FAWB
Facility for Advancing
Water Biofiltration

# FACILITY FOR ADVANCING WATER BIOFILTRATION, FAWB

## ANNUAL REPORT 2007-2008

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## WHAT IS WATER BIOFILTRATION?

Water biofiltration is the process of improving water (stormwater and wastewater) quality by filtering the water through biologically influenced media.

Stormwater biofiltration systems include:

- Bioretention systems
- Constructed surface-flow wetlands
- Constructed sub-surface-flow wetlands

A typical biofiltration system consists of a vegetated swale or basin, overlaying a filter medium (usually soil-based) with a drainage pipe at the bottom (Figure 1). Small bioretention pods are often referred to as rain gardens, while linear systems are commonly referred to as bioretention swales. The design configuration of biofilters is flexible, and possible variations include removal of the underdrain (to promote exfiltration into the surrounding soil) and the inclusion of a permanently wet, anoxic zone at the bottom (to further enhance nitrogen removal).

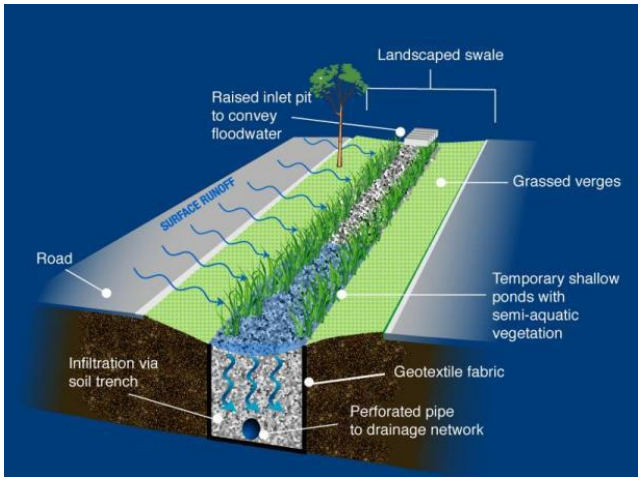



**Figure 1. Schematic of a Typical Biofilter (Bioretention System)**

**Figure 2. Existing biofilter, Victoria Park, Sydney (Landcom)**

There have been a number of successful applications of biofiltration, but also many poor outcomes owing to inappropriate utilisation of the technology, poor construction, operation and maintenance practices. There has also been insufficient understanding and dissemination of guidance on biofiltration borne out of successful applications, and research and development.

When used appropriately, biofiltration systems have been found to be viable and sustainable as a water treatment measure. Biofiltration systems also add to the quality of the landscape through the integration of these vegetated systems.

# BACKGROUND, MISSION AND MAIN AIMS

## Background

The Facility for Advancing Water Biofiltration, FAWB, is an unincorporated joint venture between EDAW (formerly with Ecological Engineering, which became a Practice Area of EDAW from July 2007) and Monash University. The joint venture was formed in mid-2005 following a successful application in the Victorian State Government's Strategic Innovation Initiative.

The following industry collaborators are also involved:

- Brisbane City Council (Qld)
- Adelaide and Mount Lofty Ranges Natural Resources Management Board (SA)
- Landcom (NSW)
- Manningham City Council (Vic)
- Melbourne Water (Vic)
- VicRoads (Vic)

(The Auckland Regional Council, New Zealand, participated as a collaborator to 30 June 2006.)

FAWB also has active collaboration arrangements (on-going joint research projects) with INSALyon, a leading Engineering School in France, and with Luleå University of Technology in Sweden.

FAWB is primarily funded through the Victorian State Government's Science, Technology and Innovation (STI) grant ($1.46 million), industry cash contributions ($0.5 million) and a direct cash contribution from Monash University ($0.35 million). The total value of the activities within FAWB, including both cash and in-kind contributions, is $4.3 million over three years.

As part of the STI Grant Application, FAWB developed a comprehensive Business Plan. This plan incorporates detailed research and marketing plans, with the opportunity to update the Plan on an annual basis.

## Mission

FAWB's mission is to provide proof of concept by developing and field-testing a range of biofilter systems that can be applied to specific market-based needs. This includes the needs of catchment managers, environmental regulators, public utilities, local governments, land developers, and design engineers.

## Main Aims

The main aims of FAWB are to:

- Provide scientific "proof of concept" for the application of stormwater biofilter technologies
- Facilitate industry-wide adoption and implementation of the technology

The specific outcomes of FAWB's work will be innovative stormwater biofilter technologies underpinned by:

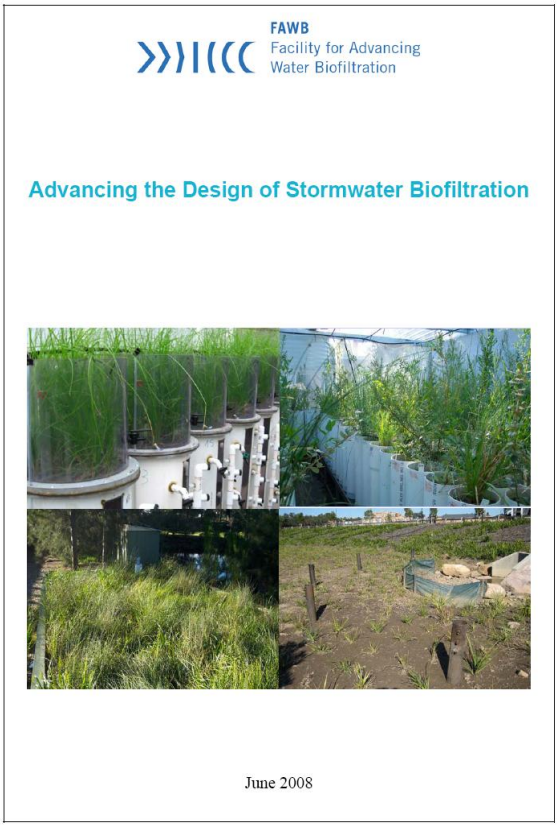
- New scientific knowledge about the key physical, chemical, and biological performances which underpin the effectiveness of stormwater biofilters
- Design specifications for biofilters that form the basis for written technical design, construction and maintenance guidelines to accompany legislation/regulation
- Algorithms that assist the design of biofilters for a wide range of applications
- Prototypes of modular units for specific applications (e.g. devices for stormwater treatment and re-use at the level of an individual household or a single commercial site)

**Session at FAWB Annual Workshop, November 2008**

## PROJECT HIGHLIGHTS

### Project 1: Technology

Inclusion of key findings and integration with those of Projects 3 and 4 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.



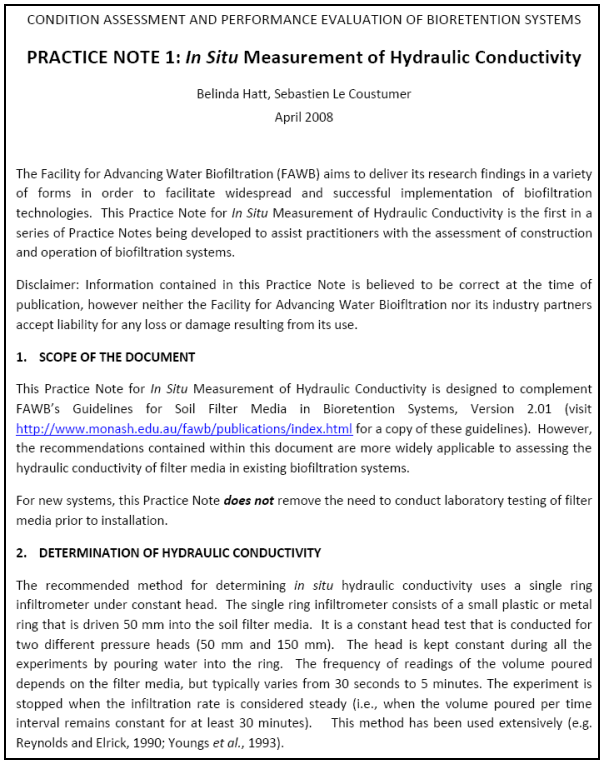

### Project 2: Policy and Risks

Completion of report on mapping the institutional transition to adoption of WSUD in Melbourne with a launch and seminar on the final report held in Melbourne for government and industry representatives on 23 July 2007.


**Speakers at launch and seminar of report on 'Transition to WSUD', July 2008.**
**L-R: Dr Tony Wong - FAWB CEO, Mr Rob Skinner – MD Melbourne Water,**
**Assoc Prof Rebekah Brown – FAWB Project Leader, Prof Russell Mein – FAWB Chair.**

## Project 3: Adoption Tools

In early May 2008, FAWB published its 'Practice Note 1: In Situ Measurement of Hydraulic Conductivity' on the FAWB website. Getting reliable measurements of hydraulic conductivity was identified as an issue for the successful adoption of biofilter technologies.



CONDITION ASSESSMENT AND PERFORMANCE EVALUATION OF BIORETENTION SYSTEMS

**PRACTICE NOTE 1: *In Situ* Measurement of Hydraulic Conductivity**

Belinda Hatt, Sebastien Le Coustumer

April 2008

The Facility for Advancing Water Biofiltration (FAWB) aims to deliver its research findings in a variety of forms in order to facilitate widespread and successful implementation of biofiltration technologies. This Practice Note for *In Situ* Measurement of Hydraulic Conductivity is the first in a series of Practice Notes being developed to assist practitioners with the assessment of construction and operation of biofiltration systems.

Disclaimer: Information contained in this Practice Note is believed to be correct at the time of publication, however neither the Facility for Advancing Water Bioifiltration nor its industry partners accept liability for any loss or damage resulting from its use.

**1. SCOPE OF THE DOCUMENT**

This Practice Note for *In Situ* Measurement of Hydraulic Conductivity is designed to complement FAWB's Guidelines for Soil Filter Media in Bioretention Systems, Version 2.01 (visit http://www.monash.edu.au/fawb/publications/index.html for a copy of these guidelines). However, the recommendations contained within this document are more widely applicable to assessing the hydraulic conductivity of filter media in existing biofiltration systems.

For new systems, this Practice Note ***does not*** remove the need to conduct laboratory testing of filter media prior to installation.

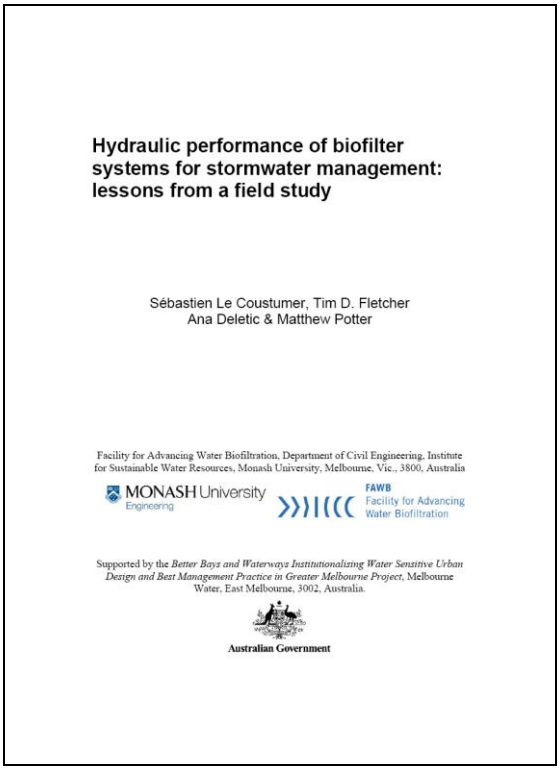
**2. DETERMINATION OF HYDRAULIC CONDUCTIVITY**

The recommended method for determining *in situ* hydraulic conductivity uses a single ring infiltrometer under constant head. The single ring infiltrometer consists of a small plastic or metal ring that is driven 50 mm into the soil filter media. It is a constant head test that is conducted for two different pressure heads (50 mm and 150 mm). The head is kept constant during all the experiments by pouring water into the ring. The frequency of readings of the volume poured depends on the filter media, but typically varies from 30 seconds to 5 minutes. The experiment is stopped when the infiltration rate is considered steady (i.e., when the volume poured per time interval remains constant for at least 30 minutes). This method has been used extensively (e.g. Reynolds and Elrick, 1990; Youngs *et al.*, 1993).

## Project 4: Demonstration and Testing

37 biofilters were tested for hydraulic performance and metal accumulation in Sydney, Brisbane and Melbourne.

The data analyses on hydraulic performance were completed and a report on this work (Hydraulic performance of biofilter systems for stormwater management: lessons from a field study) was produced for Melbourne Water.



**Hydraulic performance of biofilter systems for stormwater management: lessons from a field study**

Sébastien Le Coustumer, Tim D. Fletcher
Ana Deletic & Matthew Potter

Facility for Advancing Water Biofiltration, Department of Civil Engineering, Institute for Sustainable Water Resources, Monash University, Melbourne, Vic., 3800, Australia

MONASH University Engineering

FAWB Facility for Advancing Water Biofiltration

Supported by the *Better Bays and Waterways Institutionalizing Water Sensitive Urban Design and Best Management Practice in Greater Melbourne Project*, Melbourne Water, East Melbourne, 3002, Australia.

Australian Government

## STRUCTURE AND MANAGEMENT

The Facility for Advancing Water Biofiltration, FAWB, a joint venture research facility between EDAW (formerly with Ecological Engineering, which is now a Practice Area of EDAW) and Monash University under the auspices of the Victorian Government's Science Technology and Innovation Initiative, operates in cooperation with industry collaborators and stakeholders.


**Mr Tony Lupton MP, Parliamentary Secretary for Industry and Innovation, launching FAWB report 'Transition to Water Sensitive Urban Design', 23 July 2007**

FAWB commenced in July 2005 under the Grant Agreement between the State of Victoria and Monash University, the Joint Venture Agreement between Monash University and Ecological Engineering Holdings Pty Ltd, and Collaboration Agreements between Monash University and each of the industry collaborators listed below.

### Industry Collaborators

Adelaide and Mount Lofty Ranges Natural Resources Management Board, SA
Auckland Regional Council, New Zealand (to 30 June 2006)
Brisbane City Council, Qld
Landcom, NSW
Manningham City Council, Vic
Melbourne Water Corporation, Vic
VicRoads, Vic

The Joint Venture Agreement between Monash and Ecological Engineering was amended in March 2008 by which the parties agreed that Ecological Engineering may assign its interest to EDAW. (Ecological Engineering and EDAW are parties to an Acquisition Deed for the transfer of Ecological Engineering's business to EDAW.)

