School of Science and Engineering

Rise, and Shine

Final Report for

Performance Monitoring of the Earnshaw Street Stormwater Vegetated Infiltration Basin at Golden Beach

by the Stormwater Research Group

at the University of the Sunshine Coast

June 2018

Executive Summary

To demonstrate their commitment to improving urban stormwater runoff quality and the water quality in Pumicestone Passage, the Sunshine Coast Council (SCC) installed a vegetated infiltration basin at the end of Earnshaw Street on the Esplanade at Golden Beach, Caloundra, in 2015. At the time of its installation, there was limited research into the performance of this type of stormwater treatment system and understanding of how the systems operate and the treatment processes that occur within the system was not well developed. To this end, SCC commissioned the Stormwater Research Group (SWRG) at the University of the Sunshine Coast (USC) to undertake a one-year study to monitor and report on the stormwater treatment performance of the Earnshaw Street vegetated infiltration basin.

The specific objectives of the study were:

- To quantify the external pollutant loads entering the system from the pump-out system of an underground carpark of an adjacent apartment complex (Atrium Apartments);
- To quantify the volumes of stormwater runoff generated by the Earnshaw Street catchment and captured by the Earnshaw Street stormwater pipe network over a range of storm events. Further calculating the volumes diverted into the vegetated infiltration basin for treatment and the volumes flowing directly to Pumicestone Passage; and
- To undertake water quality analysis on samples collected on-site from a minimum of 10 storm events and compare these results to the predicted pollutant loads used in models developed as part of the design process for the infiltration basin.

The study objectives were all achieved for the Earnshaw Street Stormwater Vegetated Infiltration Basin at Golden Beach. Pollution concentrations in pump-out water from the Atrium Apartments were tested and found to be well below recommended guideline values for all pollutants. Secondly, the volume of stormwater runoff flowing through the stormwater network to the outfall at Pumicestone Passage was estimated to be 21,874m^3 of which 10,172m^3 was treated by the vegetated infiltration basin during the study period. The study also estimated that the basin removed 264 kg of TSS, 1.01 kg of TP and 9.97 kg of TN from stormwater runoff during rainfall events between 3 March 2017 and 21 October 2017 preventing significant pollutant loads from entering Pumicestone Passage.

The Earnshaw Street Stormwater Vegetated Infiltration Basin is now fully established and it can be expected that its pollution removal performance will improve in the future. This is a great result for the Pumicestone Passage, for the local community, and the Sunshine Coast Council.

Contents

1. Introduction

Sunshine Coast Council (SCC) is committed to implementing water sensitive urban design initiatives across the region to improve the quality of urban stormwater runoff and to improve the overall quality of downstream receiving waters. As part of their commitment to improving urban runoff, SCC installed a new vegetated infiltration basin at the end of Earnshaw Street on the Esplanade at Golden Beach in Caloundra (Figure 1) in 2015.

