KURANDA STORMWATER TREATMENT SYSTEM FIELD EVALUATION

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INTRODUCTION

We present a case study of a proprietary treatment train designed for elevated bridge deck structures where bio-filtration is not an option. There is however a paucity of published peer reviewed scientific information validating the removal efficiency of proprietary devices. The research referred to herein provides information to inform the performance claims of an EnviroPod® and a StormFilter ® arranged in series as a "treatment train".

The StormFilter EnviroPod Treatment Device (SFEP) is a complete self-contained 'treatment train in a box'. The main components of the train are a gully pit sedimentation chamber with a downstream filtration device. This rather conventional design is augmented with a 200 micron pre-treatment screening device, which is effective at capturing the bulk of sediments down to 100 microns diameter. Crucially, we find that by configuring this to capture the bulk of organic sediments before they enter the sedimentation chamber. By holding it dry we can isolate most of the organic nitrogen load from the water column. Retained in this manner, it does not readily break down to soluble, inorganic nitrogen species. As expected, the organic matter which does pass through the screen into the sedimentation chamber undergoes some degree of conversion to ammonia nitrogen in its comparatively anoxic environment. To counteract this, the final filtration component of the treatment train employs zeolite to capture this ammonia as ammonium ions, thus preventing it passing into the receiving waters. In addition, the filter performs its more obvious role in capturing fine suspended solids, further increasing the load of captured nitrogen. Once again, the filter holds its captured sediment dry and, in so doing, minimises its decomposition to soluble species.

METHOD

The system samples were collected using automated influent and effluent samplers, collecting continuous flow and precipitation data and water quality simultaneously. The influent sampler was programmed to send an SMS alert to Stormwater360, via the GSM cellular network, when the sampling programme was triggered. A dial up connection was then made to each sampler to download data for analysis.

To qualify as a representative sample, the following specific criteria had to be satisfied:

i. Collection of at least 3 simultaneous influent and effluent samples per storm
ii. Samples must have been collected while the treatment system operated within design flow rates
iii. The sampled portion of the storm event must represent at least 60% of the storm total flow volume.
iv. A minimum of six data sets must be collected for a full performance evaluation.

Antecedent dry period was not identified as a constraint, due to the impervious nature of the catchment and the absence of a base flow however, at least a 3 day antecedent dry period was preferred. If the storm was deemed to qualify, Stormwater 360 would inform Cairns Water and Waste Laboratory Services (Cairns Water, NATA accreditation # 14204) that samples required collection and analysis. Analysis was performed by Cairns Water and Waste Laboratory Services, ALS Laboratory Group – Brisbane (ALS, NATA accreditation # 825). All water quality parameters for qualifying storms were sent to an independent peer reviewer at Queensland University of Technology (QUT) ensuring transparency of data.

RESULTS

Results of the SFEP treatment train are given below.

Analyte	no. of events	Range of Influent EMCs (mg/L)	Median Influent EMC (mg/L)	Range of Effluent EMCs (mg/L)	Median Effluent EMC (mg/L)	Mean Removal Efficiency (Sum of Loads)
SSC	6	75 to 4384	1181	8 to 63	20	99%
SSC < 500 micron	6	48 to 180	105	8 to 62	20	78%
TP	6	0.08 to 0.19	0.123	0.02 to 0.15	0.055	47%
TN	6	0.6 to 1.5	1.045	0.2 to 0.9	0.615	44%
TKN	6	0.6 to 1.2	1.007	0.175 to 0.800	0.515	49%
NH_3-N	6	0.05 to 0.15	0.050	0.05 to 0.07	0.050	31%
TOC	6	3 to 16	7	3 to 10	5	32%
DOC	6	3 to 12	7	3 to 11	6	21%

CONCLUSIONS

The results from this field trial generally correlate well with an earlier study at this site by JCU (Munksgaard and Lottermoser, 2008). The data collection from this study has been based on a rigorous and technically demanding monitoring program which adds further credibility of the results (Goonetilleke, 2010). From an operational perspective, the system captured an appreciably large sediment load requiring annual cleaning to maintain its operational effectiveness.

The EnviroPod® / StormFilter ® “treatment train” achieved 78% removal for suspended solids under 500 microns which approximates the long term environmental target recommended by NSW DECC (2007), QLD DERM (2010) for South East QLD (SEQ) and consistent with the 80% reduction target of many consent authorities in the USA.

