SQIDEP (v1.3)
Independent Evaluators
Joint Report
Jellyfish

November 2023

Dr Baden Myers

DOCUMENT VERIFICATION

PROJECT NAME	SQIDEP INDEPENDENT EVALUATION
CLIENT CONTACT	Stormwater Australia
PROJECT NUMBER	344
DOCUMENT NAME	Joint IE Report BM & ML v2

Document History

ISSUE TO	DATE	VERSION	AUTHOR	REVIEWER
STORMWATER AUSTRALIA	25/06/23	1	ML, BM	BM, ML
STORMWATER AUSTRALIA	21/09/23	2	ML,BM	BM,ML
STORMWATER AUSTRALIA	01/11/23	3	ML,BM	BM,ML

Version History

VERSION	COMMENT
1	Draft Report for comment
2	Final Report for comment
3	Final report

Climate Change Statement

A wide range of sources, including but not limited to the IPCC, CSIRO and BoM, unanimously agree that the global climate is changing. Unless otherwise stated, the information provided in this report does not take into consideration the varying nature of climate change and its consequences on our current engineering practices. The results presented may be significantly underestimated; flood characteristics shown (e.g. flood depths, extents and hazards) are may be different once climate change is taken into account.

Disclaimer

1. Introduction

This document reports on the independent evaluation of an application by Ocean Protect (hereafter OP) to have Stormwater Australia approve a Jellyfish under the requirements included in Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP) v1.3 (hereafter referred to as SQIDEP) published in 2019 by Stormwater Australia. SQIDEP v1.3 is available on Stormwater Australia's website at the time of reporting.

This is a joint report prepared by Independent Evaluators, Dr Baden Myers and Mark Liebman, a Director of Sustainability Workshop. The Independent Evaluators were engaged by Stormwater Australia on a fee for service basis to carry out an independent evaluation of a Jellyfish.

Evaluators Independence Declarations

It is declared that both evaluators, Mark Liebman and Baden Myers, are completely independent and neither Independent Evaluator has any conflict of interest with respect to this engagement.

It is declared that Mark Liebman, in his capacity as a Council engineer, working for Blacktown Council has previously assessed and evaluated this product on behalf of Blacktown Council. This information was declared to Stormwater Australia and was known by OP.

We jointly declare that:

We are not, nor have we ever been employed or commissioned by the Applicant, Ocean Protect. We have not been involved in the design or development or monitoring of the Ocean Protect Jellyfish. We have undertaken this assessment without prejudice and in good faith.

Signed: Mark Liebman *Signed: Baden Myers*

Signature: *Signature:*

M Liebman BMyers

Statutory Declaration by Independent Monitoring Scientist

Dr Ashanta Goonetilleke from the Queensland University of Technology is considered the independent scientist. Correspondence between Dr Goonetilleke and Mark Liebman confirmed complete independence during the monitoring and evaluation project carried out by QUT.

Background

Stormwater Australia published the Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP) in January 2019. The SQIDEP process seeks to *"provide a uniform set of criteria to which stormwater treatment measures can be field-tested and reported. These criteria should guide and inform field monitoring programs seeking to demonstrate pollutant removals for stormwater treatment measures included in pollutant export modelling software. Future revisions of the protocol are anticipated to also include laboratory testing."* (Stormwater Australia, 2019).

The SQIDEP process is shown below in Figure 3. Two pathways for evaluation exist under the protocol and this application involved a body of evidence submission based on local field testing. The Independent Evaluators have not been involved with this project prior to this evaluation, for example at the Quality Assurance Project Plan (QAPP) stage and have not been privy to the QAPP.

Review Documents

The following documents form the basis of this independent evaluation:

1) Ashantha Goonetilleke, Prasanna Egodawatta, Evaluation of treatment performance of the Jellyfish® filter installation at Ipswich – Final report on the field monitoring program, 17 February 2017, Science and Engineering Faculty, Queensland University of Technology.
2) Charles Kelly, Anton Bardak, Evaluation of Treatment performance of a stormwater treatment membrane filter under Australian conditions, Australian Journal of Water Research.
3) Tony Weber, Review of performance of Jellyfish performance for installation at 292 Brisbane St, West Ipswich, Alluvium Consulting (Letter)
4) Michael Wicks, Brad Dalrymple, Jellyfish SQIDEP Compliance (undated) (spreadsheet data with more details regarding monitoring by Goonetilleke and Egodawatta [2017] – includes spreadsheets of water quality results, event flows and sample aliquots).
5) University of Florida, TARP Field Test Performance Monitoring of a Jellyfish® Filter JF4-2-1, November 2011. It is understood this document was authored by Dr. John Sansalone.

West Ipswich Site

The field testing was carried out on a new small industrial development in West Ipswich, Queensland, Australia. The catchment draining to the device was reported to be 1,678m^2 in area with a 550 m^2 roof and 1,128 m^2 of other impervious areas directly connected to the Jellyfish. The site is to all intents 100% impervious.

A review of the site and catchment conditions is shown below. The field monitoring claims to have met all the criteria of the SQIDEP protocol, and this claim is evaluated in this report.