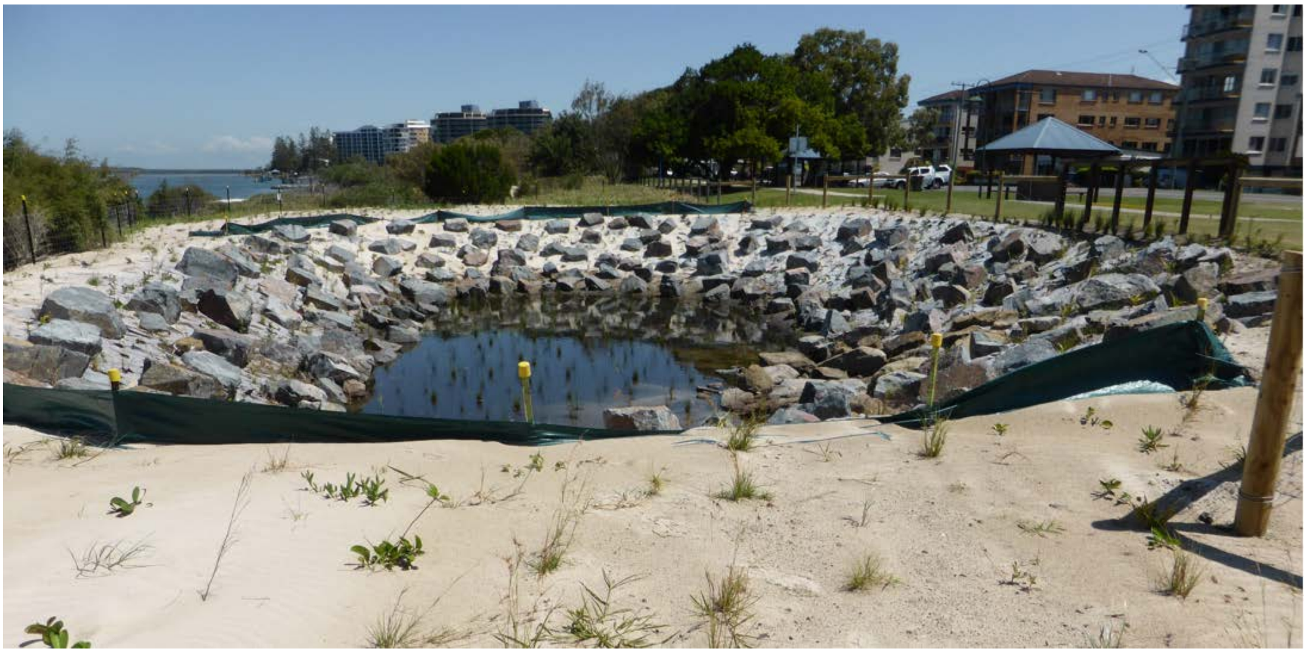

Figure 1 - Earnshaw Street Vegetated Infiltration Basin Installation (27-1-2015)

After extensive consultation with leading industry consultants, this site was identified as the most effective location for the installation of the basin in order to remove pollutants from local stormwater runoff before discharging into Pumicestone Passage (Figure 2).

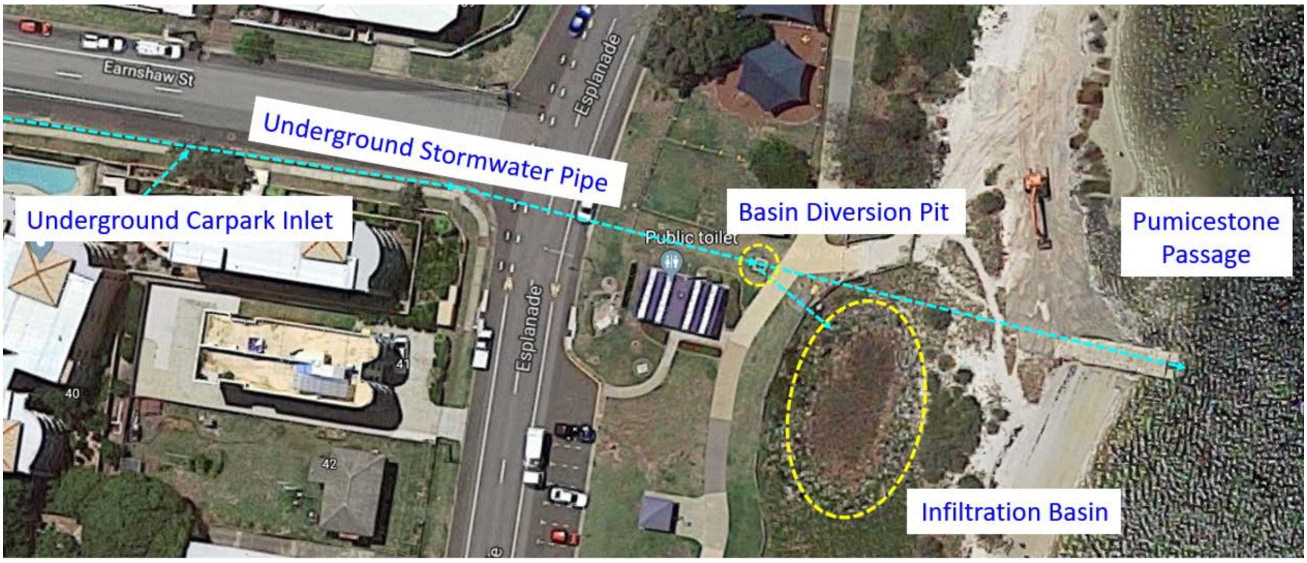

Figure 2 – Aerial View of Earnshaw Street Vegetated Infiltration Basin (Google Maps 2018)

At the time of its installation, there had only been limited research into the performance of these types of stormwater treatment systems at the field-scale, with most previous research being at a laboratory-scale. Due to the lack of research, a thorough understanding of how the systems operate and the treatment processes that occur within the system was also limited. To this end, SCC commissioned the Stormwater Research Group (SWRG) at the University of the Sunshine Coast (USC) to undertake a one-year study to monitor and report on the stormwater treatment performance of the Earnshaw Street vegetated infiltration basin. This report outlines the findings from the study.