The runoff at Streets Creek contained very low levels of phosphorus and nitrogen. Total phosphorus removal was between 45% and 70% respectively in both the Stormwater360 field trial and the JCU research project, which approximates the NSW DECC (2007) and QLD DERM (2010) SEQ long term environmental targets of 65% and 60% respectively, and is better than expected given the low influent EMCs. Total nitrogen removal was consistent, substantial and in agreement with the NSW DECC (2007) and QLD DERM (2010) SEQ 45% long term environmental target despite the proximity of the influent EMC to the irreducible concentration of the “treatment train”. The removal of Nitrogen was particularly noteworthy given that the debris captured and stored within the “treatment train” was not included in the influent load into the system, but may have been sampled as a soluble leachate by the effluent sampler.

REFERENCES

Goonetilleke, A. (2010). Letter to Author, 15th March, 2010.

NSW Department of Environment and Climate Change (DECC, 2007). *Managing Urban Stormwater: Environmental Targets.* Consultation Draft – October 2007, Department of Environment and Climate Change NSW, p.4

QLD DERM (2010). *Urban Stormwater Quality Planning Guidelines 2010* – December 2010, Department of Environment and Resource Management, Table 2.2 SEQ (2010).

Kuranda Stormwater Treatment System Field Evaluation

Michael Wicks Stormwater360 Australia
Mike Hannah & Nick Vigar Stormwater360 New Zealand

- Monitoring Stormwater BMP’s & associated issues
- Background & previous study
- Method
- Results
- Conclusion

Agenda

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- Gain an understanding of BMP performance under non-ideal conditions
- Many agencies are needing to review and approve BMPs to meet State Planning Policy Guidelines
- Accountability
  - Manufacturer
  - Regulator
- The end result can be misuse (or no use) of BMPs

Why Monitor Stormwater BMP's ?

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- Goals
  - Guidelines are often simplistic and create confusion as to how to evaluate BMP performance
- Claims
  - Field Evaluation essential
  - Performance at design flows
  - Influence of concentration
  - Validated data

Issues

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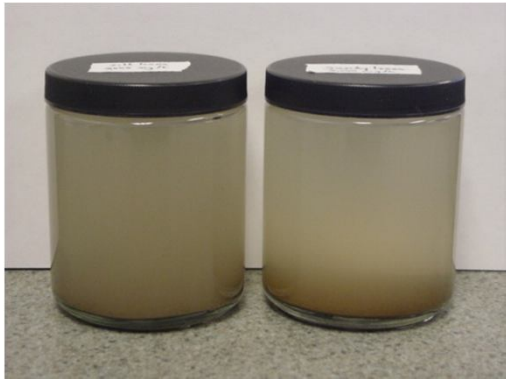
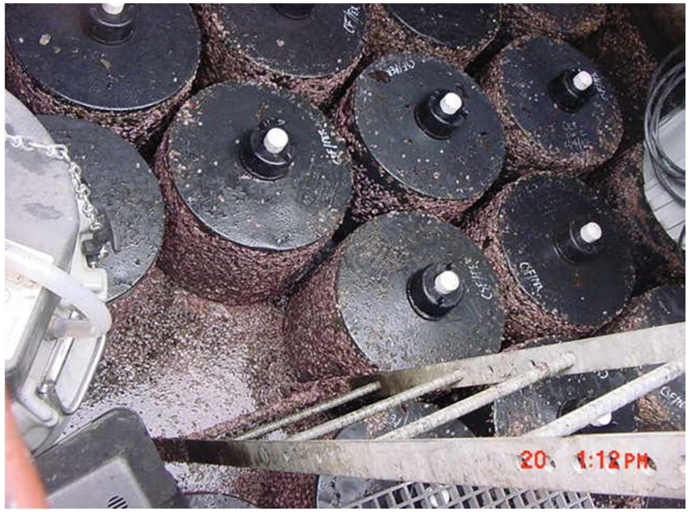
- Definitions
  - TSS Particle Size Distribution & Specific Gravity
  - Nutrients; soluble species



- Fugitive solids
  - Organics/Decomposition
  - Transformation of soluble species



- Clean Sites

Issues - Pollutants

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- Procedures
- Equipment
  - Inlet and Outlet
  - Limitation
  - Rain Gauge
- Event Occurrence
  - Antecedent conditions

What can go wrong… and is it necessary?