A Novation Deed was also signed in March 2008 between EDAW, Ecological Engineering and Monash by which the parties agreed to novate the Joint Venture Agreement. Under the Novation Deed, EDAW will be bound by the Joint Venture Agreement as it relates to Ecological Engineering and will enjoy all the rights and benefits conferred on Ecological Engineering under the Joint Venture Agreement.

The consent of the Minister for Innovation to the novation of the Joint Venture Agreement was noted in the Novation Deed.

## Organisation Structure

### Board of Management

*Independent Chairperson*

Prof Russell Mein, RG Mein and Associates

*Collaborator Representatives*

Mr Claude Cullino, Manningham City Council, Collaborator Representative
(Alternate, Mr Graham Rooney, Melbourne Water)
Ms Marianne Robertson, VicRoads

*EDAW Representatives*

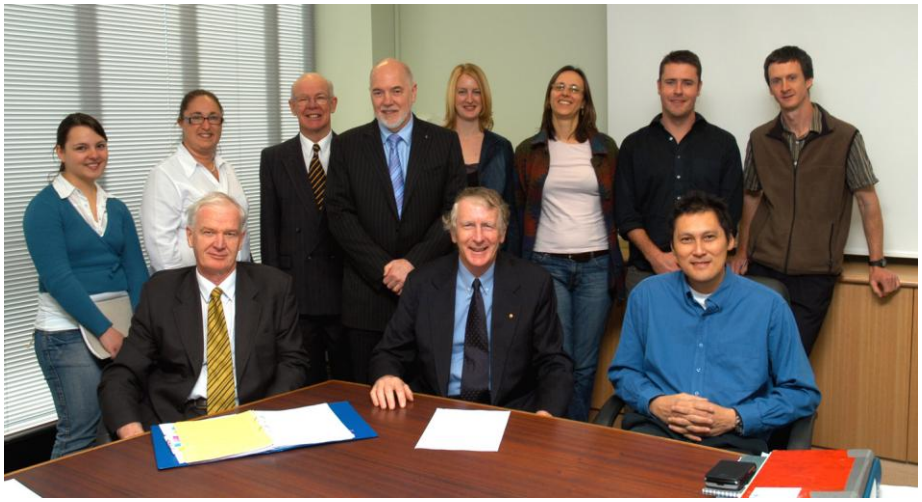
Dr Peter Breen
Mr Malcolm Eadie

*Monash University Representatives*

Dr Tim Fletcher
Prof Bill Young (to April 2008)
Prof Xiao-Ling Zhao (from May 2008 as successor to Prof Bill Young as Head of the Department of Civil Engineering at Monash)

Board Meetings
FAWB Board Meetings for 2007-2008 were held on:

6 September 2007
27 November 2007
14 February 2008
22 May 2008



**FAWB Board Members and participants, September 2007**

### FAWB Management

*Chief Executive Officer*
Dr Tony Wong, EDAW

*Research Manager*
Assoc Prof Ana Deletic, Monash University

*Project Leaders*
Assoc Prof Rebekah Brown, Monash University (Project 2)
Dr Tim Fletcher, Monash University (Project 1)
Dr Belinda Hatt, Monash University (Project 3)
Mr Justin Lewis, Monash University (Project 4)

*Business Manager*
Mr John Molloy, Monash University

**Research Program - Projects**

Project 1: Technology
Project 2: Policy and Risk
Project 3: Adoption Tools
Project 4: Demonstration and Testing

**Research Advisory Panel – Research Review**

A FAWB Research Advisory Panel was formed under the arrangements in the FAWB Joint Venture Agreement, the purpose of the Panel being to provide independent peer review and to advise the FAWB Board (through the Research Manager) on the scientific merit and rigour of the research program.

During 2007/2008, the Research Advisory Panel comprised three eminent international experts:

- Professor Bob Pitt (the Chair of the panel), Director of Environmental Engineering Programs Department of Civil and Environmental Engineering, The University of Alabama
- Dr Frans van de Ven, Faculty of Civil Engineering and Geosciences, Delft University of Technology
- Emeritus Professor Barry T Hart, Director, Water Science Pty Ltd


**FAWB Review Panel**
**L-R: Prof Bob Pitt, Dr Frans van de Ven, Prof Barry Hart**

The panel conducted a FAWB Research Review over the period 12-15 November 2007.

In preparation for the Review, FAWB produced a summary of the outcomes of the entire FAWB research effort. The outcomes document consisted of a 33-page summary and copies of 22 publications (reports, conference and journal papers) that FAWB had produced in the past two years. The document was made available to the Research Review Panel several weeks before the event.

During 12 and 13 November, the Research Review Panel discussed the research program with the FAWB Project Leaders and Research Manager in a number of closed sessions. It was very intensive and highly productive work for all the FAWB team. FAWB received lots of highly valuable feedback, including comments during those two days.

The terms of reference for the review were to:

- review the quality of the science undertaken by the Facility,
- comment on any major gaps or overlaps with research elsewhere,
- suggest further research which may add value or address major questions yet to be studied.

In the executive summary of its report, the review panel included the following comments:

> 'FAWB has a very enthusiastic and productive team of young researchers undertaking targeted and relevant research. They have already produced an impressive list of publications in prestigious, peer-reviewed journals. Additionally, the Facility has a well-defined vision and clear and achievable objectives.
>
> The work of the Facility so far has significantly advanced knowledge on the operation of biofilters.
>
> This new knowledge should allow design procedures and guidelines to be improved. Moreover, the field experiments and observations in existing facilities have led to a better view on how to integrate these facilities in urban landscape design and has provided valuable information on the long-term performance and on the problems encountered in the construction and maintenance of these facilities.
>
> We are confident that the 'proof of concept' that FAWB was seeking will be achieved…'

**Stakeholders Committee**

The FAWB Joint Venture Agreement provides for, as a central item, a Stakeholders Committee. The Stakeholders Committee advises the Board of Management (through the CEO) on Collaborator and end-user perspectives of the FAWB research program.

Stakeholder /Collaborator Representatives for 2007-2008 were:

- Mr Claude Cullino, Manningham City Council (Alternate Mr Andrew Allan)
- Mr Keith Downard, Adelaide and Mount Lofty Ranges Natural Resources Management Board
- Mr Matthew Napper, Landcom - NSW (succeeding Mr Stuart McCowan)
- Ms Marianne Robertson, VicRoads
- Mr Graham Rooney, Melbourne Water (Alternates Mr Jake Moore and Mr Toby Prosser)
- Ms Amanda Brigden, Brisbane City Council (Alternate Mr Stuart Hovermann)

Meetings of the Stakeholders Committee were held on:

- 13 November 2007 (Dinner meeting)
- 11 April 2008

*FAWB Stakeholders participation*
Coinciding with the FAWB annual workshop of November 2007, was a dinner and the six-monthly meeting of the Stakeholders (Meeting No. 5) held on 13 November 2007. This dinner meeting was attended by FAWB project leaders and representatives from five of our six Industry Collaborators (with an apology from Landcom).

FAWB Stakeholder representatives also participated in the annual workshop held on the next day, 14 November 2007, following the Stakeholders' dinner meeting. All current FAWB Collaborators, ie Adelaide and Mt Lofty Ranges NRM Board, Brisbance City Council, Landcom- NSW, Manningham City Council, Melbourne Water, and VicRoads were represented at the workshop.

**FAWB Stakeholders Dinner Meeting, November 2007**

*FAWB Stakeholders meeting, April 2008*
FAWB Stakeholders meeting No 6 was held at Monash on 11 April 2008. Representatives from the FAWB Collaborator organisations attended including: Mr Andrew Allan, Manningham City Council; Ms Amanda Brigden, Brisbane City Council; Mr Keith Downard, Adelaide and Mt Lofty Ranges Natural Resources Management Board; Ms Marianne Robertson, Vic Roads; Mr Matthew Napper, Landcom, NSW; Mr Jake Moore, Melbourne Water; and Mr Toby Prosser, Melbourne Water.

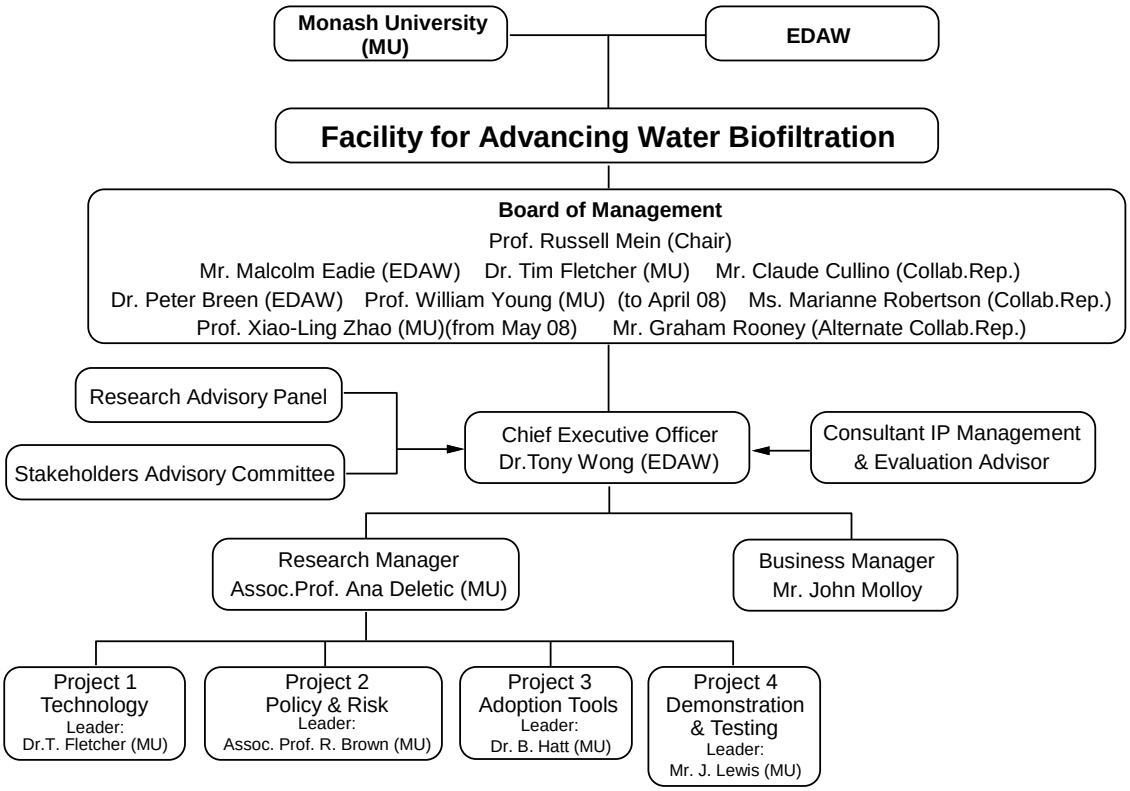
FAWB's program of research and adoption was discussed at the meeting. Key items and presenters included:

- Overview of Research Activities and Report on FAWB Research Review, held November 2007 (Assoc Prof Ana Deletic)
- Research Projects – Progress Update (Project Leaders)
- Project 1 – Technology (Dr Tim Fletcher)
- Project 2 – Policy and Risk (Assoc Prof Rebekah Brown)
- Project 4 – Demonstration and testing (Justin Lewis)
- Outline of proposed further industry and research activities and issues for Adoption Tools, Project 3 (Assoc Prof Ana Deletic and Dr Belinda Hatt)
- Discussion on future collaborative opportunities, particularly beyond June 2008, including research proposal on 'Cities as water supply catchments'. (Dr Tony Wong)

**FAWB Stakeholder Representatives at 11 April 2008 meeting.**
**L-R: Amanda Brigden (Brisbane City Council), Toby Prosser (Melbourne Water), Matthew Napper (Landcom, NSW), Keith Downard (Adelaide and Mt Lofty Ranges Natural Resources Management Board), Marianne Robertson (VicRoads), Jake Moore (Melbourne Water)**

**FAWB Stakeholder Representatives at 11 April 2008 meeting.**
**L-R: Keith Downard (Adelaide and Mt Lofty Ranges Natural Resources Management Board), Andrew Allan (Manningham City Council), Toby Prosser (Melbourne Water), Jake Moore (Melbourne Water)**

## FAWB Governance Structure




**FAWB Office**


The FAWB Office is located at:
Monash University, Department of Civil Engineering
Building 60, Clayton Campus
MONASH UNIVERSITY, VIC 3800, Australia

phone +61 3 9905 4957
fax +61 3 9905 5033
fawb@eng.monash.edu.au

## COOPERATIVE LINKAGES

## Local links

### Participants and Collaborators

FAWB linkages between its Joint Venture Participants, EDAW (succeeding Ecological Engineering) and Monash University, were strengthened during the year.

The interactions and links between the FAWB Participants and Collaborators:

- Adelaide and Mount Lofty Ranges Natural Resources Management Board, SA
- Brisbane City Council, Qld
- Landcom, NSW
- Manningham City Council, Vic
- Melbourne Water, Vic
- VicRoads, Vic

were also enhanced. In particular, there was continuing active collaboration in demonstration projects, workshops, research papers, and general awareness raising and adoption activities.

The Adelaide and Mount Lofty Ranges Natural Resources Management Board, SA, has contributed to raising awareness of biofilter technologies in its region through its participation in FAWB workshops and stakeholder meetings. It was a co-sponsor with the Stormwater Association of South Australia for the FAWB training workshop on 'Advancing the Design of Stormwater Biofiltration' held in Adelaide in June 2008.

**Dr Tony Wong advising participants at Adelaide workshop, June 2008**

Brisbane City Council has been pursuing construction of the Wakerley Bioretention System with FAWB guidance and has maintained an extensive monitoring program for the demonstration facility. Stormwater pods were also constructed and formed a pivotal part of FAWB's demonstration and testing project. Brisbane staff joined with FAWB researchers from Monash in producing conference papers on the research and technology adoption experiences with stormwater gardens in Brisbane.

Landcom has strongly maintained its collaboration, including its continuing commitment to the installation and operation of a demonstration biofilter at Second Ponds Creek and associated salinity studies at Jacaranda Rise. Additional cash funding was provided to support FAWB's research and monitoring role for these installations. Landcom was also a co-sponsor with the Stormwater Association of New South Wates for the FAWB workshop on 'Advancing the Design of Stormwater Biofiltration' held in Sydney in June 2008.

