills (via Jackson Rd)	South	Bligh Tanner
Bellbird PI Swales	swale			22 Bellbird PI, McDowell	North	Bill Manners
Bluegum PI Swales	swale			Bluegum PI, Taigum	North	Bill Manners
Rosemount PI Swales	swale			Rosemount PI, Bridgeman Downs	North	Bill Manners
Lacey Rd Swales	swale			202A Lacey Rd, Bald Hills	North	Bill Manners
Telegraph Rd Swales	swale			170 Telegraph Rd, Bracken Ridge	North	Bill Manners
Bancroft Rd Swales	swale			47 - 113 Bancroft Rd, Pinkenba	North	Bill Manners
Raynbird PI Swales	swale			Raynbird PI, Carseldine	North	LAS - North
Barbour Rd Swales	swale			Barbour Rd, Bracken Ridge	North	LAS - North
Talltrees St Swales	swale			Talltrees St, Bracken Ridge	North	LAS - North
Strove St Swales	swale			Strove St, Bracken Ridge	North	LAS - North
Mell St Swales	swale			Mell St, Bracken Ridge	North	LAS - North
Overlea St Swales	swale			Overlea St, Nudgee	North	LAS - North
Presidents PI Swales	swale			Presidents PI, Carseldine	North	LAS - North
Ecovillage Roadside Swale	swale				n/a	Bligh Tanner
Watarrka Dr Bioretention Swale	bioretention swale	roadside turfed bioretention swale (residential development)	streetscape	Watarrka Dr, Ridgewood Estate, Parkinson (via Algester Rd & Wallum Dr)	South	LAS - South
Ragamuffin Dr West Bioretention Swale	bioretention swale	roadside turfed bioretention swale (residential development)	streetscape	Ragamuffin Dr West (between Slipstream Rd & Helsal Ct), Coomera Waters, Coomera (via Foxwell Rd)	n/a	Ecological Engineering



Wallum Dr Bioretention Swale	bioretention swale	rock-lined vegetated bioretention swale in road verge (residential development)	streetscape	Adjacent to Wallum Dr near bridge connecting to Roseneath Dr, Ridgewood Estate, Parkinson	South	LAS - South
Imlay PI Bioretention Swale	bioretention swale	rock-lined vegetated bioretention swale in park area (residential development)	streetscape	In park adjacent to Imlay PI, Ridgewood Estate, Parkinson	South	LAS - South
Besline St Bioretention Swale	bioretention swale	vegetated bioretention swale in park (retrofit, including surcharge structure to divert flows from existing stormwater network)	neighbourhood	Wally Tate Park, Besline St, Kuraby	South	City Design
Hoyland St Bioretention Basin	bioretention basin	bioretention basin (retrofit)	neighbourhood	Hoyland St, Bracken Ridge	North	City Design
Rainbow Circuit Bioretention Basin	bioretention basin	bioretention basin (residential development)	neighbourhood	cnr Solo PI & Rainbow Cct, Coomera Waters, Coomera (via Foxwell Rd)	n/a	Ecological Engineering
Slipstream Rd Bioretention Basin	bioretention basin	bioretention basin (residential development)	neighbourhood	cnr Ragamuffin Dr West & Slipstream Rd, Coomera Waters, Coomera (via Foxwell Rd)	n/a	Ecological Engineering
Brushbox Ct Bioretention Basin	bioretention basin	bioretention basin (residential development)	neighbourhood	adjacent to Brushbox Ct, Sunnybank Grove, Sunnybank Hills (via Jackson Rd & Tallowood Way)	South	Bligh Tanner
Ecovillage Bioretention Basin	bioretention basin					Bligh Tanner
Mirbelia St Bioretention Basin	bioretention basin			in parkland adjoining 76 Bozatto PI, Kenmore	West	Bill Manners
Tivoli PI Bioretention Basin	bioretention basin			129 McGinn Rd, Ferny Grove (Tivoli Place)	West	Bill Manners