2. Aims and Objectives

The aim of this study was to estimate the pollutant loads entering the piped stormwater network upstream of the Earnshaw Street Stormwater Vegetated Infiltration Basin at Golden Beach and to assess the potential pollutant removal performance of the basin. It was anticipated that the results would be incorporated into a community engagement initiative to better explain the benefits of the vegetated infiltration basin to the local community. The specific objectives of the study were:

- To quantify the external pollutant loads entering the system from the pump-out system of an adjacent underground carpark ;
- To quantify the actual volumes of stormwater runoff generated by the Earnshaw Street catchment and captured by the Earnshaw Street stormwater pipe network over a range of storm events. Further calculating the volumes diverted into the vegetated infiltration basin for treatment and the volumes flowing directly to Pumicestone Passage; and
- To undertake water quality analysis on samples collected on-site from a minimum of 10 storm events and compare these results to the predicted pollutant loads used in models developed as part of the design process for the infiltration basin.

3. Methodology

3.1 Quantification of External Pollutant Loads from Underground Carpark

Samples were collected from a pit in the basement of an underground carpark (Atrium Apartments) which fills with groundwater and then pumped empty into the stormwater pipe network (Figure 2). Samples were also collected further downstream in the pipe network in Earnshaw Street. Sample collection and testing was in accordance with test methods specified in Standard Methods for the Examination of Water and Wastewater (APHA, 2005). Sample collection, storage and transport complied with AS/NZS 5667.1:1998 (AS/NZS, 1998). These samples were sent to a water laboratory accredited by the National Association of Testing Authorities in Australia (NATA) for analysis. The samples were analysed to quantify the concentrations of Total Suspended Solids (TSS), Nutrients, Heavy Metals and Hydrocarbons.

3.2 Quantification of Catchment Runoff Volumes

An automated water sampling system was installed inside the basin diversion pit (Figure 3) to measure stormwater flow volumes and to collect water samples during storm events. An automatic water sampler (ISCO GLS) was installed in the pit and the sampler was triggered automatically when the flow meter (Starflow ultrasonic probe) recorded flows of ≥ 5.0 L/s. Samples were collected by the ISCO auto-samplers at 1,000 L intervals thereafter until flow ceased. Sample aliquots (200 mL) were composited within the automatic sampler.

Internet-enabled telemetry equipment was used to notify SWRG researchers when a rainfall event had occurred and water samples were ready for collection. The composite samples were then collected by an independent contractor within six hours of the end of the rainfall event and transported to a National Association of Testing Authority (NATA) water laboratory for analysis.

Figure 3 – Installation of Automated Water Sampling Equipment in Diversion Pit

Unfortunately, despite SWRG researchers having had much success in the past with these types of sampling systems, the automated sampling system at Golden Beach was prone to problems and proved to be very unreliable. The system was repaired, and components were replaced numerous times over the course of the project. However, the automated system simply did not seem to be able to cope with being installed inside a stormwater pit and it could not produce reliable storm event flow data. As such, in the interests of completing the project on time, the decision was made to estimate catchment runoff volumes coming into the diversion pit using the catchment area and daily rainfall volumes.

The total volumes of stormwater being conveyed to the basin diversion pit by the main drainage line during storm events were calculated by multiplying the catchment area by the daily rainfall data from the BOM rain gauge at Caloundra Airport (www.bom.gov.au). A Runoff Coefficient (C) of 0.7 was applied to the volumes to allow for infiltration into the high-density urban residential catchment (QUDM, 2013 - Table 4.5.1). The rainfall catchment area for the Earnshaw Street stormwater outfall was estimated to be approximately 6.0ha (Figure 4 – SSC Stormwater Drainage Infrastructure Plan). Estimated runoff volumes are listed in Table 2.

Figure 4 – Catchment area treated by Earnshaw Street Vegetated Infiltration Basin

There was also a flowmeter installed within the Ø300mm basin inflow/diversion pipe, unfortunately it was also unreliable and could not be used to measure flow into the vegetated infiltration basin. The diversion pit contained a 400mm high weir (Figure 5) that was intended to divert all minor storm flows into the vegetated infiltration basin. Only a portion of runoff from major storm events would overflow this weir and not be treated by the infiltration basin.

The infiltration basin was designed to allow for the impact of tides, particularly during high tide events. Mean high water springs levels at Golden Beach, Caloundra are approximately RL0.5m AHD, with highest astronomical tide (HAT) level at RL 0.9m AHD. The low flow diversion weir to the basin (Figure 5) provides a barrier to tidal inflows to the basin, until tide levels rises above the diversion weir crest level (RL0.9m AHD). This effectively isolates the basin from tidal influences for all but the extreme high tide events, likely during storm surges.