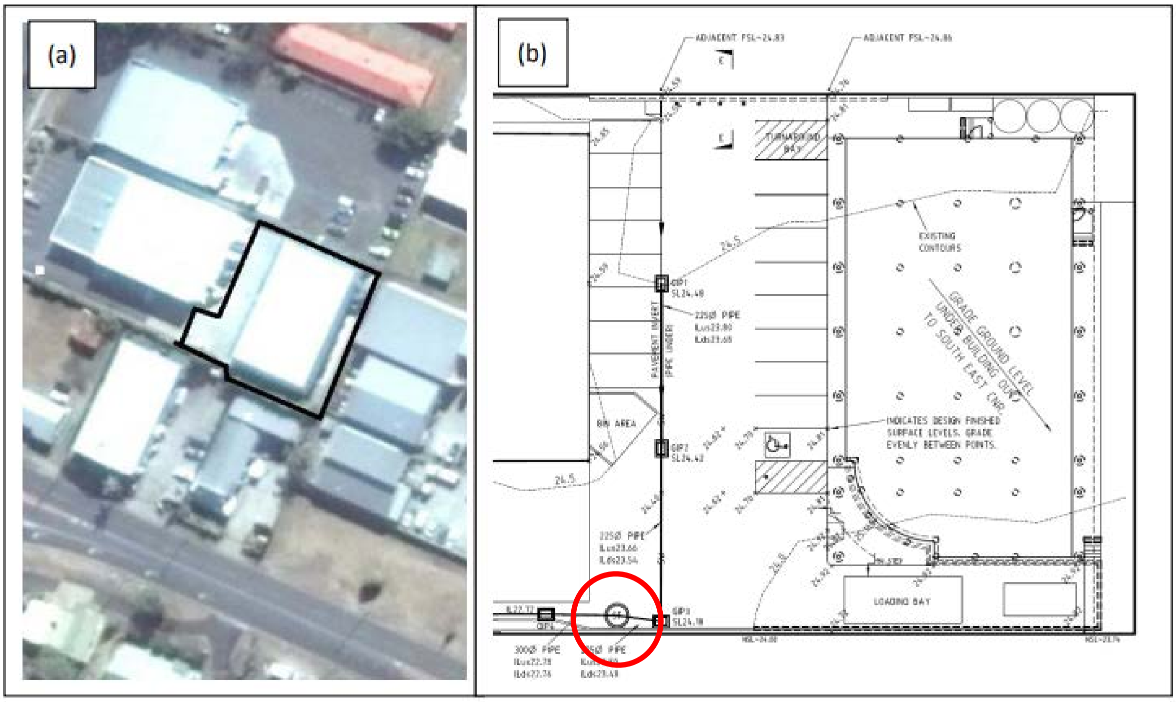

Figure 1: Images of the West Ipswich case study site indicating (a) an aerial view of the case study site catchment that appears to have been developed in 2012 and (b) a drainage plan of the case study site. The location of the Jellyfish is circled in red. Images sourced from Goonetilleke and Egodawatta (2017)

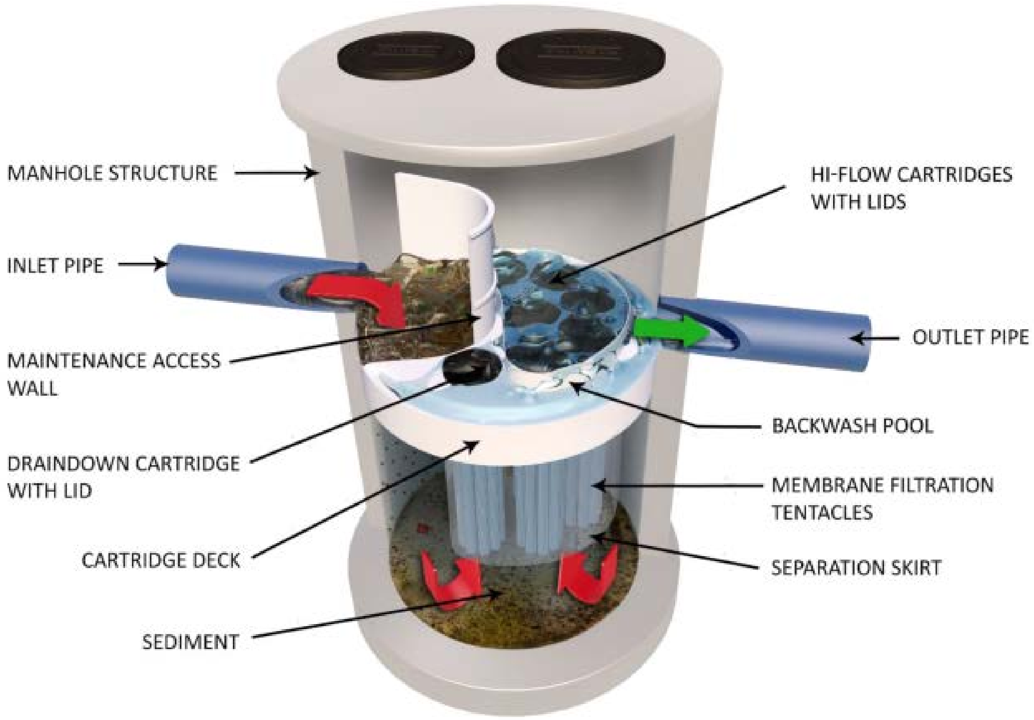

Figure 2: Conceptual image of the Jellyfish components. Image supplied by Ocean Protect Pty Ltd.