Bellbird PI Bioretention Basin	bioretention basin			22 Bellbird PI, McDowell	North	LAS - North
Streisand Dr Bioretention Pod	bioretention pod	roadside bioretention pod (retrofit)	streetscape	Streisand Dr (near intersection with Minnelli PI), McDowell	North	City Design
Saturn Ct Bioretention Pod	bioretention pod	roadside bioretention pod (retrofit)	streetscape	Saturn Ct (at intersection with Protea PI), Bridgeman Downs	North	City Design
Melbourne St Bioretention Pods	bioretention pod	roadside bioretention pod (retrofit)	streetscape	Melbourne St, South Brisbane	South	City Design
Hillcroft PI Bioretention Pod	bioretention pod			Hillcroft PI, Belmont	East	Bill Manners
Hindes St Bioretention Pod	bioretention pod			Hindes St, Lota	East	LAS - East
Surbiton Ct Bioretention	bioretention			Surbiton St, Carindale	East	Bill Manners
Parkwood Estate Bioretention	bioretention			100 Stapylton Rd, Heathwood (Parkwood Estate)	South	Bill Manners
The Sanctuary Bioretention	bioretention			Sanctuary Dr, Heathwood (The Sanctuary, Forest Lake)	South	Bill Manners
Edenbrooke Bioretention	bioretention			Edenbrooke Dr, Sinnamon Park (Edenbrooke Estate)	South	Bill Manners
Payne Rd Bioretention	bioretention			170 Payne Rd, The Gap (Parkside Place)	West	Bill Manners
Lacey Rd Bioretention	bioretention			202A Lacey Rd, Bald Hills	North	Bill Manners
Telegraph Rd Bioretention	bioretention			170 Telegraph Rd, Bracken Ridge	North	Bill Manners
Golden Ave Sedimentation Basin	sedimentation basin	concrete lined sedimentation basin directly upstream of wetland/ponds on Scrubby Ck (retrofit)	suburban	adjacent to intersection of Madder Cl & Orangetip Cr, Calamvale (via Golden Ave)	South	City Design



Inlet Pond of Bowie's Flat Wetland	sedimentation basin	inlet pond of constructed wetland (retrofit)	suburban	Bowies Flat, Bridgewater Ck, Coorparoo (via Leicester St)	East	City Design
Inlet Pond of Syzygium Grove Wetland	sedimentation basin	inlet pond of wetland	neighbourhood	Coomera Waters, Coomera (via Foxwell Rd)	n/a	Ecological Engineering
Hellawell Rd Sedimentation Basin	sedimentation basin	sedimentation basin located in base of flood detention basin (retrofit)	suburban	Lexington Pl, Sunnybank Hills (via Hellawell Rd)	South	City Design
Torquay Cres Sediment Trap	sedimentation basin			Tingalpa		City Design
Kayannie St Wetland	constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Kayannie St, Ridgewood Estate, Parkinson (via Alger Rd)	South	LAS - South
Daintree Dr Wetland	constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Daintree Dr, Ridgewood Estate, Parkinson (via Alger Rd)	South	LAS - South
Greenways Esp Wetland	constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Greenways Esp, Ridgewood Estate, Parkinson (via Alger Rd)	South	LAS - South
Roseneath Dr Wetland	constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Roseneath Dr, Ridgewood Estate, Parkinson (via Alger Rd)	South	LAS - South
Syzygium Grove Wetland	constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Ceil Cct, Coomera Waters, Coomera (via Foxwell Rd)	n/a	Ecological Engineering
Bowie's Flat Wetland	constructed wetland	constructed wetland (retrofit)	suburban	Bowies Flat, Bridgewater Ck, Coorparoo (via Leicester St)	East	City Design
Keith Boden Wetland	constructed wetland	constructed wetland (retrofit)	suburban	behind Scout Hall in Murray Duus Park, Cressey St, Nundah	North	City Design



Ingham's Wetlands	constructed wetland (x2)	constructed wetland (industrial development)	suburban	Ingham's site, Murarrie	East	Bligh Tanner
Livesay Rd Wetland	constructed wetland	dam reconditioned into constructed wetland		84 Livesay Rd, Bellbowrie	West	Bill Manners
Edenbrooke Wetland	constructed wetland			Edenbrooke Dr, Sinnamon Park (Edenbrooke Estate)	South	Bill Manners
Windermere Wetland	constructed wetland			Brinley Pl, Sinnamon Park (Windermere Estate)	South	Bill Manners
Fiesole Pl Wetland	constructed wetland			Fiesole Pl, Bridgeman Downs	North	LAS - North

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Appendix B: Shortlist of WSUD Treatment Systems

Shortlist of WSUD Systems for Life Cycle Costs Project (13/09/06)

Swales

S1. Ridgewood Estate, Parkinson (via Algester Rd and Wallum Dr)

Description: Turf roadside swales on numerous streets.

Organisation: Stockland

Construction: 2002 - 2003 (?)

Contact: ETS Group (Keith Howells)

S2. Carindale Pines, Carindale (via Wright St)

Description: Turf roadside swale along one street.

Organisation: Property Marketing Corporation

Construction: 2002 (?)

Contact: Bligh Tanner (Chris Tanner)

S3. Sunnybank Grove, Sunnybank Hills (via Jackson Rd and Tallowood Way)

Description: Turf and rock-lined roadside swales on several streets.

Organisation: Devine Homes (?)

Construction: 2004 (?)

Contact: Bligh Tanner (Chris Tanner)

S4. Coomera Waters, Coomera (via Foxwell Rd)

Description: Turf and rock-lined roadside swales on numerous streets.