Manningham City Council contributed to the governance of FAWB through the role of its representative, Mr Claude Cullino, as a Collaborator Representative on the FAWB Board. Links with FAWB were also demonstrated in Manningham's projects at a number of sites including the Ruffey Lake Park Carpark. Manningham was also instrumental in arranging in 2008 for briefings of its Council and executive staff by FAWB on FAWB research findings and proposals for future research.

Melbourne Water provided associated cash funding for additional tests on alternative biofllter soil media. This was in addition to funding already arranged for work by visiting scholar Lucie Alcazar on 'Biofilter pathogen removal experiments', and for studies and a report to Melbourne Water on hydraulic conductivity. Through its funding of Clearwater, a not-for-profit organisation that aims to accelerate the uptake of sustainable urban water management, Melbourne Water contributed to the training workshops on 'Rain gardens design' run by FAWB in conjunction with Clearwater over two days in September 2007. Melbourne Water was also active in providing access to biofilter installations in connection with FAWB's demonstration and testing project, and as part of its in-kind commitment as a FAWB collaborator. Access to large-scale biofilter installations was also provided by Melbourne Water.

**Lucie Alcazar researching pathogen removal from biofillters**

VicRoads has continued its program of installing biofilters in its substantial roadworks projects. FAWB was provided access to biofilter facilities at Hallam, Doncaster Park & Ride, Geelong Bypass, Craigieburn and Fitzgerald Road. These sites represent a major component of the in-kind contributions from FAWB collaborators.
VicRoads also contributed to the strategic direction of FAWB through the role of its representative, Ms Marianne Robertson, as a Collaborator Representative on the FAWB Board.

Joint Activity - Annual Workshop, November 2007
On 14 November 2007, the FAWB annual research workshop was held at Monash University. It was attended by over 50 people from the FAWB research group, industry (mainly our industry collaborators, and also people from other water industry organisations) and a number of international visitors. The workshop was designed as a part of our Research Review, so the Research Review Panel took an active part in the workshop.

**Participants at FAWB Annual Workshop, November 2007**

Seven FAWB postgraduates and research staff presented their work, showcasing the most important parts of our work from the past year. The feedback that FAWB has received so far from industry collaborators and participants, as well as international visitors (two participants from INSA de Lyon, France who were visiting Monash at the time), was very positive.

**Monash scholar Matthew Burns presenting at Annual Workshop 2007**

**Yaron Zinger, Monash postgraduate, presenting at Annual Workshop 2007**

**Jey Mahendra from FAWB Stakeholder, Landcom - NSW, with FAWB researcher Peter Morison at Annual Workshop, November 2007**

## International collaborative links

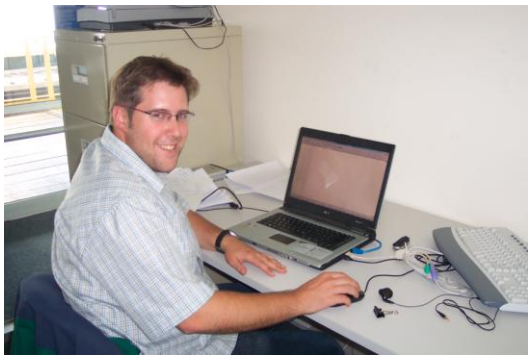
### Institute for Infrastructure, University of Innsbruck, Austria

Following collaborative discussions with Prof Wolfgang Rauch of the Institute for Infrastructure, University of Innsbruck, Austria, Manfred Kleidorfer conducted collaborative research at Monash during December 2007. Mr Kleidorfer is a PhD scholar in environmental engineering and Dip-Ing from the Institute for Infrastructure at Innsbruck.

Links with the Institute for Infrastructure, University of Innsbruck, Austria, were enhanced by the visit to Monash by Prof Wolfgang Rauch during late January, early February 2008. As noted in the January 2008 report, Prof Rauch heads a major centre for urban water research and is leading figure in that field.

While at Monash, Prof Rauch held discussions with FAWB staff and other Monash colleagues, and continued his role as research project supervisor for the visiting PhD scholar from Innsbruck, Manfred Kleidorfer.

As noted below under '*People stories (expatriates returning, visiting experts in a field, local experts, etc)',* Prof Rauch gave a seminar at Monash on his research work.



**Dip- Ing Manfred Kleidorfer, Institute for Infrastructure, University of Innsbruck, Austria**

**Prof Wolfgang Rauch, Institute for Infrastructure, University of Innsbruck, Austria**

### Collaboration with INSA de Lyon (Lyon France)

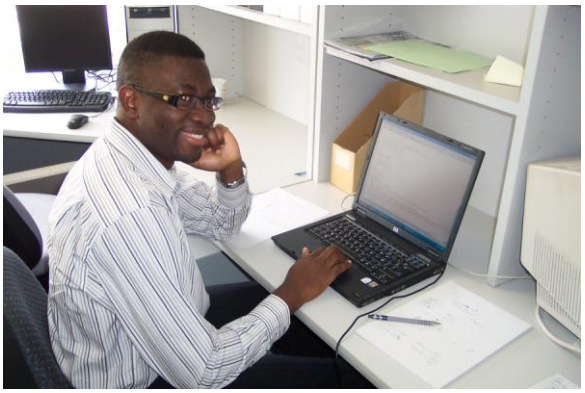
The involvement and visits of students from INSA (Institut National des Sciences Appliquées) Lyon, France continued to strengthen the links with FAWB. INSA postgraduate Sébastien Le Coustumer continued his postgraduate studies with FAWB at Monash. INSA scholar Katia Bratières returned to Monash University to continue her research with FAWB .

FAWB was visited for two weeks in November during the Review and Annual Workshop period by two experts from INSA de Lyon, Prof Jean-Luc Bertrand-Krajewski, and Dr Gislain Lipeme-Kouyi, together with graduate scholar Marjolaine Métadier. Prof Bertrand-Krajewski, and Dr Lipeme-Kouyi and Ms Métadier participated in the annual workshop together with INSA scholars Sebastien Le Coustumer and Katia Bratières already in residence at Monash University.

**Marjolaine Métadier, INSA de Lyon**

**INSA de Lyon/Monash scholar Katia Bratières, Monash PhD scholar David McCarthy, Sébastien Le Coustumer, INSA postgraduate, and FAWB Stakeholder representative Keith Downard of Adelaide and Mt Lofty Ranges NRMB, at Annual Workshop (L to R at table on LHS)**

**Prof Jean-Luc Bertrand-Krajewski, INSA de Lyon**



**Dr Gislain Lipeme-Kouyi, INSA de Lyon**

INSA scholar Katia Bratières and INSA postgraduate Sébastien Le Coustumer were joined in late April 2008 by INSA scholars Elen Devauchelle and Christelle Schang. Elen Devauchelle and Christelle Schang are doing research related to FAWB projects, particularly aspects of the role of porous pavements with biofilters.

**Collaboration with Technological University, Delft, The Netherlands**

Cooperative linkages with the Technological University, Delft, The Netherlands were enhanced by the participation of Dr Ir Frans van de Ven of the Delft Technological University in the Research Review and Annual Workshop in November 2007. TU Delft PhD scholar Rutger de Graaf also visited FAWB and was involved in the Annual Workshop. Both Delft visitors held collaborative research discussions with the team for FAWB Project 2, Policy and Risk, and researchers in the National Governance Program.

**Dr Megan O'Farrelly (FAWB, Monash) with TU Delft PhD scholar Rutger de Graaf and Dr Frans van de Ven, TU Delft, at Annual Workshop**

**Links with Public Utilities Board of Singapore (PUB) and the National Parks Board of Singapore (NParks)**

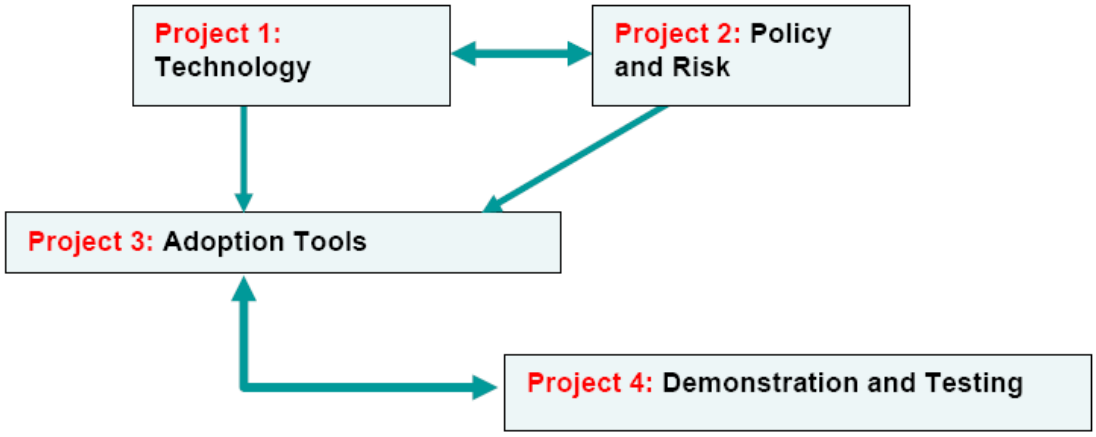
FAWB is currently assisting the Public Utilities Board of Singapore (PUB) and the National Parks Board of Singapore (NParks) in developing a research program, modelled after the activities of FAWB, to undertake studies directed at 'proof-of-concept' of biofilter technologies in tropical regions.

FAWB's link with the Singapore agencies was strengthened with the November 2007 launch of the Victoria-Singapore MOU, and acknowledgement of FAWB in the speech by Victorian Minister for Innovation Gavin Jennings.

As noted above under 'Awards and acknowledgements for the Program and people involved', the STI funded project FAWB (Facility for Advancing Water Biofiltration) was mentioned in Minister Jennings' speech as a specific example of design work being currently undertaken with Singapore.

**Biofilters under construction in Singapore**

## Research Structure




## Projects

### *Project 1: Technology*

**Project Aims**
The aim of Project 1 is to develop and test biofilter technologies that will be capable of treating stormwater runoff in a range of urban situations, and to overcome technical barriers to the utilisation of biofiltration technology.

The specific aims are to:

- Develop new biofilter designs to optimise performance and ensure long-term sustainability;
- Determine design configurations that optimise treatment performance, and reduce the risk of soil media clogging;
- Develop new filter media types for targeted pollutants (such as heavy metals, nutrients and pathogens);
- Determine sustainable pollution loadings, in order to make predictions about effective lifespan; and
- Determine the performance and risk of using stormwater biofilters as a treatment device for stormwater reuse.

Based on these aims, three Project Activities have been developed, within Project 1:

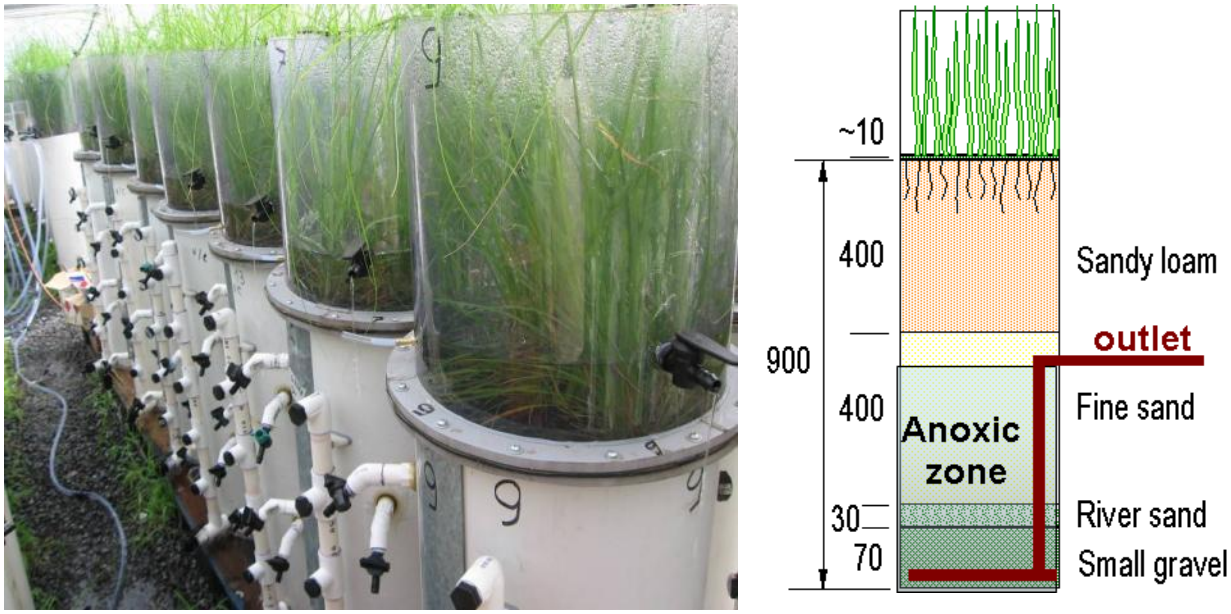
- Project Activity 1.01 Vegetation trials
- Project Activity 1.02 Laboratory biofilter column experiments
- Project Activity 1.03 Biofilter optimisation for stormwater reuse

**Project Leader**
Dr Tim Fletcher, Monash University

**Key Messages from Project 1: Technology**

1. All biofilter configurations tested (both vegetated and unvegetated) remove more than 90% of heavy metals (both particulate and dissolved). Some plant species enhance metal uptake (and may enhance filter lifespan), but plant selection will depend more strongly on hydraulic conductivity and nutrient removal (see below)
2. Most biofilters will perform well for phosphorus removal, as long as the soil has a phosphorus index of less than 100 mg/kg. Whilst plants play a role in P removal, most species will perform well. Genera such as *Carex, Juncus, Poa, Banksia, correa, Dodonea, Goodenia, Melalecua* and *Pomaderris* all perform well for P removal.
3. Critically, however, without vegetation, most soils will naturally leach some nitrogen. Biofilters therefore rely strongly on vegetation and its symbioses with bacteria and fungi, for the removal of nitrogen from stormwater.
4. The best plants for nitrogen removal are those with (i) a dense root system which penetrates the entire soil filter meda depth, (ii) high growth rate. The following species have been found to be effective: *Carex appressa, Ficinia nodosa, Juncus flavidus, Lomandra longifolia, Melaleuca ericifolia* and *Goodenia ovata*. Where N removal is important, biofilters should be planted with at least 50% of plants from this selection, where possible, and other plants selected primarily on the morphological traits as described. Aesthetic and biodiversity considerations may also need to be taken into account.