Issues - Sampling

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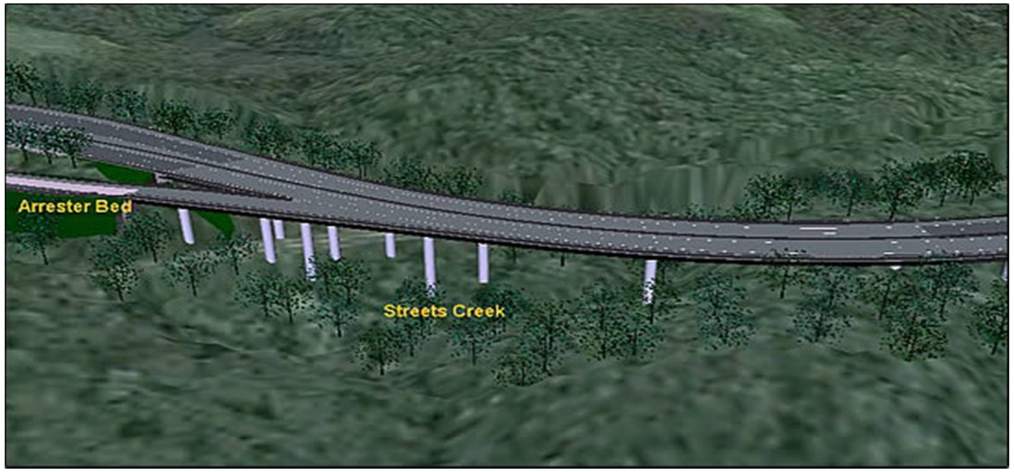
- QLD Department of Main Roads commissioned James Cook University (JCU) to investigate water quality treatment options for road upgrade

- The proposed upgrade made extensive use of elevated bridge deck to minimise environmental impacts



JCU Study - Background

Stormwater360

- JCU completed literature review of suitable technologies in 2004.

- An innovative treatment system, the StormFilter & EnviroPod (SFEP) treatment train, was selected for the field evaluation.

- Stormwater360 provided apparatus and Project Plan with monitoring protocols following North American procedures

JCU Study - Background *cont…*

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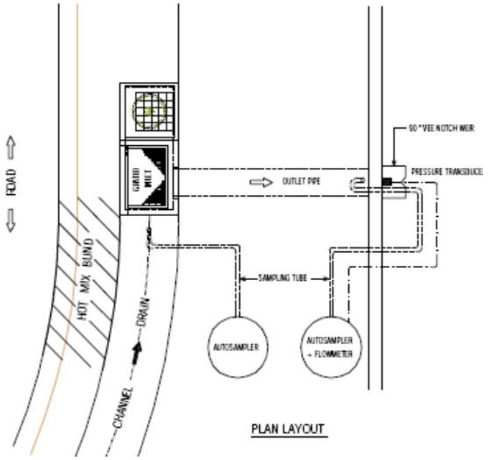

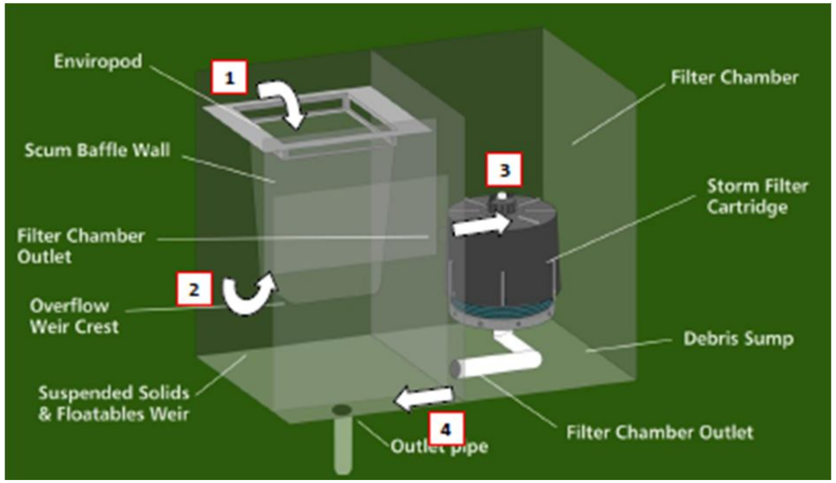

JCU Study - SFEP Treatment

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First study completed by JCU in 2005-2008