Organisation: Austcorp

Construction: 2003 - 2005

Contact: Ecological Engineering (Shaun Leinster)

Bioretention Swales

BS1. Besline St Swale in Wally Tate Park, Kuraby

Description: Regional bioretention swale in park planted with rushes and sedges.

Organisation: BCC



Construction: 2004

Contact: Ecological Engineering (Sally Taylor)

BS2. Coomera Waters, Coomera (via Foxwell Rd)

Description: Turf roadside bioretention swales on numerous streets.

Organisation: Austcorp

Construction: 2003 - 2005

Contact: Ecological Engineering (Shaun Leinster)

Bioretention Basins

BB1. Hoyland St Bioretention Basin, Bracken Ridge

Description: Regional bioretention basin.

Organisation: BCC

Construction: 1998

Contact: BCC (Alastair McHarg)

BB2. Coomera Waters, Coomera (via Foxwell Rd)

Description: Numerous bioretention basins.

Organisation: Austcorp

Construction: 2003 - 2005

Contact: Ecological Engineering (Shaun Leinster)

Bioretention Pods

BP1. Streisand Dr Bioretention Pod, McDowell

Description: Roadside bioretention pod.

Organisation: BCC

Construction: 2006

Contact: BCC (Ross Allen)

BP2. Saturn Ct Bioretention Pod, Bridgeman Downs

Description: Roadside bioretention pod.

Organisation: BCC

Construction: 2006



Contact: BCC (Ross Allen)

BP3. Melbourne St Bioretention Pods, South Brisbane

Description: Roadside bioretention pods.

Organisation: BCC

Construction: 2004

Contact: BCC (Alastair McHarg)

Sedimentation Basins

SB1. Golden Ave Sedimentation Basin, Calamvale (at Juxgold PI)

Description: Regional sedimentation basin located on Scrubby Ck.

Organisation: BCC

Construction: 1998

Contact: BCC (Alastair McHarg ?)

SB2. Inlet Pond of Bowies Flat (Bridgewater Ck) Wetland, Coorparoo

Description: Inlet pond of regional wetland located on Bridgewater Ck.

Organisation: BCC

Construction: 1999

Contact: BCC (Alastair McHarg ?)

SB3. Inlet Pond of Stage 12 Wetland, Coomera Waters, Coomera (via Foxwell Rd)

Description: Inlet pond of wetland.

Organisation: Austcorp

Construction: 2004

Contact: Ecological Engineering (Shaun Leinster)

Constructed Wetlands

W1. Wetland 5 at Ridgewood Estate, Parkinson (via Algester Rd and Daintree Dr)

Description: Wetland with meandering flow path and several zones.

Organisation: Stockland



Construction: 2002 (?)

Contact: ETS Group (Keith Howells)

W2. Stage 12 Wetland, Coomera Waters, Coomera (via Foxwell Rd)

Description: Wetland designed in accordance with BCC WSUD design guidelines.

Organisation: Austcorp

Construction: 2004

Contact: Ecological Engineering (Shaun Leinster)

W3. Bowies Flat (Bridgewater Ck) Wetland, Coorparoo (via Leicester St)

Description: Regional wetland designed in accordance with BCC WSUD design guidelines.

Organisation: BCC

Construction: 1999

Contact: BCC (Alastair McHarg ?)

W4. Cressey St Wetland, Murray Duus Park, Nundah

Description: Regional wetland.

Organisation: BCC

Construction: 1999

Contact: BCC (Alastair McHarg ?)

Infiltration Measures

IM1. Sunnybank Grove, Sunnybank Hills (via Jackson Rd and Tallowood Way)

Description: Numerous infiltration basins planted with rushes and sedges.

Organisation: Devine Homes (?)

Construction: 2004 (?)

Contact: Bligh Tanner (Chris Tanner)

Sand Filters

No suitable systems identified.