5. For maintenance of hydraulic conductivity, plants with thick roots which penetrate the entire soil profile and create macropores, are desirable. This is primarily tree species, such as *Melaleuca*. A combination of plants (e.g. *Carex, Juncus* and *Melaleuca*) delivers the ideal combination of traits for both hydraulic conductivity and nitrogen removal.
6. The addition of vermiculite and perlite (around 5% each by volume) to the soil media may help to maintain hydraulic conductivity, making the biofilter more robust to slight deviations from the specified soil media characteristics. It is also known to enhance the (already high) heavy metal adsorption capacity of biofilters, and to help in moisture retention.
7. Biofilter soil media placed 'uncompacted' will show an initially very high hydraulic conductivity, which will settle back to the design value within a few months. It is recommended that sizing/design of biofilters be undertaken using a safety coefficient of 2 in the hydraulic conductivity. e.g. if the design Ks to be used is 180 mm/hr, size the system assuming a value of 90 mm/hr.
8. Some degree of leaching of fine sediment and nutrients from the soil media will usually occur during the establishment phase, until the soil has stabilised, and plant roots have occupied the soil volume (this will typically take 2-6 months).
9. The presence of an anaerobic zone (made of sand or gravel with around 5% carbon source, such as woodchips) will improve nitrogen removal, by promoting denitrification. It will also enhance plant survival during drought periods, and reduce the risk of an "initial flush" of elevated nitrogen concentrations from the filter media after a prolonged dry period.




**Testing the impact of a submerged zone, carbon source, and variable wetting and drying in the advanced columns**

**Activity 1.01 Vegetation trials**

*Aim*
To undertake pot trials to:

- Measure growth rates under controlled watering regimes
- Measure nutrient uptake

with harvesting and assays (plant and soil) to determine mass balance .

*Achievements 2007-2008*
Twenty species commonly used in rain garden design have been tested for removal of the key stormwater pollutants, including total suspended solids (TSS), key heavy metals, total phosphorus (TP) and total nitrogen (TN) and their species.

The research findings on vegetation trials have been published in the journal 'Water Research'. The results show that for nutrients particularly, there are key differences in uptake capacity, between species.

A second paper (being submitted to Journal of Phytoremediation) reports on the plant traits which correlate with pollutant removal (for nutrients it is primarily traits such as root length and density).

Inclusion of key findings and integration with those of Projects 3 and 4 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.

**Activity 1.02 Laboratory biofilter column experiments**

*Aim*
To develop a standard experimental system for biofilter columns and:

- undertake basic mechanistic experiments - mass balance
- quantify variation in performance with different design elements
- test major design variations

*Achievements 2007-2008*
Key findings to date included:

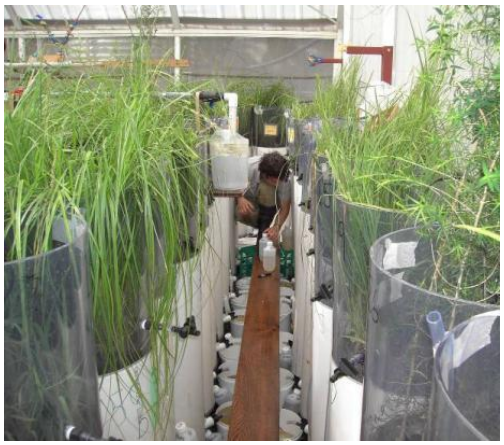
- Total Suspended Solids removal was consistently above 90%,
- Phosphorus was above 75% and heavy metals removal above 95%.
- Nitrogen removal varied substantially with vegetation type (best for Carex and Melaleuca).

Further statistical analysis is being undertaken. In particular, we are using data from the last two columns to determine:

1. The influence of drier conditions on performance
2. Effectiveness of retrofitting anaerobic zone; so far this has shown that N removal is increased, but because the anaerobic zone includes soil, it results in a leaching of P. In reality, this would not occur (because the anaerobic zone would not include the soil component)

The Project 1 team has been also working with Melbourne Water to test alternative filter media (using washed sand as a base, ameliorated to suit plant requirements). Melbourne Water provided funding for this research.)

Inclusion of key findings and integration with those of Projects 3 and 4 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.

**Laboratory biofilter column experiments: (LHS) non-vegetated soil filter media columns and (RHS) standard columns**

**Activity 1.03 Biofilter optimisation for stormwater reuse**

*Aim*
To:

- Develop new biofilter designs to optimise performance and ensure long-term sustainability;
- Determine design configurations that optimise treatment performance, and reduce the risk of soil media clogging.

*Achievements 2007-2008*
A large laboratory set-up was established to optimise biofilter design. It consisted of 140 standard and 18 advanced columns, representing different biofilter designs (with five replicates of each design). Regular dosing of the columns and monitoring of their treatment performance was conducted.

Pathogen removal by biofilters was tested using 30 standard columns. Over three months, the columns were dosed with real stormwater spiked with pathogens and the removal of three common pathogen indicators (indicators of viruses, protozoa and bacteria) was monitored. The influence of soil type, plant species, submerged zone, carbon source, and variable wetting and dry on pathogen removal was observed.

Results to date showed that most design configurations gave very good removal (around 95-99.99%), with the exception being those with carbon + saturated anaerobic zone (which result in removals of only 40-60% often).

Inclusion of key findings and integration with those of Projects 3 and 4 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.

## *Project 2: Policy and Risks*

**Project Aims**
This Project contributes to the broader Program aim of advancing the effective implementation of water biofiltration technologies, by concentrating on developing guidance strategies related to institutional change. The other project areas focus on addressing the current technical knowledge limitations to advancing widespread practice, and this project provides complementary insight into addressing significant institutional knowledge gaps. These relate to the design and administration of 'enabling' policy and regulatory frameworks, and addressing 'risk perception' related to previously identified issues such as liability and poor organisational capacities.

Therefore, Project 2 aims to develop a methodology to address institutional and social barriers to the widespread adoption of biofiltration technologies, which is focussed through two activities:

- Activity 2.01: Developing regulatory, policy and strategic guidance; and
- Activitiy 2.02: Addressing risk perception, liability and opportunities.

Key objectives of Project 2 are to:

- Construct a transition map of biofilter technology adoption across Metropolitan Melbourne (i.e. institutional, policy, niches etc);
- Assess industry 'risk perception' to the widespread implementation of biofilters;
- Determine the incentives and disincentives to improve industry receptivity; and
- Provide policy and governance advice for advancing the WSUD transition, with a particular focus on biofilter technology.

**Project Leader**
Assoc Prof Rebekah Brown, Monash University

**Project Leader Rebekah Brown at the launch of the new report**
**Transition to Water Sensitive Urban Design - The Story of Melbourne. July 2007**

**Key Messages from Project 2: Policy and Risk**

1. The WSUD approach is yet to be mainstreamed anywhere, and the mainstreaming of WSUD will require a more complex multi-sectoral governance approach that is dedicated, proactive and strategic in its pursuit of WSUD. This is because there is currently an absence of an overriding and galvanising socio-political driver or 'crisis' to drive the necessary change.
2. There is a need to provide guidance to urban water strategists and others on how to enable effective institutional change that will lead to the mainstreaming of the WSUD approach across modern cities.
3. The retrospective social research analysis of the of the key factors over the last 40 years that has enabled the successful institutionalisation of 'urban stormwater quality management' across Metropolitan Melbourne reveals: how the 'value' of environmental protection of waterways has been institutionalised towards a relatively advanced stage of increasing importance, within the broader set of well established institutional values of flood protection, public health protection, water supply security and economic efficiency within current decision and policy-making processes.
4. While the historical case study research revealed a range of interconnected activities and initiatives that on the surface seem to represent an organic development pathway, there has been a critical, and in many ways opportunistic, interplay between industry champions and important context variables that has provided the structure and catalyst for the transition so far.

5. Eight key context variables are identified as instrumental when considered as a 'package' to advancing institutional change.

| No. | Key Variables | Description |
|---|---|---|
| 1 | **Socio-Political Capital** | Aligned community, media and political concern for improved waterway health, amenity and recreation. |
| 2 | **Bridging Organisation** | Dedicated organising space that facilitates collaboration across science and policy, agencies and professions, and knowledge brokers and industry. |
| 3 | **Trusted & Reliable Science** | Accessible scientific expertise, innovating reliable and effective solutions to local problems. |
| 4 | **Binding Targets** | A measurable and effective target that binds the change activity of scientists, policy makers and developers. |
| 5 | **Accountability** | A formal organisational responsibility to the improvement of waterway health, and a mandate for influencing practices that lead to such an outcome. |
| 6 | **Strategic Funding** | Additional resources dedicated to the change effort. |
| 7 | **Demonstration Projects & Training** | Accessible and reliable demonstration of new thinking and technologies in practice, accompanied by knowledge diffusion initiatives. |
| 8 | **Market Receptivity** | A well articulated business case for the change activity. |

6. The insights from the Melbourne case study provide an important basis for other cities, and other sectors of activity, to learn from.
7. While the institutional dynamics of the WSUD approach may be more complex than those for the urban stormwater quality management (USQM) approach, the Melbourne case study provides a solid platform of evidence for how institutional change can successfully occur and identifies key factors that underpin such change.

**Activity 2.01 Policy - Regulatory, policy and strategic guidance**

*Aim*
To undertake a comprehensive review of current Victorian legislative and policy drivers for improving urban stormwater quality, building on work already carried out by FAWB partner organisations.

*Achievements 2007-2008*
Following the successful seminar and workshop to launch the report “Transition to WSUD: The Story of Melbourne, Australia” as a working document on 15 February 2007 as noted in the 2006-2007 Annual Report, the Project 2 Report on mapping the institutional transition to adoption of WSUD in Melbourne was completed.

A launch and seminar on final report was held in Melbourne for government and industry representatives on 23 July 2007.

**Industry, government and other stakeholders at launch and seminar on ‘Transition to WSUD’, July 2007**

Assoc Prof Brown presented a paper on the research into the transition to WSUD at the 2007 Novatech Conference, France. The Final Report was made available on FAWB website.

Demand for the report resulted in a second printing in June 2008.

**Activity 2.02 Risk - Risk perception, liability and opportunities**

*Aim*
To identify and categorise current industry and community perceptions of potential risks connected with the incorporation of biofilter technologies into public and private infrastructure.

*Achievements 2007-2008*
Research on 'Perceptions of institutional drivers and barriers to sustainable urban water management in Australia'
An online survey to study 'Perceptions of institutional drivers and barriers to sustainable urban water management in Australia' had been conducted and data analysed as part of the National Urban Water Governance Program (NUWGP). A draft copy of the summary report of the study was circulated at FAWB Annual Workshop, November 2007.

The final summary report of the study by Assoc Prof Rebekah Brown, Dr Megan Farrelly and Nina Keath was launched at the NUWGP Annual Forum held in Perth on 7 and 8 February 2008.

FAWB, a collaborator and funding contributor of NUWGP, was represented at the workshop by senior researchers including Research Manager, Assoc Prof Ana Deletic, and Board Member and Project Leader, Dr Tim Fletcher, in addition to the principal author and FAWB Project Leader, Assoc Prof Brown.

**Principal author, Assoc Prof Rebekah Brown**
**at NUWGP Annual Forum and launch of the report:**
**Perceptions of institutional drivers and barriers**
**to sustainable urban water management in Australia'**

The summary report provides an overview of two reports produced by the National Urban Water Governance Program, which detail the outcomes of an online questionnaire survey conducted over October and November in 2006. The Summary Report: *Perceptions of institutional drivers and barriers to sustainable urban water management in Australia. Survey results of urban water professionals across Brisbane, Melbourne and Perth,* is available on the National Urban Water Governance Program website at: www.arts.monash.edu.au/ges/research/nuwgp/pdf/survey-summary-report-drivers-barriers-suwm.pdf

The summary report was the first stage in a broader program of research aimed at investigating and identifying the institutional factors most important for enabling a Water Sensitive City. While the analysis in the summary report is mostly descriptive, future reports will provide more detailed analysis.

The purpose of the online questionnaire survey (referred to as 'the survey') was to provide reliable insights into the social and institutional drivers and barriers to SUWM as perceived by professionals operating in the urban water sector, across the cities of Brisbane, Melbourne and Perth. These cities were selected as case studies because they share similar drivers or circumstances for re-examining their water management options (drought, waterway degradation and increasing populations).

The two detailed reports for which the Summary Report provides an overview, are available at www.urbanwatergovernance.com . The reports are:

1. Advancing the Adoption of Diverse Water Supplies in Australia: A Survey of Stakeholder Perceptions of Institutional Drivers and Barriers, Report No. 07/04, National Urban Water Governance Program, Monash University, September 2007, ISBN 978-0-9804298-1-7.
2. Advancing the Adoption of Urban Stormwater Quality Management in Australia: A Survey of Stakeholder Perceptions of Institutional Drivers and Barriers, Report No. 07/05, National Urban Water Governance Program, Monash University, September 2007, ISBN 978-0-9804298-0-0.


**Covers of 'Summary Report:**
**Perceptions of institutional driversand barriers**
**to sustainable urban water management in Australia'**

## *Project 3: Adoption Tools*

**Project Aims**
Project 3: Adoption Tools, is aimed at turning the findings from the other three projects (ie 'Technology', 'Policy and Risk', and 'Demonstration Projects') into useful tools for industry.

There are two specific objectives:

- To develop the design algorithms of stormwater biofilters for a variety of possible applications; and
- To develop adoption guidelines/recommendations for biofilters.

**Project Leader**
Dr Belinda Hatt


**Dr Belinda Hatt presenting at training session in Perth, June 2008**

**Key Messages from Project 3: Adoption Tools**

1. Results from the Technology, and Demonstration and Testing, projects demonstrate that the filter media type has a strong influence on pollutant removal and that the wrong filter media can result in leaching of pollutants. FAWB has thus revised its guidelines for soil filter media to provide clear guidance for specifying filter media properties to ensure hydraulic and treatment function.
2. Pollutant removal by biofiltration systems is primarily determined by the filter media type and the presence and type of vegetation. Modelling of treatment performance will therefore be relatively simple and, in many cases, lookup tables are adequate for predicting their pollutant removal performance.
3. Results from the Technology, Policy and Risk, and Demonstration and Testing, projects are currently being synthesized in the form of guidelines for the design and adoption of stormwater biofiltration systems. These guidelines will include chapters addressing planning, technical design, construction, maintenance and monitoring.