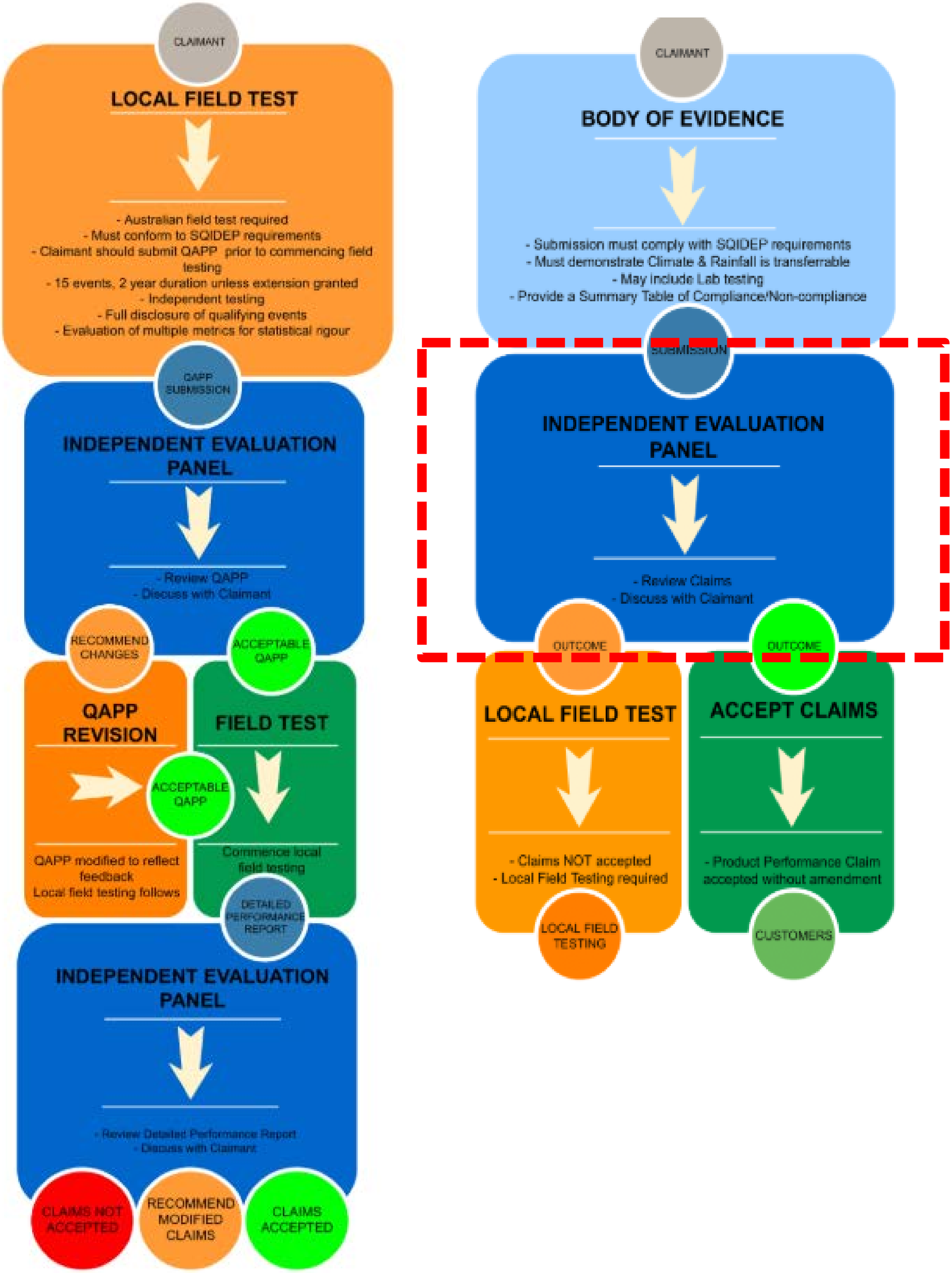

Figure 3: SQIDEP Pathways. This report specifically relates to the section boxed in dashed red – the independent evaluation panel assessment

Figure 3 shows that the Applicant is pursuing a body of evidence application. It is noted that the field testing was undertaken in 2014/2015, before SQIDEP v1.3 was published.

Performance Claim

A performance claim has been submitted on the SQIDEP Body of Evidence Pathway submission form. The performance claim for the Jellyfish is shown in Table 1.

Table 1: Performance claim for the Jellyfish

Paramter	Performance claim (% removal)
Total suspended solids (TSS)	92.6
Total phosphorous	57.0
Total nitrogen	46.8
Gross pollutants	100.0

The BoE application did not include specific evidence relating to the treatment of gross pollutants and the assessment is based on a first principles basis with qualifications. This is discussed further in Section 3.

The BoE application included more detailed flow information, specifically relating to peak flow rates that had passed through the device. The experimental set-up included one flow measurement device, located just prior to the inlet to the Jellyfish. The BOE application did not specifically test treatable flow rates though it tested the flow rates upstream of the device and the quality of influent as well as the quality of effluent including water that passed over the internal high flow bypass weir. Treatable flow rate claims are based on previous laboratory measurements in Florida, USA (University of Florida, 2011).

This Body of Evidence (BOE) claim is based on field test results from two field sites. One is located in Australia (West Ipswich, Queensland) and an additional site in the United States of America (Gainesville, Florida). Test results from both sites are comparable.