Appendix C: WSUD Treatment Systems included in Life Cycle Cost Analysis

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Name of WSUD System	Alternative Name / Reference from Design Drawings	Type of WSUD System	Description of WSUD System	Scale of WSUD System	Location	BCC LAS Region
Watarrka Dr Bioretention Swale		swale	roadside turf swale (residential development)	streetscape	Watarrka Dr, Ridgewood Estate, Parkinson (via Algester Rd & Wallum Dr)	South
Tallowood Way Roadside Swale		swale	roadside turf swale (residential development)	streetscape	Tallowood Way, Sunnybank Grove, Sunnybank Hills (via Jackson Rd)	South
Ecovillage Roadside Swale						
Ragamuffin Dr West Bioretention Swale	Coomera Waters Phase 2 Stages 13&14 - Bioretention Swale Sections BIO 4 to BIO 10	bioretention swale	roadside turfed bioretention swale (residential development)	streetscape	Ragamuffin Dr West (between Slipstream Rd & Helsal Ct), Coomera Waters, Coomera (via Foxwell Rd)	n/a
Wallum Dr Bioretention Swale		bioretention swale	rock-lined vegetated bioretention swale in road verge (residential development)	streetscape	Adjacent to Wallum Dr near bridge connecting to Roseneath Dr, Ridgewood Estate, Parkinson	South
Imlay Pl Bioretention Swale		bioretention swale	rock-lined vegetated bioretention swale in park area (residential development)	streetscape	In park adjacent to Imlay Pl, Ridgewood Estate, Parkinson	South
Besline St Bioretention Swale		bioretention swale	vegetated bioretention swale in park (retrofit, including surcharge structure to divert flows from existing stormwater network)	neighbourhood	Wally Tate Park, Besline St, Kuraby	South
Hoyland St Bioretention Basin		bioretention basin	bioretention basin (retrofit)	neighbourhood	Hoyland St, Bracken Ridge	North



Rainbow Cct Bioretention Basin	Coomera Waters Phase 2 Stage 15 - Raingarden 2	bioretention basin	bioretention basin (residential development)	neighbourhood	cnr Solo Pl & Rainbow Cct, Coomera Waters, Coomera (via Foxwell Rd)	n/a
Slipstream Rd Bioretention Basin	Coomera Waters Phase 2 Stage 16 - Raingarden 1	bioretention basin	bioretention basin (residential development)	neighbourhood	cnr Ragamuffin Dr West & Slipstream Rd, Coomera Waters, Coomera (via Foxwell Rd)	n/a
Ecovillage Bioretention Basin						
Streisand Dr Bioretention Pod		bioretention pod	roadside bioretention pod (retrofit)	streetscape	Streisand Dr (near intersection with Minnelli Pl), McDowell	North
Saturn Ct Bioretention Pod		bioretention pod	roadside bioretention pod (retrofit)	streetscape	Saturn Ct (at intersection with Protea Pl), Bridgeman Downs	North
Golden Ave Sedimentation Basin		sedimentation basin	concrete lined sedimentation basin directly upstream of wetland/ponds on Scrubby Ck (retrofit)	suburban	adjacent to intersection of Madder Cl & Orangetip Cr, Calamvale (via Golden Ave)	South
Hellawell Rd Sedimentation Basin		sedimentation basin	sedimentation basin located in base of flood detention basin (retrofit)	suburban	Lexington Pl, Sunnybank Hills (via Hellawell Rd)	South
Torquay Cr Sedimentation Basin		sedimentation basin	sedimentation basin	suburban	Torquay Crescent, Tingalpa	East
Kayannie St Wetland		constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Kyannie St, Ridgewood Estate, Parkinson (via Algester Rd)	South
Daintree Dr Wetland		constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Daintree Dr, Ridgewood Estate, Parkinson (via Algester Rd)	South



Syzygium Grove Wetland	Coomera Waters Phase 2 Stage 12A Wetland	constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Ceil Cct, Coomera Waters, Coomera (via Foxwell Rd)	n/a
Bowie's Flat Wetland	Bridgewater Ck Wetland	constructed wetland	constructed wetland in a constrained site (retrofit)	suburban	Bowies Flat, Bridgewater Ck, Coorparoo (via Leicester St)	East
Keith Boden Wetland	Cressey St Wetland	constructed wetland	constructed wetland (retrofit)	suburban	behind Scout Hall in Murray Duus Park, Cressey St, Nundah	North

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Appendix D: Summary of Life Cycle Cost Data