Sum-of-loads comparison for main trial events 1,2,3,4 weighted by no. of samples representing each concentration result - where <DL, 0.5*DL used				
Parameter	**unit**	**Influent**	**Effluent**	**Reduction %**
pH		7.59	7.21	
Ec	uS/cm	42.8	55.1	-29
>0.5mm solids	mg/L	1110	0	100
SSC	mg/L	176	192	-9
>0.5mm+SSC	mg/L	1290	192	85
Hardness	mg/L CaCO3	15	14	7
TN UF	mg/L	0.94	0.52	45
TP UF	mg/L	0.13	0.04	70
Al UF	ug/L	3760	1100	71
Al F	ug/L	45.7	45.5	0
Ni UF	ug/L	10.9	2.93	73
Ni F	ug/L	0.70	0.61	13
Cu UF	ug/L	28.6	12.0	58
Cu F	ug/L	4.03	4.42	-10
Zn UF	ug/L	193	122	37
Zn F	ug/L	10.1	40.7	-302
As UF	ug/L	1.20	0.80	33
As F	ug/L	0.37	0.47	-28
Cd UF	ug/L	0.20	0.06	69
Cd F	ug/L	0.02	0.01	26
Sb UF	ug/L	1.20	1.05	13
Sb F	ug/L	0.68	0.74	-10
Pb UF	ug/L	22.5	9.05	60
Pb F	ug/L	0.40	0.50	-26

Whilst achieved excellent results, limited data set necessitated

NEED FOR FURTHER TESTING

JCU Study - Results

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- QLD Main Roads & JCU ceased involvement

- Continuation of test site funded by Stormwater360

- Additional resources sought

- Apply what we have learned from other protocols in North America

Methodology - Current Study

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- Engaged all of the stakeholders
  – Peer Reviewer selected (QUT) to audit study
- Develop a Project Plan
  – Provide Description, define expectations & Methodology
- Data Collection Phase
  – Equipment & Sampling protocols
- Comprehensive Report
  – Consistent with Project Plan with Complete Data Set

Methodology – Project Management

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Flow proportional **fully automated upstream & downstream equipment measuring flow &** sampling water quality

Methodology – Equipment

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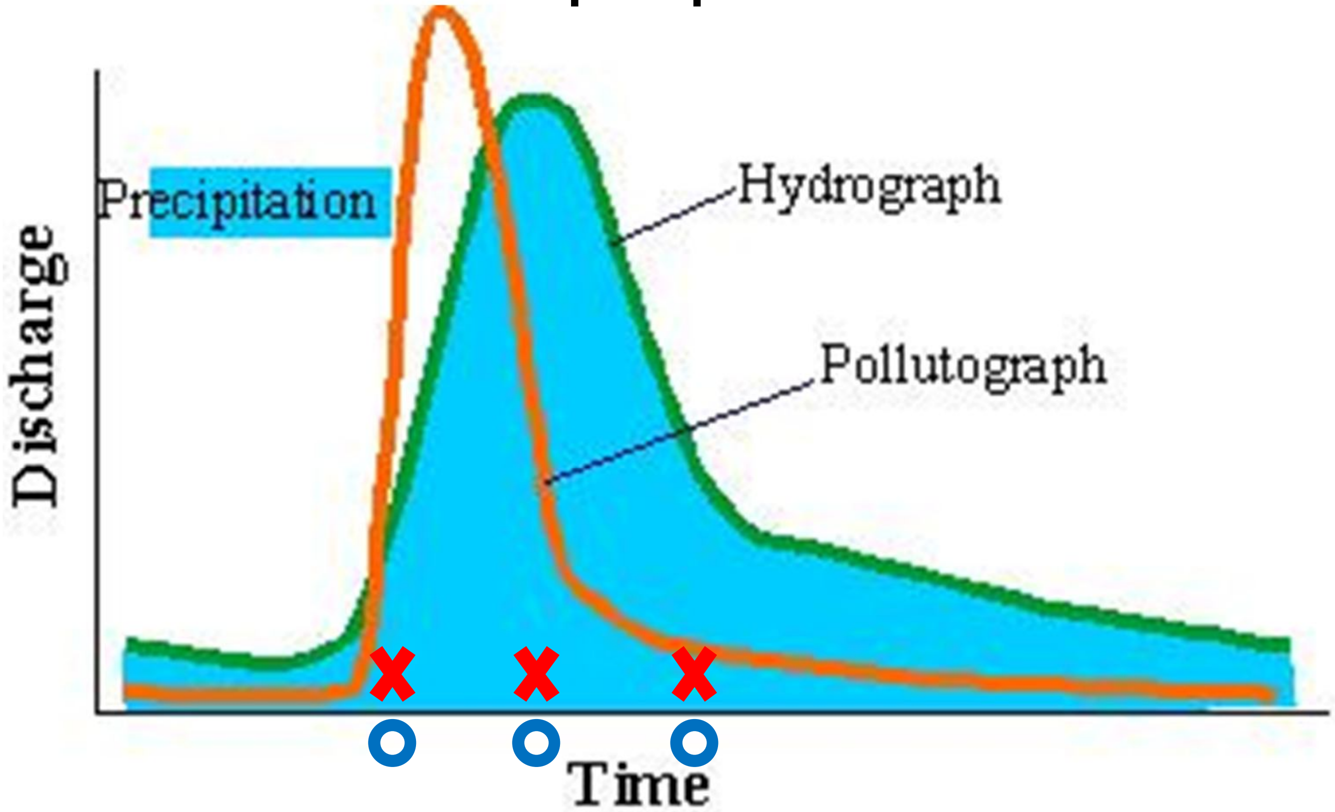
Collection of at least 3 simultaneous PAIRED influent and effluent samples per storm.