Field Site Background and Assumptions

Site 1: West Ipswich, Queensland

The Australian field site is located at 292 Brisbane Street, West Ipswich, Queensland. According to a performance report provided with the submission, the catchment for the Ocean Protect Jellyfish installed on site is 1678 m^2 including 550 m^2 roof area and 1128 m^2 of impervious driveways and parking spaces. Based on analysis of aerial imagery, the site was developed sometime between January 2012 and December 2012. Monitoring was reported to occur from 28 June 2014 to 26 September 2015. The catchment was checked for changes across the monitoring period. Aerial photography was taken from Google Earth and is shown below in Figures 4 to 6. There does not appear to be any changes in the catchment area or surrounding areas over the monitoring period. The setup of the Jellyfish and associated monitoring equipment is shown in Figure 7.

Figure 4: Surrounding area of the West Ipswich site in May 2014. The catchment of the Jellyfish is circled in red (Image courtesy of Google Maps).

Figure 5: Surrounding area of the West Ipswich site in November 2014. The catchment of the Jellyfish is circled in red (Image courtesy of Google Maps).

Figure 6: Surrounding area of the West Ipswich site in May 2015. The catchment of the Jellyfish is circled in red (Image courtesy of Google Maps).

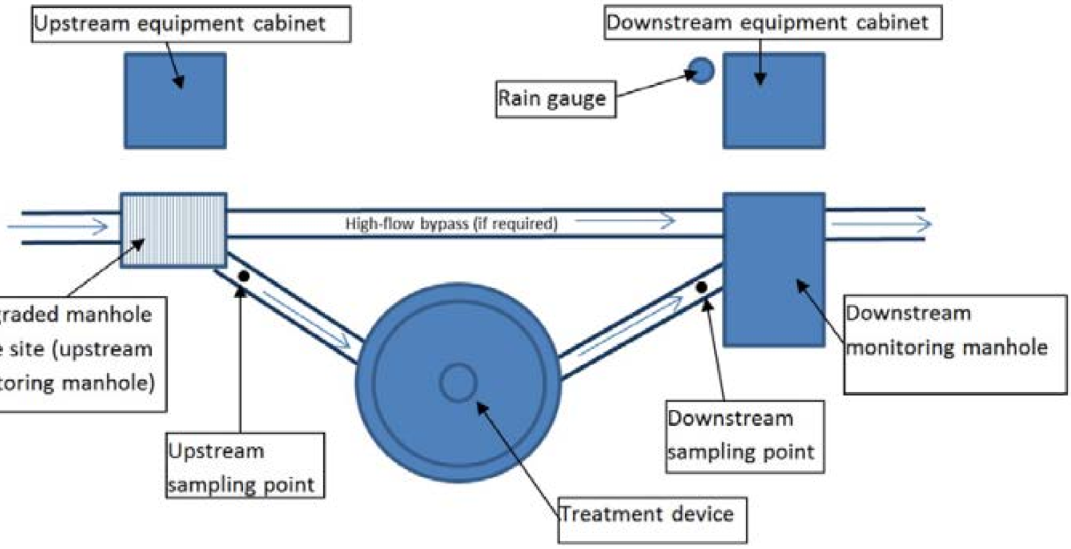

Figure 7: Location of flow measurement and water quality sampling equipment for the West Ipswich study site (Image from Goonetilleke and Egodawatta, 2017)

2. SQIDEP Compliance

The key criteria for testing are listed in SQIDEP in *Table 3 – Minimum data and qualifying event requirements for assessment* (SA, 2019) and are repeated here for comparison with some additional remarks from the SQIDEP protocol. Table 2 below assesses the Application for compliance with the criteria included in SQIDEP v1.3.

Table 2 – SQIDEP compliance requirements (adapted from Table 3 of Stormwater Australia [2018])

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
Organisational Roles and QA			
Roles and Responsibilities	*The claimant, sampling organisation, analytical laboratory and reporting organisation shall be clearly identified (especially in confirming independence requirements*	Independent monitoring was undertaken by Queensland University of Technology (QUT). Laboratory testing of water samples was undertaken independently. Although the NATA registration of the laboratory is not current at the time of writing this report, it is understood it was current at the time of sampling.	Compliance.
Sampling QA and QC	*Operation and maintenance schedules for sampling equipment shall be provided. Chain of custody documents identifying sample, collection agency, collection time, preservation used and laboratory receipt of sample and sample condition shall be provided.*	CoC data was included with the BoE application. It is known that Humes originally commissioned QUT to carry out this	Compliance.

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
		work. This work was certainly carried out independently of Ocean Protect. Additional flow data was provided however the source of this data was not able to be verified. The flow data provided matched written evidence by QUT very closely (event duration and depth).	
Reporting	*By independent organisation*	By QUT.	Compliance.
Sampling Events			
Min number of events	*15 or enough events to achieve 90% confidence interval* - *In all cases a minimum of 15 qualifying events is required, but an upper number of tests needs to be determined based on an assessment of the data using credible statistical methods (such as ANOVA/ t-test techniques) to achieve at least 90% statistical significance between paired samples of influent and effluent (Toifl et al. 2017).* - *If the level of statistical significance is not able to be demonstrated more events must be sampled until the 90% statistical significance is achieved*	17 events in total reported. 15 complying events reported for Australian site. Two events excluded on the basis of total nitrogen (TN) exceeding the upper concentration limit stipulated in SQIDEP.	Compliance.