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Description of WSUD System (Part A)								Size of WSUD System (Part B)			Acquisition Costs										Maintenance Costs										
Name of WSUD System	Alternative Name / Reference from Design Drawings	Type of WSUD System	Description of WSUD System	Scale of WSUD System	Location	BCC LAs Region	Expected Life Span	Method of Determining Life Span	Catchment Area (ha)	Surface Area of Treatment Zone (m²)	Overall Surface Area of WSUD System (m²)	Organisation Responsible for Design	Organisation Responsible for Construction	1. Cost of defining the need for the WSUD system (including conceptual design for Stormwater Management Plan)	2. Design Costs (preliminary and detailed design costs)	3. Construction Costs (including project management costs)	4. Vegetation Costs	Year to which previous acquisition costs apply	Total Acquisition Cost (2006\$)	Total Acquisition Cost - Unit Rate (2006\$/m²)	Duration of Establishment Period	Frequency of Maintenance Activities During Establishment Period	1. Average Annual Cost of General Maintenance during Establishment Period	Frequency of Activities Associated with Ongoing General Maintenance	2. Average Annual Cost of Ongoing General Maintenance	Frequency of Cleaning GPT (e.g. trash rack)	Average Annual Volume of Material Removed (m³)	3. Average Annual Cost of Cleaning GPT	Frequency of Sediment Removal (e.g. desilting Inlet pond of wetland)		
Watarka Dr Bioretention Swale		swale	roadside turf swale (residential development)	streetscape	Watarka Dr, Ridgewood Estate, Parkinson (via Algester Rd & Walkum Dr)	South	50yrs	professional judgement				ETS Group (contact: Keith Howells)	Stockland																		
Tallowood Way Roadside Swale		swale	roadside turf swale (residential development)	streetscape	Tallowood Way, Sunnybank Grove, Sunnybank Hills (via Jackson Rd)	South	50yrs	professional judgement				Bligh Tanner (contact: Chris Tanner)																			
Ecovillage Roadside Swale							50yrs	professional judgement				Bligh Tanner (contact: Chris Tanner)	Landmatters																		
Ragamuffin Dr West Bioretention Swale	Coomera Waters Phase 2 Stage 13&14 - Bioretention Swale Sections BIO 4 to BIO 10	bioretention swale	roadside turfed bioretention swale (residential development)	streetscape	Ragamuffin Dr West (between Slipstream Rd & Halsal Ct), Coomera Waters, Coomera (via Foxwell Rd)	n/a	50yrs	professional judgement	2	195	975	Ecological Engineering (contact: Shaun Leinster)	Austcorp	\$1,500 (estimate)	\$5,000 (estimate)	\$28,582 (real - from contractor's quote)	\$3,900 (real - from contractor's quote)	2004	\$46,817	\$240	1yr	weekly / fortnightly (35 - 42 visits per year)	\$2,300 (estimate - based on ongoing maintenance cost)	weekly / fortnightly (35 - 42 visits per year)	\$2,300 (real - based on advice from landscape contractor)	n/a	n/a	n/a	n/a	n/a	
Walkum Dr Bioretention Swale		bioretention swale	rock-lined vegetated bioretention swale in road verge (residential development)	streetscape	Adjacent to Walkum Dr near bridge connecting to Roseneath Dr, Ridgewood Estate, Parkinson	South	50yrs	professional judgement				ETS Group (contact: Keith Howells)	Stockland											monthly	\$5,500 (real - based on 3 months of data)	n/a	n/a	n/a	n/a		
Imlay Pl Bioretention Swale		bioretention swale	rock-lined vegetated bioretention swale in park area (residential development)	streetscape	In park adjacent to Imlay Pl, Ridgewood Estate, Parkinson	South	50yrs	professional judgement				ETS Group (contact: Keith Howells)	Stockland											monthly	\$8,500 (real - based on 3 months of data)	n/a	n/a	n/a	n/a		
Baseline St Bioretention Swale		bioretention swale	vegetated bioretention swale in park (retrofit, including surcharge structure to divert flows from existing stormwater network)	neighbourhood	Wally Tate Park, Baseline St, Kuraby	South	50yrs	professional judgement	49	750	1500	Ecological Engineering (contact: Sally Taylor)	BCC	\$5,000 (estimate)	\$57,900 (real)	\$324,367 (real - includes cost of in situ surcharge structure)	\$12,581 (real)	2004	\$480,217	\$640	2-3yrs	weekly	\$24,415 (real - based on quote from landscape contractor BAC)			quarterly		\$2,132 (real - based on 1yr of data)		included in general maintenance	