**Activity 3.01 Design Algorithm**

*Aim*
To develop a simple, but robust, design methodology for biofilter design .
.
*Achievements 2007-20087*
Dr Belinda Hatt commenced as Project Leader

The conceptualisation of the algorithm has started. The model will draw on results from Project 1, and will be tested using results from Project 4.

A database to store all the data from Project 1 and 4 activities has been developed.

Quantification of the relationships between design elements and pollutant removal has begun and a "first cut" set of algorithms for nitrogen removal, based on filter media type, vegetation and presence or absence of a submerged anoxic zone, has been developed.

Quantification of the relationships between design elements and removal of phosphorus and total suspended solids has begun.

The next step is to incorporate the influence of other design elements and hydrology into the design algorithms as well as to develop algorithms heavy metals.

Inclusion of key findings and integration with those of Projects 1 and 4 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.

**Activity 3.02 Design guidelines for multi-functional biofilters**

*Aim*
To develop a comprehensive set of design recommendations that outlines key design considerations that are necessary to preserve the effective operational processes of biofilters as water quality improvement measures.

*Achievements 2007-2008*
A focus group to develop the content and structure of the adoption guidelines was held on 25 February 2008 and was attended by 12 industry participants.

Guideline Specification for soil media had been earlier produced to assist the planning, design, construction and operation of biofiltration systems. These guidelines had been made available on the FAWB website in July 2006. Revised guidelines were published on the website on 14 March 2008 and subscribers notified. There were 754 downloads of the guidelines for the 12 months to 30 June 2008, compared with 175 downloads for 2006/07.

In early May 2008, FAWB published its 'Practice Note 1: In Situ Measurement of Hydraulic Conductivity' on the FAWB website. Getting reliable measurements of hydraulic conductivity was identified as an issue for the successful adoption of biofilter technologies.

Preparation of the design and adoption guidelines continues. Drafts of the technical design and planning chapters are currently under review, and the construction, maintenance & monitoring chapter are in preparation.

The structure of the 'Design Guidelines' being developed is:

- Volume 1: Introduction
- Volume 2: Policy & Planning
- Volume 3: Technical Design
- Volume 4: Practical Implementation
- Volume 5: Case Studies

Key findings were included and integrated with those of Projects 1 and 4 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.


**Participants at Perth training workshop, June 2008**

## *Project 4: Demonstration and Testing*

**Project Aims**
Project 4 aims to complete a number of field trials of bioretention systems in Melbourne, Brisbane and Sydney, in order to:

- Validate laboratory studies and address site specific issues;
- Provide the basis for monitoring of long term robustness under real operating conditions;
- Provide demonstrations of bioretention systems in a range of urban environments (streetscapes, greenfield, inner-city retrofits, etc); and
- Document construction procedures, for use in guidelines and standard drawings.

The focus of Project 4 is on testing the novel systems constructed in consultation with FAWB, as well as on testing a number of existing bioretention systems.

The current activities include:
Activity 4.01 Bioretention System, Second Ponds Ck, Western Sydney
Activity 4.02 Monash University Car Park Bioretention System
Activity 4.03 Wakerley Bioretention System, Brisbane
Activity 4.04 Testing Existing Bioretention Systems
Activity 4.05 Saturn Cres stormwater garden, Brisbane

**Project Leader**
Justin Lewis


**Project Leader Justin Lewis**

**Key Messages from Project 4**

1. In field applications, biofilters may demonstrate high variations in hydraulic performance due to different specifications of filter media characteristics, and poor construction and maintenance practices (43% of tested existing systems have field infiltration capacity below 50 mm/hour).
2. Site characteristics such as filter area (relative to catchment area), age and inflow volume were not useful predictors of long term conductivity. Rather, the initial conductivity of the filter media was found to be far more indicative of a biofilter's long-term performance.
3. To ensure reliable operation of bioretention systems, filter media specifications must be adhered to in terms of both composition and hydraulic conductivity. FAWB has produced such specifications that will be updated as required to reflect new and relevant research insights. Dispersive clay and silt from the Western Sydney area are generally unsuitable material for creating bioretention filter media owing to their unreliability in maintaining media hydraulic conductivity. Furthermore, it is important to tests soils prior their installation (see Project 1, Key Message 6).
4. Vegetation was shown to be critical in maintaining the infiltration capacity of biofiltration systems, helping them to recover from the inevitable reduction in hydraulic conductivity due to initial compaction of the filter media under hydraulic loading. The creation of macropores due to root growth and senescence is thought to contribute to this behaviour.
5. Vermiculite and perlite were also found to help maintain filter media hydraulic conductivity, making the biofilter more robust to slight deviations from the specified filter media characteristics.
6. There will be leaching of silt and some pollutants over the establishing phase. The flushing of solids should cease within 3-6 months in most cases (dependent on the amount of rainfall during this period).

7. Bioretention systems constructed in sodic soil without impermeable lining are not at risk of exporting salt from insitu soil into local streams.
8. Effective communication between designers and construction contractors is essential, throughout all stages of the project. It is imperative that quality control issues are addressed in planning and design, construction and maintenance throughout the life of the bioretention system, and that the design intent is communicated to the contractors, at a pre-construction briefing.
9. Maintenance requirements could be high during the establishment phase; frequent weed removal is required and the juvenile vegetation should be watered during extended dry periods. However the need for this level of maintenance reduces significantly as the vegetation matures. The development of mosses on the surface should be discouraged, as these can reduce the hydraulic capacity of the system. Dense planting of the preferred plants at the time of construction will help to minimise the extent of weed invasion, and minimise any moss growth.

**Activity 4.01 Bioretention System in Western Sydney**

*Aim*

To provide insight into sodic soil interaction with the bioretention filter media and the significance of trench lining on the hydrologic performance of bioretention swales in Second Ponds Creek and to document design and construction procedures for bioretention systems in sodic soil environments.

*Achievements 2007-2008*

The two trial trenches were re-vegetated to determine whether vegetation, coupled with filter media developed from the FAWB specifications, would improve performance at this site. Final planting of *sporobolus virginicus* was completed.

Principal findings from the work at Second Ponds Creek were:

- Filter media sourced locally is unstable and tends to collapse on wetting and drying, thus affecting hydraulic conductivity.
- Tighter specifications for soil filter media have been developed (available on FAWB website)
- Improved soil filter media tested under laboratory conditions at Monash University prior to installation at Second Ponds Creek.
- After 3.5 months hydraulic conductivity remained at 180mm/h.
- Leaching of salt does not appear to be a concern for unlined biofilters constructed in sodic soils.
- Initial leaching of silt (first 3months) until the system matures

Key findings were included and integrated with those of Projects 1 and 3 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.

**Second Ponds Creek Bioretention System**

**Activity 4.02 Monash University Carpark Bioretention System**

*Aim*
To provide knowledge about the operation and treatment efficiency of the bioretention system in removing typical urban stormwater pollutants and to complement laboratory experiments on different biofilter configurations and soil media.

*Achievements 2007-2008*
In order to test the laboratory findings, as well as the specified FAWB design, the middle cell of the Monash biofilter was excavated. Replacement filter media which complies with the latest FAWB specifications was sourced and tested. The cell was planted out with 100% *Carex appressa*. Testing will continue in 2008-2009.

**Monash Carpark Biofilter – October 2007**

**Monash Carpark Biofilter April 2008**

**Activity 4.03 Wakerley Bioretention, Brisbane**

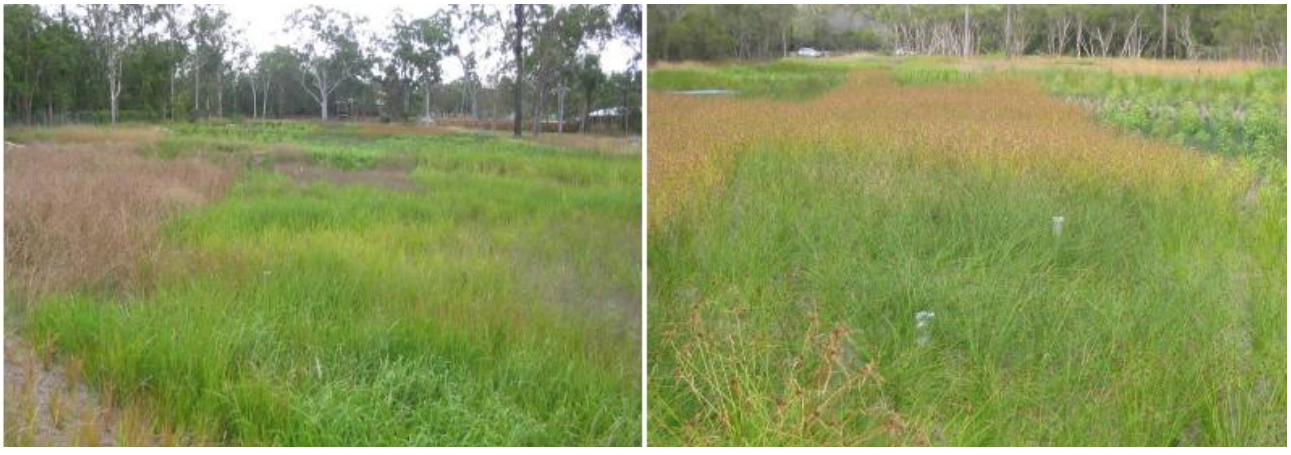
*Aim*
To provide knowledge about the operation and treatment efficiency of the bioretention system in removing typical urban stormwater pollutants and to complement laboratory experiments on different biofilter configurations and soil media.

*Achievements 2007-2008*
The system has been designed with three hydraulically separate filtration cells, each with a slightly different sub-surface drainage configuration and vegetation specification, thus providing a unique monitoring opportunity.

The main research questions to be investigated at this site are:

1. How effective is the submerged zone in this system at removing nitrogen from urban stormwater?
2. How do different vegetation types impact on performance?

FAWB continued to assist with the design of the monitoring program being established by Brisbane City Council (BCC). The Wakerley bioretention system has been recognised as complex, and thus a challenge to monitor.



**Wakerley bioretention system**

**Activity 4.04 Testing Existing Bioretention Systems**

*Aim*
To provide knowledge about the operation and treatment efficiency of the bioretention system in removing typical urban stormwater pollutants and to complement laboratory experiments on different biofilter configurations and soil media.

*Achievements 2007-2008*
Altogether, 37 biofilters were tested for hydraulic performance and metal accumulation in Sydney, Brisbane and Melbourne. Metal analyses were initiated to determine the levels of toxicants in soils.

The data analyses on hydraulic performance were completed and a report on this work (Hydraulic performance of biofilter systems for stormwater management: lessons from a field study) was produced for Melbourne Water.

Key findings were included and integrated with those of Projects 1 and 3 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.

**An existing biofilter tested in Activity 4.04**

**Activity 4.05 Saturn Cres stormwater garden, Brisbane**

*Aim*

To assist in the design, construction and testing of bio-pods, (small and functional biofiltration systems that have been retro-fitted into the urban landscape in Brisbane) to achieve effective biofilter performance.

*Achievements 2007-2008*
In October 2007, FAWB conducted a third and fourth storm simulation at the Saturn Crescent Biofilter. Flow and water quality data were collected.

With the maturation of the biofilter system and the replacement of the *Dianella* vegetation with *Carex*, improved nutrient reduction was achieved. The system already efficiently removed sediment, heavy metal and phosphorous with moderate reductions in nitrogen. However with the planting of *Carex* the system has now been shown to remove over 60% of Nitrogen. Plans are being developed to reconfigure the system with an anaerobic zone

There are some interesting findings from the last two rounds of testing of the Brisbane pod. The nitrogen removal is again very good, with TN concentration reductions of approximately 60%.

Key findings were included and integrated with those of Projects 1 and 3 in the workshop document 'Advancing the Design of Stormwater Biofilters' prepared for training workshops on advancing the design of rain gardens and biofiltration systems in Adelaide, Sydney, Perth and Albany, June 2008.

**BCC and FAWB working together to test the Saturn Crescent bio-pod**

## COMMERCIALISATION, PUBLIC RELATIONS AND COMMUNICATIONS

## Commercialisation - Networking and integration with Australian and international government and business

**Dutch Ministry of Economic Affairs delegation to FAWB**
FAWB hosted a visit at Monash by a delegation from the Ministry of Economic Affairs of the Netherlands on 18 October 2007. The visit by the Dutch Ministry was associated with the delegation's fact finding mission on the Victorian model for promoting and facilitating technological innovation in industry through its Science Technology and Innovation.

The delegation was led by Mr Hans de Groene, Deputy Director General for Enterprise & Innovation, and included the Consul of the Netherlands for Victoria, Mr Hans Nieuwland.

CEO Dr Tony Wong, Research Manager Assoc Prof Ana Deletic, and Project Leaders Dr Rebekah Brown and Belinda Hatt discussed the FAWB research and adoption activities with the delegation.

**Dutch Ministry of Economic Affairs delegation visting FAWB, October 2007**

**Visit by Members of the Victorian Cabinet for Bio Tech Cabinet Forum to Monash, 12 February 2008**
Closer links with the Victorian Government were developed with the visit of the Victorian Cabinet delegation to Monash on 12 February 2008.

The delegation included the following Cabinet members and their staff:

- The Hon Jacinta Allan MP, Minister for Regional & Rural Development, Minister for Skills & Workforce Participation (accompanied by Chris Gartner, Adviser)
- The Hon Gavin Jennings MLC, Minister for Innovation, Minister for Environment & Climate Change (accompanied by Prue Stewart, Chief of Staff, and Chris McDermott, Adviser)
- The Hon Maxine Morand MP, Minister for Children & Early Childhood Development, Minister for Women's Affairs (accompanied by David Bell, Adviser)
- The Hon Tony Robinson MP, Minister for Consumer Affairs, Minister Assisting the Premier on Veterans' Affairs,
- Minister for Gaming
- The Hon Rob Hudson MP, Parliamentary Secretary for Public Transport and the Arts

The Department of Innovation, Industry & Regional Development was represented by Amanda Caples, Executive Director, Office of Science and Technology, and Antoinette Pellegrini.