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
	- *At least two (2) peak inflows from the sampled events should exceed 75% of the design TFR of the device, and 1 at or greater than its design TFR* - *Sampling events should be sufficiently distributed throughout the monitoring period to capture seasonal influences on storm conditions and device performance.* - *There is no stipulated minimum storm event duration, however for the majority of qualifying events (80%) at least 8 aliquots are required if discreet aliquots are being collected* - *The independent evaluation panel must be satisfied that the qualifying storms being assessed includes a good range of storm events including longer and shorter duration storms of varying magnitude and that at least 50% of qualifying storms should include the first 70% storm hydrograph coverage.* - *Where storm events are longer than 8 hours in duration, sampling over the first 8 hours is regarded as sufficient.*	- TFR of the installed device is based on Appendix C of Reference Document 5 which tested TFR of both clean and dirty cartridges. The claimed TFR is considered conservative. - Rainfall events are well distributed, with events in June (2), August (3), September (3), October (2), November (2), December (1), March (1), April (2) and May (1). No events in January or February which are typically months with high rainfall in West Ipswich. - 3 of 15 events had less than 8 sample aliquots collected. This is on the limit of acceptability which requires a minimum of 12 samples. Refer to discussion for more information. - Good range of storm rainfall depths ranging from 2.8 to 33 mm, average of 10.9 mm and well distributed when plotted.	Compliance.

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
		- Good range of rainfall durations ranging from 19 mins to 20.4 hours, average of 5.3 hours.	
Min rainfall depth	Sufficient to collect minimum sample volume for lab testing.	QUT reported a minimum rainfall threshold of 2.6 mm.	Compliance.
Inter event period	Minimum 6 hours dry	Minimum inter-event period was 3 days.	Compliance.
Device Size	Full size - Full Scale (where a ‘family’ of devices are being included as part of the claim sizing relationships must be provided for evaluation along with any basis of justification).	- Used a full size single modular device. - Flow capacity is indicated to be 12.5 L/s based on lab testing of cartridges by University of Florida as part of the TARP application. - Details of the family of devices are provided – flow capacity is linearly interpolated based on capacity of the 5 L/s per cartridge, plus 2.5 L/s for each ‘drain down’ cartridge.	Compliance.
Runoff Characteristics	Target pollutant profile of influent and effluent	The catchment area of the device appears to be typical of a light industrial building and car park. There was one	A qualified compliance should be

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
		notable departure being the generation of gross pollutants. The study site is reported as 100% impervious consisting of roof and carpark which would be unlikely to generate typical gross pollutant loads. This could fail to stress test the device under field conditions where gross pollutants could potentially impact on device performance. Refer to discussion for more information.	issued on the basis that the catchment would be unlikely to have generated significant gross pollutants.
Runoff volume or peak flow	At least 2 events should exceed 75% of the TFR and 1 event greater than the TFR.	- The TFR is reported to be 12.5 L/s - The flow rate of qualifying events through the system varies from 0.3 L/s to 222.9 L/s although flow rate measurements above 20 L/s are considered inaccurate. - The peak flow exceeded the TFR for eight of the 17 events. Eight events also exceeded 0.75 × TFR (9.375 L/s) Refer to discussion for more information.	Compliance.

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
Automated sampling	Composite samples on a flow or time weighted basis	- According to Goonetilleke (2017): "Sampling intervals were programmed to vary based on the intensity of the rainfall received". - Considering the catchment is reported as 100% impervious rainfall intensity is an acceptable analogue for flow. Refer to discussion for more information.	Compliance.
Minimum number of aliquots	80% of field test collections should have at least 8 per event.	- Number of sample aliquots is provided by the spreadsheet submission data (Wicks and Dalrymple, supplied). - Aliquots ranged from 3 to 24 per event. 3 of the 17 events had less than 8 aliquots (28 June 2014; 25 Sept 2014; 27 Oct 2014). - Therefore ~82% events were greater than 8 aliquots. - On detailed inspection of the storm data it was found that for some events 2 aliquots were sampled at the same time at the start of sampling. If these	Compliance.

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
		duplicate aliquots are excluded it would reduce the number of storm events with 8 or more aliquots to 12 of 15 which is 80% of storm events. Refer to discussion for more information.	
Hydrograph coverage	At least 50% of qualifying storms should include the first 70% storm coverage.	- The percentage of hydrograph coverage was not reported by QUT. - Based on the provided flow data at least 50% of storms cover more than 70% of the hydrograph. - The reviewers have undertaken a risk-based approach to ensure that, given the rainfall intensity triggered sampling method adopted, samples were taken to provide good coverage. Refer to discussion for more information.	Compliance.