Hoyland St Bioretention Basin		bioretention basin	bioretention basin (retrofit)	neighbourhood	Hoyland St, Bracken Ridge	North	50yrs	professional judgement	2.3	675	800	BCC - City Design (contact: ???)	BCC	\$1,920 (estimate - based on SQIDS constructed between 1998-2003)	\$12,500 (real - from expenditure records)	\$37,500 (real - from expenditure records)	Included in construction cost	2000	\$74,713	\$111	no data	no data	no data	every 2 months	\$1,313 (real - avg of 4yrs maintenance cost data - 02/03 to 05/06)	n/a	n/a	n/a	n/a	included in general maintenance	
Rainbow Cct Bioretention Basin	Coomera Waters Phase 2 Stage 15 - Raingarden 2	bioretention basin	bioretention basin (residential development)	neighbourhood	orr Solo Pl & Rainbow Cct, Coomera Waters, Coomera (via Foxwell Rd)	n/a	50yrs	professional judgement	2.2	300	450	Ecological Engineering (contact: Shaun Leinster)	Austcorp	\$3,000 (estimate)	\$15,000 (estimate)	\$49,513 (real - from contractor's quote)	\$11,250 (estimate - based on typical \$/m² rate)	2004	\$94,594	\$315	2-3yrs	weekly	\$3,087 (real - based on advice from landscape contractor)	weekly	\$1,627 (estimate - based on maintenance cost for establishment period)	n/a	n/a	n/a	n/a	included in general maintenance	
Slipstream Rd Bioretention Basin	Coomera Waters Phase 2 Stage 16 - Raingarden 1	bioretention basin	bioretention basin (residential development)	neighbourhood	orr Ragamuffin Dr West & Slipstream Rd, Coomera Waters, Coomera (via Foxwell Rd)	n/a	50yrs	professional judgement	4	600	900	Ecological Engineering (contact: Shaun Leinster)	Austcorp	\$4,000 (estimate)	\$20,000 (estimate)	\$100,174 (real - from contractor's quote)	\$22,500 (estimate - based on typical \$/m² rate)	2004	\$176,155	\$294	3-4yrs	weekly	\$4,700 (real - based on advice from landscape contractor)	weekly	\$3,240 (estimate - based on maintenance cost for establishment period)	n/a	n/a	n/a	n/a	included in general maintenance	
Ecovillage Bioretention Basin							50yrs	professional judgement																							
Streisand Dr Bioretention Pod		bioretention pod	roadside bioretention pod (retrofit)	streetscape	Streisand Dr (near intersection with Minneil Pl), McDowell	North	50yrs	professional judgement	0.1	20	30	BCC - City Design (contact: Ross Allen)	BCC	included in design costs	\$20,000 (real - this is considered to be a high cost due to design of unfamiliar system. Estimated design cost of subsequent system is \$7,000)	\$21,530 (real - this is considered to be a high cost because of the need to incorporate monitoring facilities. Estimated construction cost of pod without monitoring facilities is \$15,000)	\$1,862 (real)	2006	\$43,392	\$2,170	2yrs	fortnightly	\$4,428 (real - calculated as \$200/month for general maintenance and 26 watering visits per year at \$78/visit)	every 2 months	\$1,000 (estimate - based on maintenance cost for Hoyland St)	n/a	n/a	n/a	n/a	included in general maintenance	
Satum Ct Bioretention Pod		bioretention pod	roadside bioretention pod (retrofit)	streetscape	Satum Ct (at intersection with Protea Pl), Bridgeman Downs	North	50yrs	professional judgement	0.1	20	30	BCC - City Design (contact: Ross Allen)	BCC	included in design costs	\$20,000 (real - this is considered to be a high cost due to design of unfamiliar system. Estimated design cost of subsequent system is \$7,000)	\$19,172 (real - this is considered to be a high cost because of the need to incorporate monitoring facilities. Estimated construction cost of pod without monitoring facilities is \$15,000)	\$1,862 (real)	2006	\$41,034	\$2,052	2yrs	fortnightly	\$4,428 (real - calculated as \$200/month for general maintenance and 26 watering visits per year at \$78/visit)	every 2 months	\$1,000 (estimate - based on maintenance cost for Hoyland St)	n/a	n/a	n/a	n/a	included in general maintenance	