Assoc Prof Ana Deletic, Institute for Sustainable Water Resources, Research Manager FAWB; and Belinda Hatt, Institute for Sustainable Water Resources, Project Leader FAWB; gave a presentation to the delegation on FAWB and the Institute's work on sustainable water resources and proposals for the future, including further research on biofiltration.

Other presentations on aspects of biotechnology and tours of facilities were given by Monash researchers:

- Prof Milton Hearn, Director, Centre for Green Chemistry
- Prof Rod Hill, Pro Vice-Chancellor, Industry & Commercialisation
- Prof Ian Smith, Biochemistry & Molecular Biology
- Michael Spiegel, Deputy Director, Monash Antibody Technology Facility (MAFT)

Damien Farrell, Director, External Relations, Office of the Vice-Chancellor, managed the arrangements.

**Group of participants in visit to Monash by members of Victorian Cabinet**

***Back Row (l-r)*: Prof Milton Hearn, Michael Spiegel, Belinda Hatt*;**
***Middle Row (l- r)*: Prof Ian Smith, Hon Maxine Morand MP, Hon Rob Hudson MP,**
**Hon Tony Robinson MP, Prof Dave Griggs;**
***Front Row (l- r)*: Hon Jacinta Allan MP, Hon Gavin Jennings MLC, Prof Rod Hill, Assoc Prof Ana Deletic**

## Research and development contracts negotiated

Building on the skills and research findings achieved in FAWB projects, members of the FAWB have negotiated the following contracts or grants with industry and government.

**Alternative biofilter soil media**
Funding of $85k has been negotiated with Melbourne Water for additional tests on alternative biofllter soil media. This is in addition to funding of $30k already arranged with Melbourne Water for work by visiting scholar Lucie Alcazar on "Biofilter pathogen testing experiments", and $5k for studies and a report to Melbourne Water on hydraulic conductivity.

**Smart Water Fund Grant**
Monash Civil Engineering PhD postgraduate David McCarthy, FAWB Research Manager Assoc Prof Ana Deletic, and FAWB Project Leader Dr Tim Fletcher were successful with Monash Epidemiology and Preventive Medicine PhD scholar, Joanne O'Toole, in winning a Victorian Government Smart Water Fund grant. The grant ($249,000 over two years) will be used to conduct a research project entitled "New Technologies for Mitigating Risks of Stormwater Reuse".

**Research into Porous Pavements**
FAWB Project Leader Dr Tim Fletcher and FAWB Research Manager Assoc Prof Ana Deletic were successful with other colleagues in attracting and negotiating a research contract with private investors to investigate sustainable water resources aspects of porous pavements. The contract provides funding of $1.2 million.

**Other discussions and negotiations on biofilter development and potential commercialisation**
FAWB has been involved in discussions and negotiations with:

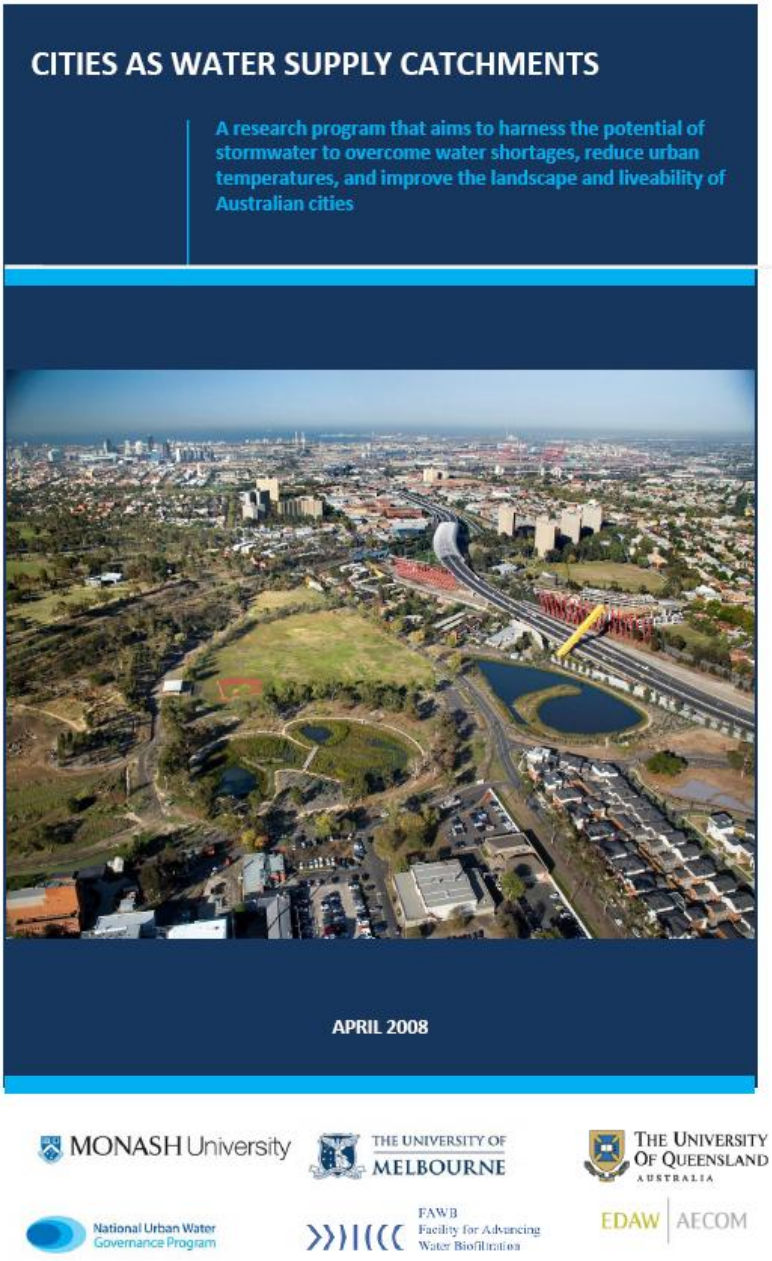
- Israeli industry and government on biofilter development, including potential funding by the Jewish National Fund (JNF) for a proposed pilot project for a biofiltration system in Israel.
- The Victoria-Israel Science and Technology R&D Fund (VISTECH) regarding a project to develop novel and robust technologies for the recycling of greywater and stormwater.
- Cardno Grogan Richards for FAWB to undertake a trial of prefabricated biofilters using vegetated columns.

**FAWB trial of prefabricated biofilters using vegetated columns.**
A key impediment to the more widespread adoption of biofiltration systems is the "fussiness" of their construction, in terms of specification and placement of filter media, and the planting and maintenance of plants. In response to this, Cardno Grogan Richards have, in partnership with Australian Ecosystems, developed a concept which involves "pre-growing" the selected vegetation in FAWB-specified filter media (within a nursery situation).

FAWB has developed a proposal for the testing of Cardno Grogan Richards' pre-established biofilter design so determine whether pre-established biofilter soil media/plant arrangement will work effectively in treating stormwater and maintaining hydraulic conductivity over time. Funding arrangements are under discussion.

## Collaboration with proposal for future research – 'Cities as Water Supply Catchments'

FAWB staff have led the development of a proposal for future research. The proposal, entitled 'Cities as Water Supply Catchments', combines expertise from EDAW and several faculties at Monash University, and also involves the active collaboration of specialists from The University of Melbourne and The University of Queensland.




An extensive schedule of presentations to potential water industry partners or stakeholders was undertaken by the FAWB leadership group during April to June 2008. Details of the presentations and briefings are outlined in the table on 'Presentations or Briefings to Government, Industry, Research and other Organisations'.

## Other interactions with government and industry

Assoc Prof Ana Deletic and Dr Tim Fletcher gave presentations on Monash research capabilities in water and energy, including FAWB, at a high level meeting on 6 May 2008 between GE and Monash University. GE Global Research, New York; GE Infrastructure; and GE Australia & New Zealand were represented.

Mr Craig Wallace, Queensland Minister for Natural Resources and Water and Minister Assisting the Premier in North Queensland met with FAWB staff, Dr Tony Wong, Assoc Prof Rebekah Brown and Dr Tim Fletcher on 22 May 2008. Mr Wallace was briefed on current water issues, including approaches to sustainable urban water management.

**Meeting with Qld Minister Wallace, 22 May 2008.**
**L-R: Dr Tim Fletcher, Mr Craig Wallace, Dr Tony Wong, Assoc Prof Rebekah Brown,**

## Public Relations and Communications

### FAWB website

The FAWB website continued to provide a focus for FAWB links with stakeholders and to be a source of information on FAWB activities.

There were 43,541 successful website hits to 30 June 2008 for 2007/2008 compared to a total of 23,632 hits recorded for 2006/2007.

Active use has been made of the publications generated by FAWB. At July 2008, a total of four reports, eleven journal paper abstracts, and eleven conference paper abstracts were posted for the guidance of users under the technical categories:

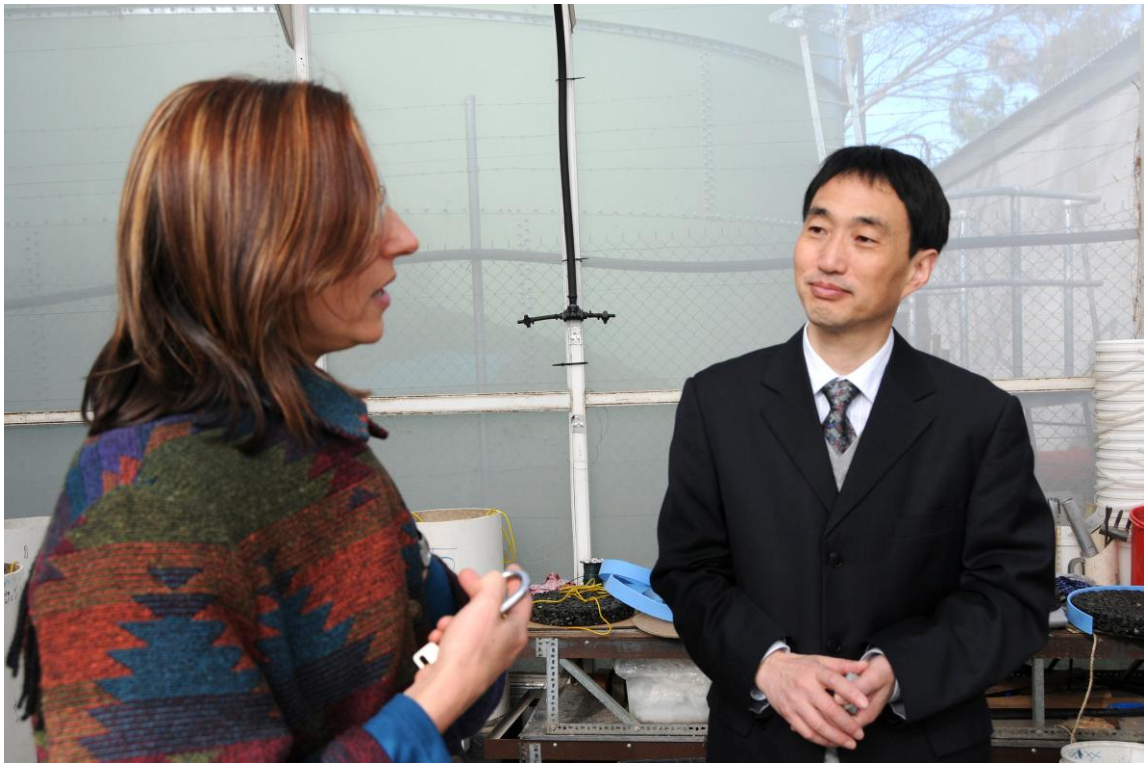
- Policy and Risk
- Filter Media
- Vegetation
- Submerged Zone
- Hydraulic Performance
- Field Studies
- Other

**FAWB Presentations, Seminars, Workshops 2007-2008**

*Presentations or Briefings to Government, Industry, Research and other Organisations*

An extensive program of briefings or presentations to government, industry and research organisations was undertaken by FAWB staff, including the collaborative links discussed earlier.

For example, links were established by FAWB with Tongji University, Shanghai, China, through the visit of Prof Zhou Qi, Dean of School of Environmental Science and Engineering at Tongji University,Shanghai, China. Prof Zhou had discussions with Assoc Prof Ana Deletic and inspected FAWB laboratory installations on 22 May 2008.



**Discussions between Prof Zhou Qi, Tongji University, Shanghai, and Assoc Prof Ana Deletic. May 2008**

Outline details of the nineteen briefings or presentations made during 2007-2008 are listed in the following table.