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
Hydrograph coverage	Multiple peaks should be accounted for (at least 1 occurrence).	- Plotting flow records provided in the supplied spreadsheet data (Wicks and Dalrymple, supplied) indicates that this appears to have been achieved on some events e.g. 1 April 2015.	Compliance.
Grab sampling	Not Applicable	- Automatic sampling was undertaken for the site. This was reported by Goonetilleke and Egodawatta (2017).	Not applicable.
Sampling locations	- *The inlet sample shall be taken as close as possible to the device, at a minimum this should be at a point where total site runoff is sampled.* - *Outlet flow should be sampled either prior to or after mixing with bypass flow and Claims identify the inclusion/exclusion of bypass flows*	- Sampling occurred upstream and downstream of the Jellyfish device. The sampler locations are depicted by Figure 2 of Goonetilleke and Egodawatta (2017) (reproduced for convenience in Figure 7 of this report). - This setup complies with Figure 2 of the SQIDEP for studies where flow sensor and sample intake locations are situated and where	Compliance.

<table>
<tr><th>Performance Criteria</th><th>Performance Requirement</th><th>Monitoring action or result</th><th>Compliance or non-compliance</th></tr>
<tr><td></td><td></td><td>bypass flows are not accounted for in analysis).</td><td></td></tr>
<tr><td>Chemical and physical analytes</td><td>As identified in the QAPP.</td><td>QAPP not sighted.</td><td>Not applicable to a BOE application.</td></tr>
<tr><td>Min and max concentrations within range</td><td>Typical untreated stormwater quality for this review is defined by SQIDEP Table 1.
<table>
<tr><th>Pollutant</th><th>Min</th><th>Mean (Standard deviation)</th><th>Adopted max. average</th><th>Max for individual event**</th></tr>
<tr><td>TSS</td><td>LOD*</td><td>151 (+220)</td><td>371</td><td>591</td></tr>
<tr><td>TP</td><td>LOD*</td><td>0.34 (+0.37)</td><td>0.71</td><td>1.1</td></tr>
<tr><td>TN</td><td>LOD*</td><td>1.82 (+1.27)</td><td>3.09</td><td>4.4</td></tr>
<tr><td colspan="5">* Limit of detection
** Mean + 2(standard deviation)</td></tr>
</table></td><td>It is noted that the inflow pollutant concentrations are reasonably typical.
- TSS loads were lower than the adopted mean and acceptable
- TP loads were lower than the adopted mean and acceptable
- TN loads were higher than the adopted mean, with two inflow values higher than the adopted max for an individual event (events 27/10/2014 and 28/11/2014). Based on this, the two events where TN exceeded 4.4 mg/L were excluded from the analysis. This resulted in 15 complying storms and TN loads lower than the adopted mean.</td><td>Compliance.</td></tr>
</table>

<table>
<tr><th>Performance Criteria</th><th>Performance Requirement</th><th>Monitoring action or result</th><th>Compliance or non-compliance</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Pollutant</th><th>Min</th><th>Mean (Standard deviation)</th><th>Max for individual event**</th></tr>
<tr><td>TSS</td><td>11</td><td>58 (56)</td><td>180</td></tr>
<tr><td>TP</td><td>0.53</td><td>0.25 (0.13)</td><td>0.49</td></tr>
<tr><td>TN</td><td>1.0</td><td>2.2</td><td>4.4 after exclusion of two events > 4.4</td></tr>
</table>
</td><td></td></tr>
<tr><td>Analytical methods</td><td>NATA accredited sample handling and analytical methods</td><td>- It was reported by Goonetilleke that water samples were analysed by ‘Advanced Analytical Laboratory’, which were NATA accredited at the time of analysis (Goonetilleke and Egodawatta, 2017).</td><td>Compliance.</td></tr>
</table>

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
Flow measurement location	Inlet, outlet and bypass, as applicable.	Flow recorded at inlet (prior to bypass) only. The device claims no storage or flow reduction benefit therefore inflow would be a strong surrogate for outflow.	Compliance.
Precipitation Measurement	A pluviometer is required	According to Goonetilleke and Egodawatta (2017), “A RIMCO RIM7499 tipping bucket rain gauge installed to measure rainfall [had] a resolution of 0.2 mm.”	Compliance.
Rainfall recording interval	5 minutes or less.	Records of sample aliquot timing in the supplied spreadsheet data (Wicks and Dalrymple, supplied) indicated that rain records were at less than 5-minute intervals.	Compliance.
Rainfall recording increments	<0.25 mm	0.2 mm adopted.	Compliance.
Pluviometer calibration	To be calibrated twice during the monitoring period.	No information provided regarding calibration of the RIMCO RIM7499 tipping bucket rain gauge during the study.	Unknown but not considered critical to the outcome of this study. The

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
			data was collected in a period of 15 months during which time it is unlikely the rain gauge lost calibration.
Performance Indicators	The target pollutants and testing rationale must be described in the QAPP and Detailed Performance Report.	A QAPP was not submitted as part of the application. Performance is claimed for TSS, TP, TN and gross pollutant reductions. TSS, TP and TN were measured. Gross pollutants, while being claimed, were not measured. Refer to discussion for more information.	Partial Compliance. Refer to Section 3.
Performance Indicators	ER claimed	The ER method is one of the acceptable methods included in SQIDEP.	Compliance.

In the supply of documentation for this performance review, Wicks (2021) also requested that the Ocean Protect Jellyfish be assessed against additional criteria. These criteria are listed in Table 3 and assessed as per the SQIDEP requirements in Table 2.

Table 3: Additional assessment requirements requested by Ocean Protect by correspondence to Stormwater Australia (see Wicks [2021]).