Golden Ave Sedimentation Basin		sedimentation basin	concrete lined sedimentation basin directly upstream of wetland/ponds on Scrubby Ck (retrofit)	suburban	adjacent to intersection of Maddler Ct & Orangepl Cr, Calamvale (via Golden Ave)	South	50yrs	professional judgement	235	216	300	BCC - City Design (contact: ???)	BCC	\$1,920 (estimate - based on SQIDS constructed between 1998-2003)	\$5,000 (real - attained from financial progress report Schedule 156)	\$45,000 (real - attained from financial progress report Schedule 156)	n/a	1998	\$77,620	\$359	n/a	n/a	n/a	monthly	\$1,800 (estimate - calculated as 25% of cost of general maintenance of entire Golden Ave wetland/pond system)	n/a	n/a	n/a	approx every 2 yrs		
Hellawell Rd Sedimentation Basin		sedimentation basin	sedimentation basin located in base of flood detention basin (retrofit)	suburban	Lexington Pl, Sunnybank Hills (via Hellawell Rd)	South	50yrs	professional judgement				BCC - City Design (contact: ???)	BCC						2006												
Torquay Cr Sedimentation Basin		sedimentation basin	sedimentation basin	suburban	Torquay Crescent, Tingalpa	East	50yrs	professional judgement	14.0			BCC - City Design (contact: ???)	BCC	\$1,920 (estimate - based on SQIDS constructed between 1998-2003)	\$13,000 (real - attained from financial progress report Schedule 156)	\$77,000 (real - attained from financial progress report Schedule 156)	n/a	1998	\$137,420		n/a	n/a	n/a	monthly	34.0 (based on 05/06)	\$7,621 (real - avg of 4yrs maintenance cost data - 02/03 to 05/06)		approx every 5yrs			
Kayannie St Wetland		constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Kayannie St, Ridgewood Estate, Parkinson (via Algester Rd)	South	50yrs	professional judgement	5	4900	10100	ETS Group (contact: Keith Howells)	Stockland				\$63,714 (real - from landscape architect)						monthly	\$8,400 (real - based on less than 1yr of data)	quarterly	\$6,000 (real - based on less than 1yr of data)		approx every 5yrs			
Daintree Dr Wetland		constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Daintree Dr, Ridgewood Estate, Parkinson (via Algester Rd)	South	50yrs	professional judgement	31	5000	9000	ETS Group (contact: Keith Howells)	Stockland				\$65,000 (estimate - based on vegetation cost for Kayannie St Wetland)						monthly	\$5,400 (real - based on less than 1yr of data)	quarterly	\$2,500 (real - based on 2yrs of data)		approx every 5yrs			
Syzygium Grove Wetland	Coomera Waters Phase 2 Stage 12A Wetland	constructed wetland	constructed wetland with several zones (residential development)	neighbourhood	Cell Cct, Coomera Waters, Coomera (via Foxwell Rd)	n/a	50yrs	professional judgement	2	1000	2500	Ecological Engineering (contact: Shaun Leinster)	Austcorp	\$5,000 (estimate)	\$40,000 (estimate)	\$92,222 (real - from contractor's quote)	\$62,500 (estimate - based on typical \$/m² rate)	2004	\$239,866	\$240	2-3yrs	weekly	\$8,932 (real - based on advice from landscape contractor)	weekly	\$4,552 (estimate - based on maintenance cost for establishment period)	n/a	n/a	n/a	n/a	approx every 3 yrs	
Bowie's Flat Wetland	Bridgewater Ck Wetland	constructed wetland	constructed wetland in a constrained site (retrofit)	suburban	Bowie's Flat, Bridgewater Ck, Cooraroo (via Leicester St)	East	50yrs	professional judgement	197	8000	(including inlet pond)	BCC - City Design (contact: ???)	BCC	\$42,000 (cost of feasibility study)	\$108,000 (concept design cost = \$45,000, licence/permit applications = \$5,000, detailed design development = \$37,000, communication and consultation plan = \$12,000, environmental assessment = \$9,000)	\$2,070,000 (downstream natural channel construction = \$138,000, community facilities = \$299,000, drainage infrastructure = \$529,000, earthworks costs = \$506,000, general construction costs = \$598,000)	\$230,000 (real)	1999	\$3,613,750	\$462				monthly	100 (avg of 3yrs data - 03/04 to 05/06)	\$9,030 (real - avg of 4yrs maintenance cost data - 02/03 to 05/06)		approx every 5yrs			
Keith Boden Wetland	Cressey St Wetland	constructed wetland	constructed wetland (retrofit)	suburban	behind Scout Hall in Murray Dues Park, Cressey St, Nundah	North	50yrs	professional judgement	120	5000	6000	BCC - City Design (contact: ???)	BCC	\$1,920 (estimate - based on SQIDS constructed between 1998-2003)	\$42,500 (estimate - from Water Resources)	\$382,500 (estimate - from Water Resources)	included in construction cost	1999	\$629,707	\$126				monthly	\$22,737 (real - avg of 4yrs maintenance cost data - 02/03 to 05/06)		included in general maintenance costs	approx every 4yrs			