Methodology – Sampling Protocols

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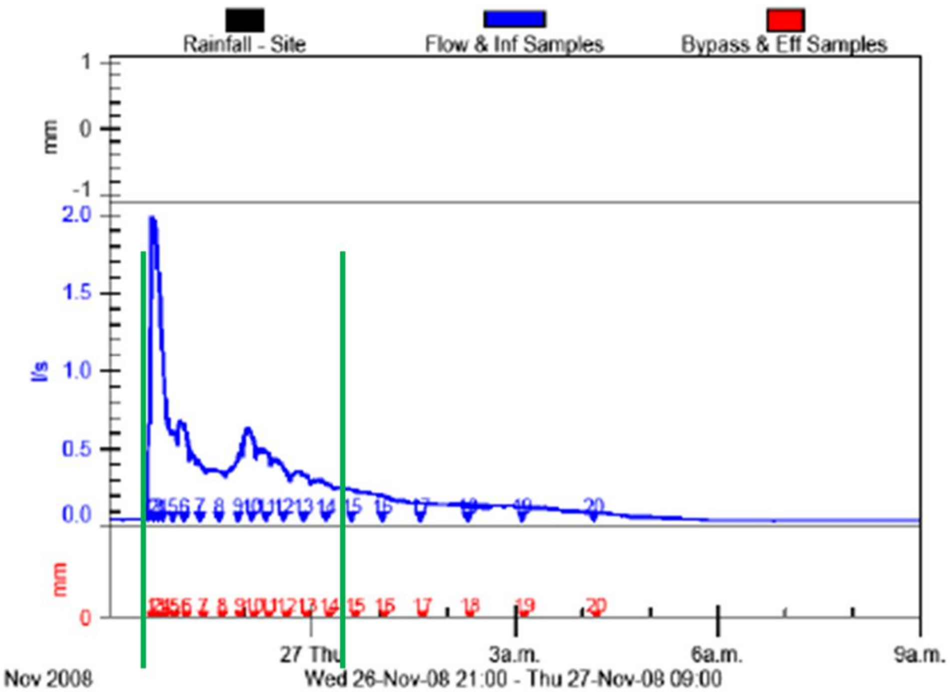
The sampled portion of a storm event must represent at least 60% of the total storm volume.



Methodology – Sampling Protocols *cont…*

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• Equipment remotely programmed & monitored by Stormwater360 in Auckland (real time)

• Once samplers triggered, Cairns Water contacted to retrieve samples & analysis conducted & distributed if storm complying

ALL Results sent to peer reviewer (QUT) and Stormwater360 regardless of analysis!!!

Methodology – Sampling Process

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Analyte	No. of events	Range of Influent EMCs (mg/L)	Median Influent EMC (mg/L)	Range of Effluent EMCs (mg/L)	Median Effluent EMC (mg/L)	Mean Removal Efficiency (Sum of Loads)
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Results

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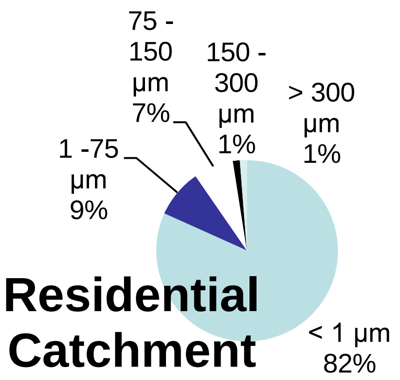
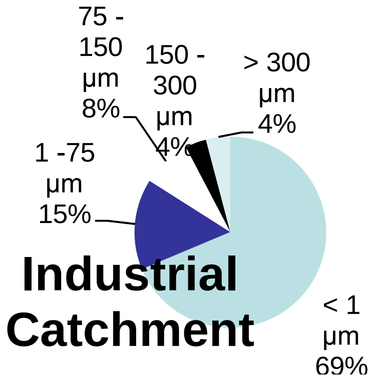
Discussion – Total Nitrogen Composition SEQ