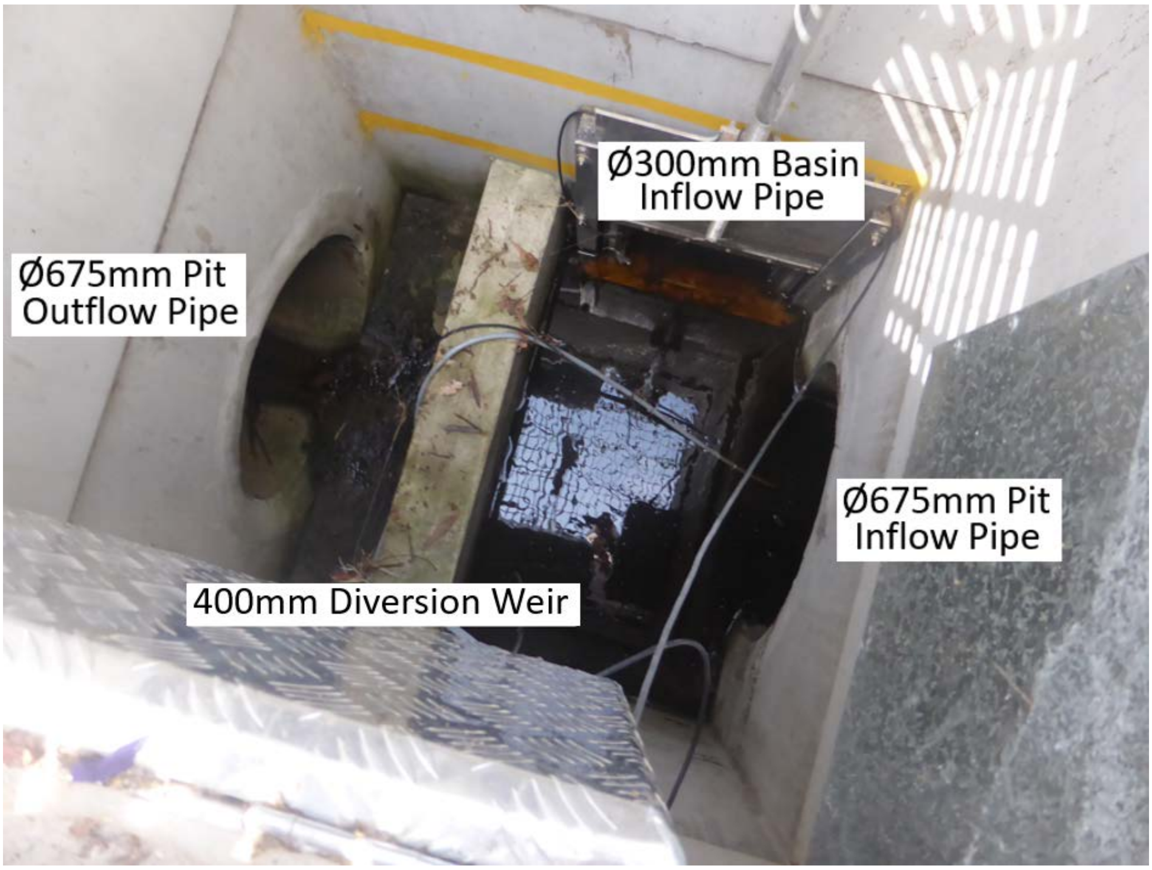

Figure 5 – Catchment area treated by Earnshaw Street Infiltration Basin

3.3 Water Quality Sampling and Analysis

As discussed above, the automated water sampling equipment installed in the basin diversion pit was unreliable. Instead of relying on the auto-samplers, a manual grab sampling procedure was developed to collect water samples during rainfall events. This meant that somebody had to drive to Golden Beach and collect water samples during rainfall events. Despite trialling SWRG researchers or students to collect samples during rainfall events, this proved to be very problematic and also unreliable. It was therefore decided to arrange for an independent contractor to collect samples during rainfall events. This worked very well and a good number of qualifying samples were collected during 2017.

It must be noted, that due to required travel time by researchers and contractors, samples were generally collected after the rainfall event had commenced. Typically, there was a delay of approximately 15 minutes before grab samples commenced collection. This meant that the water samples were unlikely to have included the pollutants concentrations representative of the first-flush. See Section 4.3 for more information on first-flush.

Sample collection and testing was in accordance with test methods specified in Standard Methods for the Examination of Water and Wastewater (APHA, 2005). Sample collection, storage and transport complied with AS/NZS 5667.1:1998 (AS/NZS, 1998). The samples were analysed to quantify the concentrations of Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorous (TP).

4. Results and Discussion

4.1 External Pollutant Loads from Underground Carpark

Samples were collected on two separate occasions from a pit in the basement of the underground carpark at the Atrium Apartments. The pit collects carpark runoff and groundwater and then pumps it directly into the Earnshaw Street stormwater pipe network (see Figure 2). Samples were also collected from the stormwater pit on Earnshaw St that the carpark water is pumped into. Samples were analysed to quantify the pollutant loads entering the Earnshaw Street piped stormwater network from the pump-out system of the underground carpark.