Life Cycle Costs of WSUD System (Part C)

Name of WSUD System	4. Average Annual Cost of Sediment Removal	Year to which previous maintenance costs apply	Average Annual Maintenance Cost during Establishment Period (2006\$)	Average Annual Ongoing Maintenance Cost (2006\$)	Average Annual Maintenance Cost during Establishment Period - Unit Rate (2006\$/m ²)	Average Annual Ongoing Maintenance Cost Unit Rate (2006\$/m ²)	Renewal & Adaptation Activities & Expected Timeframes	Renewal & Adaptation Costs (2006\$)	Disposal & Decommissioning Costs	Design Costs	Construction Costs	Vegetation Costs	Maintenance Costs	How was information Gathered?	Unusual Cost Elements	Variation of Maintenance Costs Over Time	Variation of Acquisition and/or Maintenance Costs Over Time
Watarka Dr Bioretention Swale										ETS	ETS	SPLAT	BCC LAS - South				
Tallowood Way Roadside Swale										BT	BT						
Ecovillage Roadside Swale										BT	BT						
Ragamuffin Dr West Bioretention Swale	n/a	2006	\$2,300	\$2,300	\$11.8	\$11.8	resetting of bioretention swale (incl. replacement of under-drainage pipes, soil, vegetation) every 25yrs (estimated at \$150/m ²)	\$29,250		EE	GD	TC	AUSTCORP				
Wallum Dr Bioretention Swale	n/a	2006		\$5,500						ETS	ETS	SPLAT	BCC LAS - South				
Imlay Pl Bioretention Swale	n/a	2006		\$8,500						ETS	ETS	SPLAT	BCC LAS - South				
Baseline St Bioretention Swale	included in general maintenance	2006	\$26,547		\$35.4		resetting of bioretention swale (incl. replacement of under-drainage pipes, soil, vegetation) every 25yrs (estimated at \$150/m ²)	\$195,000		EE	BCC	BCC	B4C	Design and construction costs obtained from City Design. Maintenance cost for cleaning GPT / trash rack			
Hoyland St Bioretention Basin	included in general maintenance	2004	no data	\$1,577		\$2.3	resetting of bioretention basin (incl. replacement of under-drainage pipes, soil, vegetation) every 25yrs (estimated at \$150/m ²)	\$101,250		BCC	BCC	BCC	BCC				
Rainbow Cct Bioretention Basin	included in general maintenance	2006	\$3,087	\$1,627	\$10.3	\$5.4	resetting of bioretention basin (incl. replacement of under-drainage pipes, soil, vegetation) every 25yrs (estimated at \$150/m ²)	\$45,000		EE	GD	TC	AUSTCORP				
Slipstream Rd Bioretention Basin	included in general maintenance	2006	\$4,700	\$3,240	\$7.8	\$5.4	resetting of bioretention basin (incl. replacement of under-drainage pipes, soil, vegetation) every 25yrs (estimated at \$150/m ²)	\$90,000		EE	GD	TC	AUSTCORP				
Ecovillage Bioretention Basin							resetting of bioretention basin (incl. replacement of under-drainage pipes, soil, vegetation) every 25yrs (estimated at \$150/m ²)										
Streisand Dr Bioretention Pod	included in general maintenance	2006	\$4,428	\$1,000	\$221.4	\$50.0	resetting of bioretention pod (incl. replacement of under-drainage pipes, soil, vegetation) every 25yrs (estimated at \$150/m ²)	\$3,000		BCC	BCC	BCC	BCC				
Satum Ct Bioretention Pod	included in general maintenance	2006	\$4,428	\$1,000	\$221.4	\$50.0	resetting of bioretention pod (incl. replacement of under-drainage pipes, soil, vegetation) every 25yrs (estimated at \$150/m ²)	\$3,000		BCC	BCC	BCC	BCC				
Golden Ave Sedimentation Basin	\$3,000 <small>(estimate - based on typical cost of de-silting)</small>	2006	n/a	\$4,800						BCC	BCC	BCC	BCC LAS - South				
Hollowell Rd Sedimentation Basin																	
Forquay Ct Sedimentation Basin	\$1,200 <small>(estimate - based on typical cost of de-silting Golden Ave.)</small>	2004	n/a	\$10,594													
Kayannie St Wetland	\$1,200 <small>(estimate - based on typical cost of de-silting Golden Ave. Has never been done at this site)</small>	2006		\$15,600		\$3.2	resetting & replanting of macrophyte zone every 20yrs (estimated at \$65/m ²)	\$318,500		ETS	ETS	Tim Lyne	BCC LAS - South				
Daintree Dr Wetland	\$1,200 <small>(estimate - based on typical cost of de-silting Golden Ave. Has never been done at this site)</small>	2006		\$9,100		\$1.8	resetting & replanting of macrophyte zone every 20yrs (estimated at \$65/m ²)	\$325,000		ETS	ETS	Tim Lyne	BCC LAS - South				
Syzygium Grove Wetland	\$833 <small>(estimate - based on advice from landscape contractor. Has never been done at this site)</small>	2006	\$9,765	\$5,385	\$9.8	\$5.4	resetting & replanting of macrophyte zone every 20yrs (estimated at \$65/m ²)	\$65,000		EE	GD	TC	AUSTCORP				
Bowie's Flat Wetland	\$1,200 <small>(estimate - based on typical cost of de-silting Golden Ave. Has never been done at this site)</small>	2004		\$12,286		\$1.5	resetting & replanting of macrophyte zone every 20yrs (estimated at \$65/m ²)	\$390,000		BCC	BCC	BCC	BCC	constrained site			
Keith Boden Wetland	\$1,013 <small>(real - based on one de-silting event in 2003)</small>	2004		\$28,524		\$5.7	resetting & replanting of macrophyte zone every 20yrs (estimated at \$65/m ²)	\$325,000		BCC	BCC	BCC	BCC	A Bypass channel had to be constructed and a sewer pipe had to be re-routed (additional cost of \$43,272). Birds and water level impacted upon landscaping plants (additional cost of replanting was \$9,822). Community influenced wetland by utilising it as a pool. The wetland is in a major flood area resulting in stormwater coming from 2 separate directions making monitoring very difficult.			