Performance Criteria	Performance Requirement	Monitoring action or result	Compliance or non-compliance
Number of events from a single site	Require a minimum of seven (7) storms from a single site, and data must include sequential qualifying (in range) storm events.	At least 15 qualifying storms were from a single site. Analysis of nearby rain gauges indicated an incomplete record close to the site and we were unable to verify sequencing of events.	No comment
Average concentration of dissolved inorganic nitrogen	Require a minimum average dissolved inorganic nitrogen % (DIN % of total nitrogen) of 25%.	DIN, in fact NOx alone was verified to comprise on average, 28% of the nitrogen fraction of influent.	Compliance.

3. Discussion

Our independent evaluation finds that:

- As shown in Table 2, the testing regime and results comply with SQIDEP protocol requirements.
- The field study appears to be a scientifically sound study and would be repeatable under similar conditions which it is noted are deemed representative.

Detailed investigations and discussion with OP focussed on:

1) The gross pollutant claim.
2) How well the rainfall intensity triggered sampling method provided a composite sample which captured both rising and falling limbs and other key features of storm event hydrographs.
3) The impact of excluding what appeared to be double counting of the first aliquot.
4) How accurately flows were measured and if the flow data was considered usable. It is noted that flow data was only used to determine if the device was tested to 75% of the TFR and 100% of the TFR. This is because aliquots were collected based on a rainfall intensity trigger not a flow trigger.
5) Verification of the TFR

These issues are discussed further below.

Gross Pollutant Claim

The Jellyfish works by causing flows to back up behind a maintenance access wall or weir. Flow then enters a chamber and leaves the chamber by flow through one of the tentacles.

There is no pathway for a gross pollutant to get through one of the tentacles. The only other potential pathway for a gross pollutant to leave the system would be by flowing over the weir.

To ensure this does not occur, it has been agreed with Ocean Protect that:

1) The weir (maintenance access wall) shall be set a minimum of 100 mm above the system design hydraulic grade line.
2) If this is not achievable then weir level shall be set so that is a maximum of 50 mm below the soffit of the chamber.
3) At all times the weir (The maintenance access wall) shall be above the system design HGL regardless of requirements 1 and 2.

Adequacy of Rainfall Intensity Triggered Sampling

The reviewers understand that SQIDEP has a preference for water quality samples to be collected on a flow weighted basis during a storm but does allow for time-weighted sampling (SQIDEP, Table 3). This study is a body of evidence study carried out prior to the publication of SQIDEP. It relies on rainfall intensity triggered sampling, which was considered by reviewers to be potentially less reliable than flow-weighted sampling, however it was considered acceptable for two reasons:

- Rainfall intensity-weighted sampling is superior to time-weighted sample collection which is still acceptable in SQIDEP; and
- at the West Ipswich site, rainfall intensity-weighted sampling may be a reasonable surrogate to flow weighted sampling due to the small, fully impervious catchment.

The adequacy of this approach was reviewed in more detail by both authors to ensure that aliquots were collected across the hydrograph to ensure that the event mean concentration of each storm was reasonably representative.

Double Counting of some Aliquots

The authors of this report observed that for some storm events, it appears that two aliquots were sampled at the same time at the start of the storm event.

SQIDEP stipulates that 80% of complying storm events had at least 8 aliquots. In this case there were 15 complying storm events. Therefore at least 12 needed to have 8 or more aliquots.

If duplicate aliquots were excluded, the result would have been that 11 events would have had 8 aliquots or more and the application would need to be refused.

The authors have evaluated the impact of the duplicate aliquot on the spread of aliquots across the storm event for the single event which becomes 7 aliquots when removing the duplicate. The event was on 6 November 2014, was 48 minutes duration and had 7 aliquots (excluding a duplicate). Sampling was spread across the storm event and provided representative coverage as shown in Figure 8.

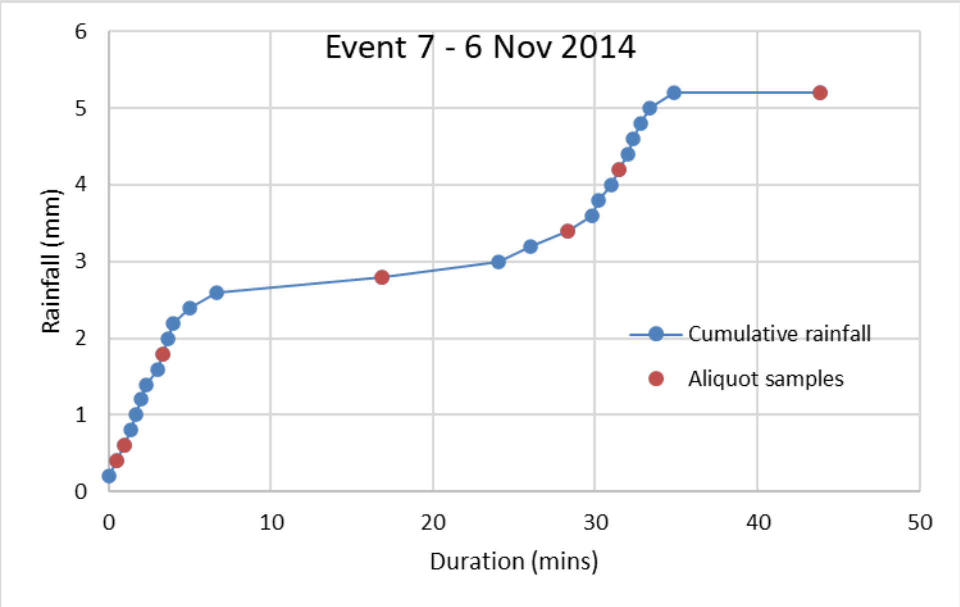

Figure 8: Plot indicating the timing of aliquot sample collection throughout the storm event at West Ipswich on 6 November 2014. Plot indicates cumulative rainfall during the storm, with aliquot samples collected at each plot point in red (noting there were two aliquots at the first plot point).