The results of the water quality testing (Table 1) show that TSS and TN pollutant loads in the pump-out pit (Sample Location: Carpark) as well as those further downstream in the piped stormwater network (Sample Location: Earnshaw St) were well below the mean values recommended by MUSIC (WBD, 2010) for urban residential stormwater base-flows. TP were found to fall within the range of MUSIC guideline values.

Table 1 – Observed and Recommended Pollutant Concentrations in Water Samples

Sample Date	**Sample Location**	**Observed TSS** (mg/L)	**MUSIC** TSS Mean* (mg/L)	**Observed TP** [mg/L]	**MUSIC** TP Mean* (mg/L)	**Observed TN** [mg/L]	**MUSIC** TN Mean* (mg/L)
17/3/2016	Earnshaw St	<1.0	10	0.11	0.11	0.50	1.6
17/3/2016	Carpark	<1.0	10	0.17	0.11	0.50	1.6
1/4/2016	Earnshaw St	5.3	10	0.19	0.11	0.60	1.6
1/4/2016	Carpark	4.3	10	0.17	0.11	0.50	1.6

**These are mean baseflow values (WBD, 2010)*

Polycyclic Aromatic Hydrocarbons and Heavy Metals were also tested and these were all found to be below the limit of detection or below recommended levels. The full water quality testing results from the basement pit and the downstream receiving stormwater pipe network can be found in Appendix A.

4.2 Volumes of Stormwater Entering the System

As discussed in Section 3.2, stormwater runoff volumes were estimated using daily rainfall and the catchment area. A Runoff Coefficient (C) of 0.7 was applied to the volumes to allow for infiltration into the high-density urban residential catchment (QUDM, 2013 - Table 4.5.1). The contributing catchment area was estimated to be 4.2ha. Volumes of stormwater being conveyed by the Ø675mm main drainage line for each event are shown in Table 2 below.

Table 2 – Rainfall Data and Runoff Volume for Sampled Events

Event Date	Rainfall (mm)	Estimated Catchment Runoff Area (m^2)	Runoff Volume Conveyed by Ø675mm Stormwater Pipe (m^3)	Runoff Volume Treated by Basin (m^3)
3/03/2017	1.0	42,000	42	42
4/03/2017	23	42,000	983	798
14/03/2017	51	42,000	2,134	798
15/03/2017	0.4	42,000	17	16.8
17/03/2017	2.0	42,000	84	84
19/03/2017	136	42,000	5,729	798
19/05/2017	57	42,000	2,394	798
13/06/2017	21	42,000	882	798
14/06/2017	19	42,000	798	798
6/07/2017	3.4	42,000	143	143
7/07/2017	4.1	42,000	172	172
16/07/2017	2.8	42,000	118	118
7/08/2017	14	42,000	588	588
22/09/2017	10	42,000	420	420
2/10/2017	60	42,000	2,520	798
4/10/2017	44	42,000	1,848	798
14/10/2017	22	42,000	924	798
16/10/2017	35	42,000	1,470	798
21/10/2017	15	42,000	609	609
Median	**19**	**Total Flow =**	**21,874**	**10,172**

While there was also a flowmeter installed directly in the Ø300mm basin inflow pipe, this was unreliable and could not be used to measure flow into the vegetated infiltration basin. As discussed in Section 3.2, the Basin Diversion Pit had a 400mm high weir installed within it to divert low (environmental) flows into the vegetated infiltration basin. The weir allowed higher flowrates to flow over the top of the weir and bypass the vegetated infiltration basin so that the upstream stormwater network did not back up and cause flooding. In order to estimate the flow through the basin, the median rainfall depth (19mm) was selected as the trigger for the weir to overflow. The last column in Table 2 lists the estimated runoff volumes treated by the vegetated infiltration basin under this bypass rainfall assumption. As can be seen in Table 2, the basin was estimated to treat approximately half the total runoff from the catchment during the 19 recorded storms.

4.3 Water Quality Data and Analysis

Water samples were collected (grab sampling) from the diversion pit and analysed from a total of 19 rainfall events over the period from 3/03/2017 to 21/10/2017. The average pollutant concentrations across all reported events are shown in Table 3 and fall significantly below typically expected values according to the MUSIC guideline values for urban residential stormwater runoff (WBD, 2010).