**Presentations or Briefings to Government, Industry, Research and other Organisations 2007-2008**

| Date | Speakers/Presenters | Topic | Organisation/Venue |
|---|---|---|---|
| 6 July 2007 | Dr Tim Fletcher, Monash | Monash research capabilities in water including FAWB | Environment Protection Authority, Vic /Melbourne |
| 16 Aug 2007 | Dr Tim Fletcher, Monash | Discussion on French-Australian research collaboration, focussed on cotutelle research in FAWB | French Scientific Attaché Dr. Michel Thibier/Monash, Clayton |
| 6 September 2007 | Lucie Alcazar, INSA de Lyon, Visiting scholar | Biofilter Pathogen Removal Experiments | FAWB Board/ Monash, Clayton |
| 18 October 2007 | Dr Tony Wong, EDAW;<br>Assoc Prof Ana Deletic, Monash;<br>Assoc Prof Rebekah Brown, Monash;<br>Belinda Hatt, Monash | FAWB research and adoption activities | Dutch Ministry of Economic Affairs delegation/ Monash, Clayton |
| 8 Jan 2008 | Dr Tim Fletcher,Monash; Sebastien Le Coustumer | Role of hydraulic conductivity in the design of biofiltration systems | Melbourne Water/Melbourne |
| 12 February 2008 | Assoc Prof Ana Deletic, Monash;<br>Belinda Hatt, Monash | FAWB, work on sustainable water resources, and proposals for the future, including further research on biofiltration. | Victorian Cabinet for Bio Tech 'Cabinet Forum' delegation/ Monash, Clayton |
| 14 March 2008 | Dr. Tim Fletcher, Monash | Performance of biofiltration systems in pathogen removal | Melbourne Water Corporation and Manningham City Council/ Monash, Clayton |
| 7 April 2008 | Dr Tony Wong, EDAW;<br>Assoc Prof Ana Deletic, Monash | Proposal for future research: 'Cities as Water Supply Catchments' | Staff of DIIRD, DSE, Treasury and State Cabinet/ DIIRD, Melbourne |
| 24 April 2008 | Assoc Prof Rebekah Brown, Monash;<br>Assoc Prof Ana Deletic, Monash | Proposal for future research: 'Cities as Water Supply Catchments' | Councillors and Executive of the City of Manningham/ City of Manningham, Doncaster |
| 24 April 2008 | Dr Tony Wong, EDAW;<br>Assoc Prof Rebekah Brown, Monash;<br>Dr Tim Fletcher, Monash;<br>Assoc Prof Ana Deletic, Monash | Proposal for future research: 'Cities as Water Supply Catchments' | Director Sustainability, Recycling and Innovation, Office of Water, Department of Sustainability and Environment, Victoria / Monash, Clayton |
| 6 May 2008 | Assoc Prof Ana Deletic, Monash;<br>Dr Tim Fletcher, Monash | Monash research capabilities in water and energy, including FAWB | Meeting between GE Global Research, New York; GE Infrastructure; GE Australia & NZ; and Monash/Monash, Clayton |
| 8 May 2008 | Assoc Prof Ana Deletic, Monash;<br>Assoc Prof Rebekah Brown, Monash | FAWB research findings | Councillors and Executive of the City of Manningham/ City of Manningham, Doncaster |
| 22 May 2008 | Dr Tony Wong, EDAW;<br>Assoc Prof Rebekah Brown, Monash;<br>Dr Tim Fletcher, Monash | Sustainable urban water management | Mr Craig Wallace, Queensland Minister for Natural Resources and Water and Minister Assisting the Premier in North Queensland/Monash |
| 22 May 2008 | Assoc Prof Ana Deletic, Monash | FAWB research findings and facilities | Prof Zhou Qi, Dean of School of Environmental Science and Engineering, Tongji University, Shanghai, China/Monash |
| 30 May 2008 | Dr Tony Wong, EDAW;<br>Assoc Prof Rebekah Brown, Monash;<br>Dr Tim Fletcher, Monash;<br>Assoc Prof Ana Deletic, Monash | Proposal for future research: 'Cities as Water Supply Catchments' | Melbourne Water senior group including Chair, MD, Gen. Mgr/ Melbourne Water |
| 2 June 2008 | Dr Tony Wong, EDAW;<br>Assoc Prof Rebekah Brown, Monash;<br>Dr Tim Fletcher, Monash;<br>Assoc Prof Ana Deletic, Monash | Proposal for future research: 'Cities as Water Supply Catchments' | Dept of Sustainability and Environment/ Dept of Sustainability and Environment, Melbourne |
| 4 June 2008 | Dr Tony Wong, EDAW;<br>Assoc Prof Ana Deletic, Monash | Proposal for future research: 'Cities as Water Supply Catchments' | Water Services Association of Australia (WSAA), Executive Director, Mr Ross Young |
| 5 June 2008 | Dr Tony Wong, EDAW;<br>Assoc Prof Rebekah Brown, Monash;<br>Dr Tim Fletcher, Monash;<br>Assoc Prof Ana Deletic, Monash | Proposal for future research: 'Cities as Water Supply Catchments' | National Water Commission (NWC) and officers of the Department of Environment, Water, Heritage and the Arts/ NWC, Canberra |
| 25 June 2008 | Dr Tony Wong, EDAW;<br>Assoc Prof Ana Deletic, Monash | Proposal for future research: 'Cities as Water Supply Catchments' | Executives of Department of Innovation, Industry and Regional Development (DIIRD)/ Melbourne |

*Seminars*

In addition to the conferences and seminars where proceedings/papers are listed under 'Publications', FAWB arranged, or was substantially involved with, six seminars during 2007-2008.

Two major events were the launch and seminar for the final report on the 'Transition to WSUD: the Story of Melbourne' and the forum on 'Sustainable water futures for Melbourne'. As discussed under Project 2, the 'Transition to WSUD' report was launched on 23 July 2007 by Mr Tony Lupton, Parliamentary Secretary for Industry and Innovation.

As part of Monash University's 50th Anniversary Public Lecture Series, the Faculty of Engineering presented a forum on 'Sustainable water futures for Melbourne' on 22 April 2008, at the BMW Edge Theatre at Federation Square. Over 200 guests including Monash alumni, members of the public, guests from the water and energy industry, Monash staff and students attended. FAWB was represented by Assoc Prof Ana Deletic, and Dr Gavin Mudd, two of the four Monash speakers.

**L-R: Dr Gavin Mudd, Assoc Prof Ana Deletic, Prof Paul Webley (meeting chair), Dr Grace Mitchell, David Flower**

**Audience at the forum on 'Sustainable water futures for Melbourne' on 22 April 2008 at Federation Square**

**Seminars 2007-2008**

| Date | Speakers/Presenters | Topic | Organisation/Venue |
|---|---|---|---|
| 23 July 2007 | Prof Russell Mein, FAWB Chair | Seminar welcome | DIIRD, FAWB/ Treasury Theatre, Treasury Place, Melbourne. |
| | Mr Tony Lupton, Parliamentary Secretary for Industry and Innovation | Launch of the final report: 'Transition to Water Sensitive Urban Design: the Story of Melbourne, Australia' | |
| | Dr Tony Wong, EDAW, FAWB CEO, | FAWB research program, aims and activities. | |
| | Assoc Prof Rebekah Brown, Monash | 'Transition to Water Sensitive Urban Design: the Story of Melbourne, Australia' | |
| | Mr Rob Skinner, Managing Director, Melbourne Water | Closing remarks for the seminar proceedings. | |
| 21 Aug 2007 | Dr Tim Fletcher, Assoc Prof Ana Deletic, Dr. Belinda Hatt, Yaron Zinger, (all Monash) | Various conference presentations regarding FAWB | Rainwater and Urban Design 2007 Conference / Sydney |
| 28 Aug 2007 | Dr Tim Fletcher, Monash | Water recycling and filtration as an alternative water source | Research Matters public seminar series, Monash University/ Clayton |
| 22 November 2007 | Assoc Prof Ana Deletic, Monash | Researching for improved stormwater outcomes | Australian Water Association (AWA), Stormwater Industry Association of Victoria (SIAV) seminar on 'Climate change and stormwater opportunities'/ Bayview Eden, Melbourne |
| | Dr Peter Breen, EDAW | Cities as Catchments: As Illustrated by Royal Park Wetland and Stormwater Reuse System | |
| | Belinda Hatt, Monash | Advancing stormwater biofiltration | |
| 6, 7 December 2007 | Dr Tim Fletcher, Monash; Yaron Zinger, Monash; Assoc Prof Ana Deletic, Monash; Katia Bratières, INSA de Lyon, Visiting scholar, Monash | Biofiltration Technologies for Treating Polluted Waters: Results of a Large Scale Laboratory Study | Tri-University Advanced Research Workshop 2007 (convened by Monash University, Central South University, China, and Wuhan University of Technology, China)/ Monash, Clayton |
| | Assoc Prof Ana Deletic, Monash; Dr Tim Fletcher, Monash | Urban Water Sustainability; Focusing on Stormwater | |
| 22 April 2008 | Assoc Prof Ana Deletic, Monash; Dr Gavin Mudd, Monash; (with David Flower, Monash; Dr Grace Mitchell, Monash; and meeting chair, Prof Paul Webley, Monash) | Sustainable water futures for Melbourne | Monash University's 50th Anniversary Public Lecture Series/ BMW Edge Theatre at Federation Square |

*Workshops*

Six workshops on the design of rain gardens or biofilters were run by FAWB during September 2007 and June 2008 in conjunction with stakeholder organisations. The workshops were held in Melbourne at Monash, Clayton and in Adelaide, Sydney, Perth and Albany. Details are outlined in the following table.

**Dr Tim Fletcher presenting at Rain Gardens workshop, 4 September 2007**

**Workshops 2007-2008**

| Date | Speakers/Presenters | Topic | Organisation/Venue |
|---|---|---|---|
| 4 September 2007 | Assoc Prof Ana Deletic, Monash; Dr Tim Fletcher, Monash; Belinda Hatt, Monash | 'Design of Rain Gardens' : Summary of key research findings from FAWB Projects 1 and 4 | FAWB, Clearwater/ Monash, Clayton |
| 5 September 2007 | Dr Tony Wong, EDAW; Dr Sara Lloyd, EDAW; Dr Robin Allison, EDAW; Georgie Wettenhall, EDAW; Kerrie Burge, EDAW | 'Design of Rain Gardens' : Workshop on design of biofilters | FAWB, Clearwater/ Monash, Clayton |
| 3,4 June 2008 | Assoc Prof Ana Deletic, Monash; Dr Tim Fletcher, Monash; Dr Tony Wong, EDAW: Dr Belinda Hatt, Monash | Advancing Rain Garden Design | Stormwater Industry Association, SA; Adelaide and Mt Lofty Ranges Natural Resources Management Board; FAWB; EDAW; Monash / National Wine Centre, Adelaide, SA |
| 10,11,12 June 2008 | Assoc Prof Ana Deletic, Monash; Dr Tim Fletcher, Monash; Dr Tony Wong, EDAW: Dr Belinda Hatt, Monash | Advancing the Design of Rain Gardens | Sydney Metropolitan Catchment Management Authority; FAWB; EDAW; Monash / Waterview Convention Centre: Bicentennial Park, Sydney Olympic Park, Sydney, NSW |
| 17,18 June 2008 | Assoc Prof Ana Deletic, Monash; Dr Tim Fletcher, Monash; Dr Tony Wong, EDAW: Dr Belinda Hatt, Monash | Advancing rain gardens and biofiltration systems in Western Australia | Department of Water, WA; FAWB; EDAW; Monash / Bayswater City Council, Bayswater, Perth, WA |
| 19, 20 June 2008 | Assoc Prof Ana Deletic, Monash; Dr Tim Fletcher, Monash; Dr Tony Wong, EDAW: Dr Belinda Hatt, Monash | Advancing rain gardens and biofiltration systems in Western Australia | Department of Water, WA; FAWB; EDAW; Monash / Midds Bluewater Restaurant, Middleton Beach Albany, WA |

**Dr Sara Lloyd assisting Adelaide workshop participants, June 2008**

*Media References*

FAWB activities, staff or postgraduates, were featured in some six media references during the year. An article on postgraduate Yaron Zinger and his research appeared in the Melbourne suburban newspaper 'Port Phillip Leader' in August 2007. (Details of the media references are listed in the table below.)

Young water scientist Yaron Zinger. Picture: STEVEN CRABTREE N06CK501

# Device to help improve health of rivers

CAULFIELD North PhD candidate Yaron Zinger won't let the rivers run dry.

Mr Zinger, 34, is one of three finalists in the 2007 "Riversymposium" Young Water Scientist Award.

The Monash student has invented a system to reduce nitrogen in fresh water to improve river health.

The "biofilter" is a tank that houses plants to reduce nitrogen levels and bring life back to unhealthy rivers.

Mr Zinger moved from Israel in March 2005 to study at Monash.

The engineering student said he had done work in genetics and cancer research, but because Australia had experienced its driest decade in 100 years, working with the environment became his priority.

Have you seen a smart way to save water or energy in your neighbourhood?

Leader Community Newspapers has begun its Greener Communities competition to reveal, celebrate and reward households, schools and businesses that are being smart about the environment.

Three winners, chosen by the Department of Sustainability and Ecovantage, will each receive an enviro-pack.

Readers can nominate themselves, their neighbours, their local school or business.

» **Go to www.leadernews.com.au and look for the Greener Communities banner**

**Media References 2007-2008**

| Date (Page) | Medium | Title / Subject | FAWB Representative /Aspect |
|---|---|---|---|
| 25 July 2007 | Monash Memo *(Monash University website weekly newsletter)* | Melbourne as a model for sustainable stormwater management | Launch of report by Dr Rebekah Brown and Ms Jodi Clarke, from the University's School of Geography and Environmental Science and Facility for Advancing Water Biofiltration, authors of Transition to Water Sensitive Urban Design: The Story of Melbourne, Australia. |
| 14 August 2007 | Port Phillip Leader *(Melbourne suburban newspaper)* | Device to help improve health of rivers | Project by FAWB PhD scholar Yaron Zinger |
| August – September 2007 | Hydroplus *(French technical journal)* | L'Australie, un pays sec gros consommateur d'eau | Interview in France with FAWB Project Leader, Dr Tim Fletcher. |
| 12 December 2007 | Monash Memo | Joint winners of Vice-Chancellor's Early Career Researcher Awards | FAWB Project Leader, Dr Rebekah Brown, from the Faculty of Arts, and Dr Travis Beddoe, from the Faculty of Medicine, Nursing and Health Sciences - joint winners of the Vice-Chancellor's Awards for Excellence in Research by Early Career Researchers. |
| January 2008 | Urban: Sustainable Solutions for a Developing Australia *(magazine distributed to members of the National Urban Development Industry Association (UDIA))* | A Storm of Innovation | Four-page article as follow up to the July 2007 launch of the FAWB report 'Transition to Water Sensitive Urban Design: The Story of Melbourne, Australia', by Assoc Prof Rebekah Brown and Jodi Clarke, at Treasury Place , Melbourne |
| 6 May 2008 | Faculty of Engineering website, Monash University | Sustainable water futures for Melbourne | Article on Faculty of Engineering forum as part of Monash's 50th Anniversary Public Lecture Series, held at the BMW Edge Theatre, Federation Square, 22 April 2008 (FAWB was represented by Assoc Prof Ana Deletic, and Dr Gavin Mudd, two of the four Monash speakers.) |
| May-June 2008 | Stormwater Industry Association website (State links to national association website) | Advancing Rain Garden Design | Event notices for FAWB training workshops in Adelaide, SA; Sydney, NSW; Perth and Albany, WA, held in June 2008. |

## EDUCATION AND TRAINING

### Annual Research Workshop

As noted earlier, the third FAWB annual research workshop was held at Monash University on 14 November 2007.Over 50 people attended from the FAWB research group, industry (particularly our industry collaborators) and a number of international scholars..

FAWB postgraduates, visiting scholars and research staff gave presentations on the research and adoption activities.

**Belinda Hatt (right) presenting at the FAWB Annual Workshop 2007**

### Postgraduates

Five postgraduates worked on PhD studies associated with FAWB and its staff. Details of the postgraduates, including their topics and supervisors, and the higher degrees completed, are set out in the following tables.