The authors also considered the potential impact of having two aliquots triggered at the start of the storm event on EMC data and came to the conclusion that both inlet and outlet samples were affected equally and given this is a comparative assessment the impact would have been considered minimal on reported removal rates. Moreover, the influent concentrations for TSS and TP were low compared to SQIDEP Table 1 mean values while TN was high but well within the acceptable range.

Based on this analysis of the event data, it was decided that the EMC data collected and reported would have been representative.

Analysis of Flows

The authors have analysed reported flows in the following manner:

1) We checked flows against reported depths and corresponding rating data (for the 8 inch Parker-Bowlus flume) for those depths to ensure that reported flows corelated with the flume's rating table. They did to the nearest 0.1 L/s.
2) Events were checked to ensure that the device, with its claimed TFR of 12.5 L/s, was stress tested. It was observed that when depth exceeded the rating table, reported flows were inaccurate.
3) It was found that at least 3 storm events would have resulted in flows exceeding the TFR.

Verification of the TFR

Verification of the TFR of the Jellyfish was not possible with data available from the field site. However, the reviewers approached Ocean Protect to clarify the claim regarding the determination of a TFR for the Jellyfish device and received design flow rate assumptions used when implementing a Jellyfish to meet a required TFR. These are reproduced in Table 4 below.

Table 4: Design assumptions applied by Ocean Protect for Jelly fish cartridges (or tentacles) with different driving head (Source: Ocean Protect)

Driving head	Cartridge Length	Peak flux rate (L/s/m2) (per cartridge)	Higher flow TFR (L/s)	Drain-down TFR (L/s)
457 mm (18 inches) (Standard)	1.37m (54 inch)	0.141	5	2.5
	0.686m (27 inch)	0.071	2.5	1.30
305 mm 12 inches	1.37m (54 inch)	0.094	3.34	1.96
	0.686m (27 inch)	0.055	1.68	0.98
229 mm 9 inches	1.37m (54 inch)	0.071	2.52	1.58
	0.686m (27 inch)	0.045	1.27	0.79

Laboratory data collected at the University of Florida (2011) (reference document 5) was reviewed to examine the compliance of the Jellyfish device with the stated TFR and design flow rate assumptions, including the 12.5 L/s stated for the West Ipswich device. Jellyfish cartridge flow capacity testing was detailed in Appendix C of the report.

The components tested included the two key components used to design a TFR for the Jellyfish device in Australia – the higher flow cartridge which is fitted with a 70 mm orifice (marked as ‘Hi-flow cartridges with lids’ in Figure 2) and a 2.5 L/s ‘drain down’ cartridge with a 35 mm orifice. Cartridges were tested in both new condition and used condition. Used cartridges had been in applied in the field for one year). The data collected by the University of Florida indicated:

- The claimed performance of the higher flow cartridge (full length with a 70 mm orifice) namely a design capacity of 5 L/s, was considered conservative – the University of Florida study indicated that the actual capacity was over 7 L/s with equivalent driving head.
- The claimed performance of the drain down cartridge (full length with a 35 mm orifice), namely a design capacity of 2.5 L/s, was considered acceptable. The University of Florida study indicated that the actual capacity was 2.7 L/s with equivalent driving head.
- The flow capacity of cartridges which had been applied in the field for over one year was very similar to new condition.
- The reduced flow rate of the drain down cartridge appears to be attributable to the orifice. As such, while there was no measured verification of the half length (27 inch) cartridges, it may be reasonably assumed that the half length cartridges have half the flow capacity.

4. Conclusions

Approved treatment efficiencies for the Jellyfish are provided below in Table 5. The approved treatment flow rates for the device components are provided in Table 6.

Table 5: Independent evaluator accepted claim for Jellyfish water quality treatment performance

Pollutant	**Claimed Performance (ER) (% retained on average per annum)**	**Accepted Performance (ER) (% retained on average per annum)**
Total suspended solids (TSS)	92.6	92.6
Total phosphorous	*57.0*	*57.0*
Total nitrogen	*46.8*	*46.8*
Gross pollutants	*100.0*	*100*

Table 6: Independent evaluator accepted claim for the treatment flow rate and peak flux rates of Jellyfish filter components

Driving head	**Cartridge Length**	**Peak flux rate (L/s/m2) (per cartridge)**	**Higher flow TFR (L/s)**	**Drain-down TFR (L/s)**
457 mm (18 inches) (Standard)	1.37m (54 inch)	0.141	5	2.5
	0.686m (27 inch)	0.071	2.5	1.30
305 mm 12 inches	1.37m (54 inch)	0.094	3.34	1.96
	0.686m (27 inch)	0.055	1.68	0.98
229 mm 9 inches	1.37m (54 inch)	0.071	2.52	1.58
	0.686m (27 inch)	0.045	1.27	0.79