Table 3 – Diversion Pit Stormwater Runoff Grab Sample Average Pollutant Concentrations

Grab Sample Date	Average Pollutant Concentration		
	TSS (mg/L)	TP (mg/L)	TN (mg/L)
3/03/17	20	<0.005	0.916
4/03/17	8	<0.005	0.875
14/03/17	7	0.05	0.917
15/03/17	48	<0.005	1.09
17/03/17	6	0.046	0.998
19/03/17	11	0.044	0.961
19/05/17	2	<0.005	0.246
13/06/17	2	0.084	0.754
14/06/17	1	0.092	0.82
6/07/17	4	0.087	0.774
7/07/17	34	0.016	0.833
16/07/17	26	0.134	0.933
7/08/17	67	0.256	2.64
22/09/17	27	0.123	0.778
2/10/17	97	0.12	1.34
4/10/17	44	0.192	1.4
14/10/17	14	0.017	0.377
16/10/17	<1	0.054	0.743
21/10/17	23	0.174	1
Average	**26**	**0.099**	**0.98**
MUSIC Concentration Parameters (Stormflow)	151 (±2.5)	0.34 (±2.04)	1.82 (±1.70)
MUSIC Concentration Parameters (Baseflow)	10 (±2.2)	0.11 (±2.04)	1.58 (±1.58)

It must be noted, that due to required travel time by researchers and contractors, samples were generally collected after the rainfall event had commenced. Typically, there was a delay of approximately 15 minutes before grab samples commenced collection. This meant that the water samples were unlikely to have included the pollutants concentrations representative of the first-flush.

The first-flush phenomenon is when the highest fraction of pollutants is transported within the initial runoff volume from an event (Taebi & Droste, 2004, Alias et al., 2013). Miguntanna et al. (2013) observed that the TN and TP concentrations were highest within the first 5 minutes of an event while Tiefenthaler and Schiff (2001) reported that TSS concentrations during the first 10 minutes of an event were a factor of 2.4-5.4 higher than concentrations during the remainder of the event. Alias et al. (2013) found that the first-flush phenomenon typically lasted for up to 40% of the runoff volume.

It can therefore be assumed that the grab samples collected over the study period do not represent the worst-case scenario in terms of pollutant loads in the stormwater runoff, which could only have been achieved with functional automated sampling equipment. Accordingly, the pollutant concentrations shown in Table 3 may significantly underestimate the pollutant concentrations of the first 15 minutes of rainfall runoff, and also underestimate the pollution loads treated by the vegetated infiltration basin.

4.4 Estimated Pollutant Removal Performance

It was not possible to calculate the pollutant concentration reduction efficiency of the vegetated infiltration basin given that there is no outlet for the system. However, previous research has shown vegetated infiltration basins to be highly effective in the reduction of TSS, TP and TN in stormwater runoff (Birch et al., 2005; Fletcher et al., 2007; Glaister et al., 2013; Hatt et al., 2008).

While TSS and TP reduction occur readily in infiltration systems with sand as the filter media (Hatt et al., 2008), TN reduction relies more heavily on vegetation selection, with *Carex appressa* demonstrating high nutrient removal rates (Bratieres et al., 2008). The combination of sand as the filter media and *Carex* as one of the main species planted in the basin suggests that it would be possible to use previous research results to estimate the pollution removal performance of the Earnshaw Street vegetated infiltration basin.

Research on biofiltration basins by Fletcher et al. (2007) found that TSS loads were reduced by an average of 98%. Total phosphorus was reduced by an average of 80%, whilst careful selection of plants and media type was able to achieve a reduction of 50-70% in TN. Bratieres et al. (2008) found similar results in their study with pollution removal results of 95% for TSS, 85% for TP and 70% for TN.

Using these previous research results as a guide, the pollution loads removed by the Earnshaw Street vegetated infiltration basin were estimated to be 264 kg TSS, 1.01 kg TP and 9.97 kg TN for the 19 rainfall events recorded in this study (Table 4).

Table 4 – Estimated Pollutant Load Removal by the Earnshaw Street Vegetated Infiltration Basin during USC Study Period (3/03/2017 to 21/10/2017)

	TSS	TP	TN	Total Runoff Volume Treated by Basin
Average Concentration (mg/L)	26	0.099	0.980	10,172 (m^3)
Estimated Load Removal (kg)	264	1.01	9.97	

The conservative pollution removal results shown in Table 4 are quite impressive and clearly demonstrate the potential effectiveness of the Earnshaw Street vegetated infiltration basin. Obviously, the estimated pollution removal rates in Table 4 could be much higher if first-flush and unrecorded rainfall events are considered.

5. Additional Study Observations

In addition to the water-borne pollutants removed by the vegetated infiltration basin, a substantial amount of litter was also trapped by the basin and subsequently removed. This litter was also prevented from entering Pumicestone Passage. Details about the amount and type of litter trapped by and removed from the basin can be found here: https://www.sunshinecoast.qld.gov.au/Council/Planning-and-Projects/Infrastructure-Projects/Golden-Beach-Infiltration-Basin/Golden-Beach-Monitoring-Program

The results of this study clearly demonstrate that the installation of the new vegetated infiltration basin at the end of Earnshaw Street on the Esplanade at Golden Beach was a good decision on many levels. Besides the all-important pollutant removal function of the basin, it also demonstrates Sunshine Coast Council's commitment to implementing water sensitive urban design initiatives across the region to improve the quality of urban stormwater runoff and to improve the overall quality of downstream receiving waters.