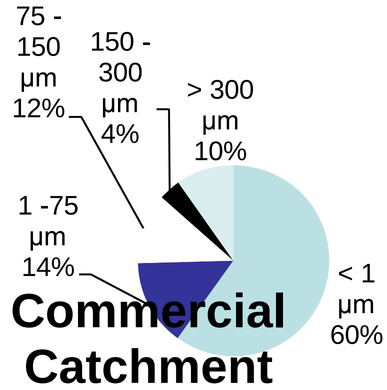
Source: Miguntanna, Goonetilleke, Kokot, Egodawatta. *Analysis of nutrients wash-off processes on urban road surfaces*. In press 2009. Personal communication Prof Ashantha Goonetilleke



89% TKN
11% Nitrate



89% TKN
11% Nitrate



91% TKN
9% Nitrate

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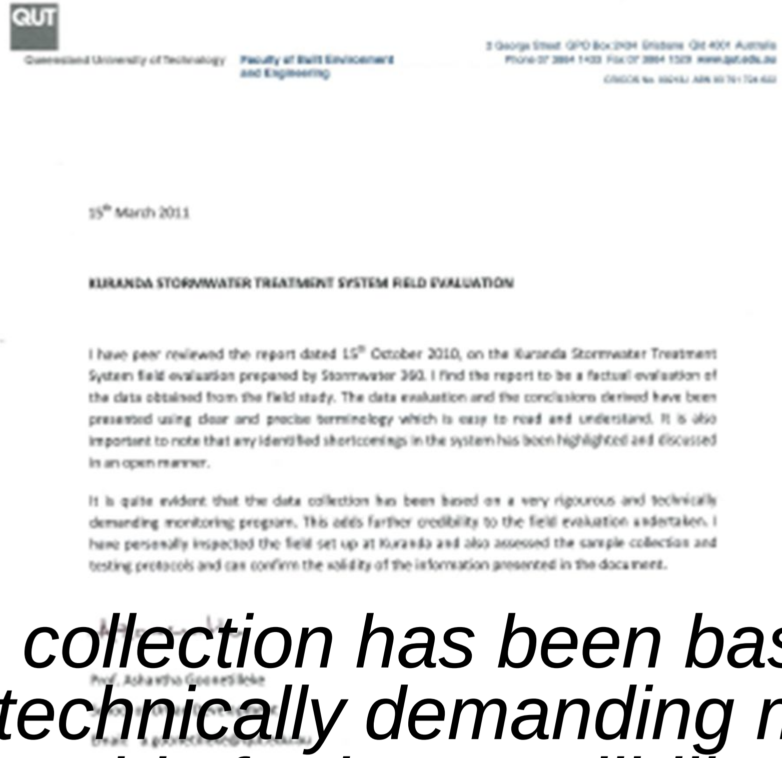
"…report to be a factual evaluation of the technology."



QUT

Queensland University of Technology Faculty of Built Environment and Engineering

15th March 2011

KURANDA STORMWATER TREATMENT SYSTEM FIELD EVALUATION

I have peer reviewed the report dated 15th October 2010, on the Kuranda Stormwater Treatment System field evaluation prepared by Stormwater 360. I find the report to be a factual evaluation of the data obtained from the field study. The data evaluation and the conclusions derived have been presented using clear and precise terminology which is easy to read and understand. It is also important to note that any identified shortcomings in the system has been highlighted and discussed in an open manner.

It is quite evident that the data collection has been based on a very rigourous and technically demanding monitoring program. This adds further credibility to the field evaluation undertaken. I have personally inspected the field set up at Kuranda and also assessed the sample collection and testing protocols and can confirm the validity of the information presented in the document.

Prof. Ashantha Goonetilleke

…"…the data collection has been based on a very rigorous and technically demanding monitoring program. This adds further credibility to the field evaluation undertaken.

Discussion – Peer Review

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- Scientifically credible results for in agreement with current load based objectives

- Good example of robust field evaluation and processes that can be undertaken by any technology

- Provides accountability for all stakeholders in assessing any technology as part of any approval process

Conclusion

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