The success of the Earnshaw Street vegetated infiltration basin may be used as a case study for the implementation of such devices at other locations in future. However, a few points are worth noting regarding the design and installation of these systems. When installing vegetated infiltration basins in low-lying topographically areas like the Golden Beach site, it is vitally important to ensure that it is not possible for tidal surges and other backwater effects to cause saltwater to travel back up the pipe and potentially flood the basin. Saltwater intrusion into the basin could potentially affect the health of the basin vegetation and this must be avoided. Installing one-way flow flaps on the end of pipes in strategic locations can help alleviate this potential risk. These considerations proved successful in this basin design.

Another important issue to consider during basin construction and establishment is the installation of sediment fencing around the basin to protect the vegetation in the initial growth stages. Not only does this act as a deterrent for the public and animals to stop them entering the basin and potential damaging the plants, it also protects the plants from the elements. The Golden Beach vegetated infiltration basin was often subjected to high winds loads which not only put extra stress on the plants during the initial growth stage, it also deposited large quantities of sand into the basin which could also affect plant growth and health. Installation of a good quality sediment fence was crucial to the successful establishment of the Golden Beach infiltration basin vegetation.

6. Summary

This study of the Earnshaw Street Stormwater Vegetated Infiltration Basin at Golden Beach successfully met the specific objectives of the study which were to quantify the volumes of stormwater runoff treated by the vegetated infiltration basin, and to estimate the pollution removal performance of the basin. The study found that the basin removed an estimated 264 kg of TSS, 1.01 kg of TP and 9.97 kg of TN from runoff from rainfall events between 3-3-2017 and 21-10-2017 and prevented these significant pollutant loads from entering Pumicestone Passage. The basin is now fully established (Figure 6) and it can be expected that the pollution removal performance of the vegetated infiltration basin will improve even further in the future. This is a great result for Pumicestone Passage, for the local community, and for the Sunshine Coast Council.

Figure 6 – Fully Established Vegetation in Earnshaw Street Infiltration Basin

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Appendix A

Water Quality Testing Results from Atrium Apartments Carpark

eurofins | mgt

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 20794

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

University of the Sunshine Coast
90 Sippy Downs Drive
Sippy Downs
QLD 4556

Attention: **Michael Nielsen**

Report **495399-W**
Project name
Received Date Apr 05, 2016

Client Sample ID			**P1**	**P2**	**POND**	**EARNSHAW STREET (17.03.16)**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins | mgt Sample No.			**B16-Ap03371**	**B16-Ap03372**	**B16-Ap03373**	**B16-Ap03374**
Date Sampled			**Mar 31, 2016**	**Mar 31, 2016**	**Mar 31, 2016**	**Mar 17, 2016**
Test/Reference	LOR	Unit				
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	0.001	mg/L	-	-	-	< 0.001
Acenaphthylene	0.001	mg/L	-	-	-	< 0.001
Anthracene	0.001	mg/L	-	-	-	< 0.001
Benz(a)anthracene	0.001	mg/L	-	-	-	< 0.001
Benzo(a)pyrene	0.001	mg/L	-	-	-	< 0.001
Benzo(b&j)fluoranthene[N07]	0.001	mg/L	-	-	-	< 0.001
Benzo(g.h.i)perylene	0.001	mg/L	-	-	-	< 0.001
Benzo(k)fluoranthene	0.001	mg/L	-	-	-	< 0.001
Chrysene	0.001	mg/L	-	-	-	< 0.001
Dibenz(a.h)anthracene	0.001	mg/L	-	-	-	< 0.001
Fluoranthene	0.001	mg/L	-	-	-	< 0.001
Fluorene	0.001	mg/L	-	-	-	< 0.001
Indeno(1.2.3-cd)pyrene	0.001	mg/L	-	-	-	< 0.001
Naphthalene	0.001	mg/L	-	-	-	< 0.001
Phenanthrene	0.001	mg/L	-	-	-	< 0.001
Pyrene	0.001	mg/L	-	-	-	< 0.001
Total PAH*	0.001	mg/L	-	-	-	< 0.001
2-Fluorobiphenyl (surr.)	1	%	-	-	-	90
p-Terphenyl-d14 (surr.)	1	%	-	-	-	95
Ammonia (as N)	0.01	mg/L	< 0.01	< 0.01	< 0.01	0.20
Conductivity (at 25°C)	1	uS/cm	200	310	230	-
Nitrate & Nitrite (as N)	0.05	mg/L	< 0.05	0.52	< 0.05	0.14
Nitrate (as N)	0.02	mg/L	< 0.02	0.52	< 0.02	0.13
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
pH	0.1	pH Units	7.6	7.3	7.4	-
Phosphate ortho (as P)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Phosphate total (as P)	0.05	mg/L	< 0.05	0.06	0.06	0.11
Suspended Solids	1	mg/L	7.7	95	3.9	< 1
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	0.3	0.3	0.4	0.4
Total Nitrogen (as N)	0.2	mg/L	0.3	0.8	0.4	0.5

eurofins | mgt

Client Sample ID			P1	P2	POND	EARNSHAW STREET (17.03.16)
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B16-Ap03371	B16-Ap03372	B16-Ap03373	B16-Ap03374
Date Sampled			Mar 31, 2016	Mar 31, 2016	Mar 31, 2016	Mar 17, 2016
Test/Reference	LOR	Unit				
Heavy Metals						
Aluminium	0.05	mg/L	< 0.05	11	< 0.05	0.51
Arsenic	0.001	mg/L	0.002	0.003	0.001	0.004
Barium	0.02	mg/L	< 0.02	0.08	< 0.02	< 0.02
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	0.008	< 0.001	< 0.001
Cobalt	0.001	mg/L	< 0.001	0.002	< 0.001	< 0.001
Copper	0.001	mg/L	< 0.001	0.003	< 0.001	< 0.001
Iron	0.05	mg/L	0.36	9.7	0.16	0.41
Lead	0.001	mg/L	< 0.001	0.008	< 0.001	< 0.001
Manganese	0.005	mg/L	0.067	0.094	0.012	0.030
Nickel	0.001	mg/L	< 0.001	0.003	< 0.001	< 0.001
Vanadium	0.005	mg/L	< 0.005	0.015	< 0.005	< 0.005
Zinc	0.001	mg/L	0.002	0.017	0.005	0.011

Client Sample ID			EARNSHAW STREET (01.04.16)	GARBAGE ROOM (01.04.16)	GARBAGE ROOM (17.03.16)
Sample Matrix			Water	Water	Water
Eurofins | mgt Sample No.			B16-Ap03375	B16-Ap03376	B16-Ap03377
Date Sampled			Apr 01, 2016	Apr 01, 2016	Mar 17, 2016
Test/Reference	LOR	Unit			
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Acenaphthylene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Benz(a)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Benzo(a)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Benzo(b&j)fluoranthene[N07]	0.001	mg/L	< 0.001	< 0.001	< 0.001
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Chrysene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Fluorene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Naphthalene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Phenanthrene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001
Total PAH*	0.001	mg/L	< 0.001	< 0.001	< 0.001
2-Fluorobiphenyl (surr.)	1	%	95	63	54
p-Terphenyl-d14 (surr.)	1	%	97	55	53
Ammonia (as N)	0.01	mg/L	0.14	0.32	0.35
Nitrate & Nitrite (as N)	0.05	mg/L	0.15	< 0.05	< 0.05
Nitrate (as N)	0.02	mg/L	0.12	< 0.02	< 0.02
Nitrite (as N)	0.02	mg/L	0.02	< 0.02	< 0.02

eurofins | mgt

Client Sample ID			EARNSHAW STREET (01.04.16)	GARBAGE ROOM (01.04.16)	GARBAGE ROOM (17.03.16)
Sample Matrix			**Water**	**Water**	**Water**
Eurofins | mgt Sample No.			**B16-Ap03375**	**B16-Ap03376**	**B16-Ap03377**
Date Sampled			**Apr 01, 2016**	**Apr 01, 2016**	**Mar 17, 2016**
Test/Reference	LOR	Unit			
Phosphate ortho (as P)	0.05	mg/L	0.06	0.08	0.08
Phosphate total (as P)	0.05	mg/L	0.19	0.17	0.17
Suspended Solids	1	mg/L	5.3	4.3	< 1
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	0.4	0.5	0.5
Total Nitrogen (as N)	0.2	mg/L	0.6	0.5	0.5
Heavy Metals					
Aluminium	0.05	mg/L	0.66	0.58	0.60
Arsenic	0.001	mg/L	0.005	0.005	0.005
Barium	0.02	mg/L	< 0.02	< 0.02	< 0.02
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	0.001	< 0.001	< 0.001
Iron	0.05	mg/L	0.93	0.60	0.63
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.025	0.023	0.022
Nickel	0.001	mg/L	< 0.001	< 0.001	< 0.001
Vanadium	0.005	mg/L	< 0.005	< 0.005	< 0.005
Zinc	0.001	mg/L	0.006	0.006	0.005