**Postgraduates, 2007-2008**

| Name | University | Type of postgraduate enrolment (PhD, MEngSc etc) | Supervisor(s) | Funding source(s) ARC /Uni/etc | Topic |
|---|---|---|---|---|---|
| Dale Browne | Monash | PhD | Assoc Prof A. Deletic (Monash)<br>Dr T. Fletcher (Monash)<br>Dr G. Mudd (Monash) | MDS* | Predicting and modelling the clogging of stormwater infiltration systems |
| Belinda Hatt | Monash | PhD | Assoc Prof A. Deletic (Monash)<br>Dr T. Fletcher (Monash)<br>Dr P. Webley (Monash) | MDS*/James McNeill scholarship | Filtration technologies for stormwater harvesting |
| Sébastien Le Coustumer | Institut National des Sciences Appliquees (INSA) de Lyon. | PhD (enrolled at both INSA and Monash University) | Dr S Barraud (Lyon)<br>Assoc Prof A. Deletic (Monash)<br>Dr T. Fletcher (Monash) | Cotutelle Program, France/ MDS* | Measurement and modelling of hydraulic and environmental performance of urban stormwater infiltration systems |
| Anke Wendelborn | Monash | PhD | Dr G. Mudd (Monash)<br>Assoc Prof A. Deletic (Monash)<br>Assoc Prof P. Dillon (Flinders, SA/CSIRO) | MDS* | Stormwater injection aquifer storage and recovery in Melbourne and associated water quality issues. |
| Yaron Zinger | Monash | PhD | Assoc Prof A. Deletic (Monash)<br>Dr T. Fletcher (Monash) | MDS*/MGS§ | Advancing stormwater biofilter technologies |

* Monash Departmental Scholarship
§ Monash Graduate Scholarship

**Higher Degrees Completed and Destinations of Postgraduates, 2007-2008**

| Name | Degree, University | Supervisor(s) | Topic | Date Thesis Submitted/ Passed | Destination |
|---|---|---|---|---|---|
| Belinda Hatt | PhD, Monash | Assoc Prof A. Deletic (Monash)<br>Dr T. Fletcher (Monash)<br>Dr P. Webley (Monash) | Filtration technologies for stormwater harvesting | December 2007/ May 2008 | Lecturer - Dept of Civil Engineering, Monash University |
| Anke Wendelborn | PhD, Monash | Dr G. Mudd (Monash)<br>Assoc Prof A. Deletic (Monash)<br>Assoc Prof P. Dillon (Flinders, SA/CSIRO) | Zinc and copper behaviour during stormwater aquifer storage and recovery in sandy aquifers. | May 2008/ | |

## Visiting Scholars

INSA scholar Katia Bratières and INSA postgraduate Sébastien Le Coustumer were joined in late April 2008 by INSA scholars
Elen Devauchelle and Christelle Schang. Elen Devauchelle and Christelle Schang are doing research related to FAWB projects, particularly aspects of the role of porous pavements with biofilters.

**INSA de Lyon, France, researchers**
**(L-R) Sébastien Le Coustumer, Elen Devauchelle, Katia.Bratieres, Christelle Schang**

**Visiting Scholars, 2007-2008**

| Name | University | Type of enrolment | Supervisor(s) | Funding source(s) ARC /Uni/etc | Topic |
|---|---|---|---|---|---|
| Lucie Alcazar | Institut National des Sciences Appliquées (INSA) de Lyon. | Undergraduate | Assoc Prof A. Deletic and Dr T. Fletcher, (Monash) | Exchange student (to October 2007) | Treatment of pathogens by biofiltration. |
| Katia Bratières | Institut National des Sciences Appliquées (INSA) de Lyon. | Undergraduate | Dr T. Fletcher (Monash) | Exchange student | Impact of design parameters and operating conditions on nutrient removal by biofilters. |
| Elen Devauchelle | Institut National des Sciences Appliquées (INSA) de Lyon. | Undergraduate | Assoc Prof A. Deletic and Dr T. Fletcher, (Monash) | Exchange student (from April 2008) | Porous pavements and biofilters |
| Christelle Schang | Institut National des Sciences Appliquées (INSA) de Lyon. | Undergraduate | Assoc Prof A. Deletic and Dr T. Fletcher, (Monash) | Exchange student (from April 2008) | Porous pavements and biofilters |

## PUBLICATIONS 2007-2008

### Edited Books

Deletic, A. & Fletcher, T.D. (2007) Water Science & Technology (IWA) Special Issue on Urban Drainage Modelling and Water Sensitive Urban Design #*

Fletcher, T. D. & Deletic, A. (Eds.). (2007). Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis.# *

# Updated Reference listed as 'In press" in 2006-2007 FAWB Annual Report

* Publication related to FAWB activities and involving FAWB participants, but not directly arising from FAWB Projects.

### Book Chapters

Bertrand-Krajewski, J.-L., Fletcher, T. D., and Mitchell, V. G. (2007). Chapter 5 - Temporal and spatial scale considerations. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis. #*

Breil, P., Lafont, M., Fletcher, T. D., and Roy, A. (2007). Chapter 20 - Aquatic ecosystems. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis. #*

Deletic, A., and Fletcher, T. D. (2007). Chapter 2 - Overview of guiding principles. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis #*

Deletic, A., and Fletcher, T. D. (2007). Chapter 4 - Selecting variables to monitor. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis.#*

Fletcher, T. D., and Bertrand-Krajewski, J.-L. (2007). Chapter 3 - Defining objectives and applications of monitoring. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis #*

Fletcher, T. D., and Bertrand-Krajewski, J.-L. (2007). Chapter 12 - Financial considerations. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis. #*

Fletcher, T. D., and Mitchell, V. G. (2007). Chapter 13 - Monitoring to understand interactions between urban water cycle components. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis.#*

Fletcher, T. D., Mitchell, V. G., Deletic, A., and Maksimovic, C. (2007). Chapter 1 - Introduction. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis #*

Shuster, W., Fletcher, T. D., and Deletic, A. (2007). Chapter 17 - Stormwater. In T. D. Fletcher & A. Deletic (Eds.), Data requirements for integrated urban water management. Paris: UNESCO Publishing and Taylor & Francis.#*

# Updated Reference listed as 'In press" in 2006-2007 FAWB Annual Report

* Publication related to FAWB activities and involving FAWB participants, but not directly arising from FAWB Projects.

### Technical Reports

Brown, R. R. and Farrelly, M. A. (2007). Advancing urban stormwater quality management in Australia: A survey of stakeholder perceptions of institutional drivers and barriers. Report No. 07/05, National Urban Water Governance Program, Monash University. (www.urbanwatergovernance.com)

Coustumer, S., Fletcher, T.D., Deletic, A. and Potter, M. (2008) Hydraulic performance of biofilter systems for stormwater management: lessons from a field study, Facility for Advancing Water Biofiltration, Department of Civil Engineering, Institute for Sustainable Water Resources, Monash University, Melbourne, Vic.,

Hatt, B., and Le Coustumer, S. (2008) Condition assessment and performance evaluation of bioretention systems. Practice Note 1: In Situ Measurement of Hydraulic Conductivity, Facility for Advancing Water Biofiltration, April 2008.

(www.monash.edu.au/fawb/publications)

Smith, N. (2007). Stormwater gardens: bioretention basins for urban streets. Brisbane City Council

## Refereed Journal Papers

Blecken, G. T., Muthanna, T., Zinger, Y., Deletic, A., Fletcher, T. D., and Viklander, M., (2007). The influence of temperature on nutrient treatment efficiency in stormwater biofilter systems. Water Science and Technology, 56(10), 83–91.

Bratières, K., Fletcher, T. D., Deletic, A., and Zinger, Y. (2008) Nutrient and sediment removal by stormwater biofilters; a large-scale design optimisation study. Water Research, doi: 10.1016/j.watres.2008.06.00

Bratières, K., Fletcher, T.D., Deletic, A., and Zinger, Y., (in press), Optimisation of the treatment efficiency of biofilters; results of a large-scale laboratory study. Water Research

Browne, D., Deletic, A., Mudd, G.M. and Fletcher, T.D. (In press). A new saturated/unsaturatd model for stormwater infiltration systems. Hydrologic Processes.

Fletcher, T. D., and Deletic, A. (2007). Statistical evaluation and optimisation of stormwater quality monitoring programmes. Water Science and Technology, 56(12), pp1-9*

Fletcher, T. D., Deletic, A., Mitchell, V., and Hatt, B. E. (in press). Reuse of urban runoff – a review of recent Australian advances and remaining challenges. Journal of Environmental Quality.*

Hatt, B.E., Fletcher, T.D.and Deletic, A. (2007) Hydraulic and pollutant removal performance of stormwater filters under variable wetting and drying regimes, Water Science and Technology 56(12), 11-19

Hatt, B. E., Fletcher, T. D., and Deletic, A. (2008). Hydraulic and treatment performance of fine media stormwater filters. Environmental Science and Technology, 42, 2535-2541.#

Hatt, B. E., Fletcher, T. D., and Deletic, A. (in press). Hydrologic and pollutant removal performance of biofiltration systems at the field scale. Journal of Hydrology.

Le Coustumer, S., Fletcher, T. D., Deletic, A., and Barraud, S. (2007). Hydraulic performance of biofilters: first lessons from both laboratory and field studies. Water Science and Technology, 56(10), 93–100

Lloyd, S. and Wong, T.(in press) Paired catchment storm event monitoring: assessing the performance of a bioretention system (rain garden), Australian Journal of Water Resources.

McCarthy, D., Deletic, A., Mitchell, V. G., Fletcher, T. D., and Diaper, C. (2008). Uncertainties in stormwater E. coli levels. Water Research, 42, 1812-1824.*

Mitchell, V. G., McCarthy, D., Deletic, A., and Fletcher, T. D. (2008). Sensitivity of urban stormwater harvesting storage capacity-reliability-yield relationships to behaviour analysis method selection. Environmental Modelling and Software, 23, 782-793.*

Read, J., Wevill, T., Fletcher, T. D., and Deletic, A. (2008). Variation among plant species in pollutant removal from stormwater in biofiltration systems. Water Research, 42(4-5), 893-902.

Roy, A. H., Wenger, S. J., Fletcher, T. D., Walsh, C. J., Ladson, A. R., Shuster, W. D., Thurston, H. W., and Brown, R. R. (in press). Impediments and solutions to sustainable, watershed-scale urban stormwater management: lessons from Australia and the United States. Environmental Management.*

Siriwardene, N., Deletic, A., and Fletcher, T. D. (2007). Modelling of sediment transport through stormwater gravel filters over their life span. Environmental Science and Technology, 41(23), 8099-8103.

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Sun, G., and Cooper, D. (in press) A statistical analysis on the removal of organic matter in constructed wetlands in the UK. Environmental Technology. (ISSN: 0959-3330)*

Sun, G., and Zhang, G. (2008) The design of treatment wetlands in the UK: successes, failures and alternative approaches. Wetland Science. 6(2): 343-350. (ISSN: 1672-5948)*

Walsh, C. J., Fletcher, T. D., and Ladson, A. R. (in press). Retention capacity: a metric to link stream ecology and stormwater management. Journal of Hydrological Engineering.*

# Updated Reference listed as 'In press" in 2006-2007 FAWB Annual Report

* Publication related to FAWB activities and involving FAWB participants, but not directly arising from FAWB Projects.

## Conference Papers

Blecken, G., Zinger, Y., Deletic, A., Fletcher, T.D., and Viklander, M. (in press) Heavy metal removal by stormwater biofilters: Can it withstand alternative wetting and drying conditions?, 11th International Conference on Urban Drainage, Edinburgh, Scotland, UK, 31 August - 5 September 2008

Bratieres, K., Fletcher, T. D., Deletic, A., Alcazar, L., Le Coustumer, S. and McCarthy, D. (in press) Removal of nutrients, heavy metals and pathogens by stormwater biofilters. 11th International Conference on Urban Drainage, Edinburgh, Scotland, UK, 31 August - 5 September 2008

Hatt, B.E., Fletcher T.D., and Deletic, A. (in press) Improving stormwater quality through biofiltration: Lessons from field studies, 11th International Conference on Urban Drainage, Edinburgh, Scotland, UK, 31 August - 5 September 2008

Le Coustumer, S., Fletcher, T.D., Deletic, A., and Barraud, B. (in press) Influence of time and design on the hydraulic performance of biofiltration systems for stormwater management, 11th International Conference on Urban Drainage, Edinburgh, Scotland, UK, 31 August - 5 September 2008

Lewis, J.F., Hatt, B.E., Le Coustumer, S., Deletic, A., and Fletcher, T.D. (in press) The impact of vegetation on improving the hydraulic conductivity of stormwater bioretention systems: results from two field scale biofilters, 11th International Conference on Urban Drainage, Edinburgh, Scotland, UK, 31 August - 5 September 2008

Lloyd, S. and Blunt, S. (in press) City as a catchment: a strategy for adaptation, World Sustainable Building Conference 2008, Melbourne, Vic, 21-25 September 2008

Smith, N., Allen, R., McKenzie-McHarg, A., Deletic, A., Fletcher, T.D., and Hatt, B. (2007) Retrofitting functioning stormwater gardens Into existing urban landscapes, Cairns International Public Works Conference, Cairns, 26-30 August 2007

McKenzie-McHarg, A., Smith, N. and Hatt, B. (2008). Stormwater gardens to improve urban stormwater quality in Brisbane, Stormwater 2008, 8-11 July 2008, Surfers Paradise, QLD.

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Sun G., and Ladson A. (2008) Modelling of wastewater treatment wetlands: what's removed in the greenbox, and how? Proceedings of International Symposium on Sanitary and Environmental Engineering. Held in 24-27 June 2008, Florence, Italy. (ISBN: 978-88-903557-0-7) (8 pages in CD-Rom)*

Sun G., Kadlec R. H., Austin D., and Zhu Y. (in press) A lab-scale study of environmental factors affecting nitrogen removal in vertical flow wetlands? Accepted for oral presentation at: 11th International Conference on Wetland Systems for Water Pollution Control. To be held in: 1-7 November 2008, Ujjain, India*

Sun G., Cooper P., and Cooper, D. (in press) The removal of organic matter in horizontal flow reed beds in the UK: performance evaluation using monod and first order kinetics. Accepted for oral presentation at: 11th International Conference on Wetland Systems for Water Pollution Control. To be held in: 1-7 November 2008, Ujjain, India*

Sun G., and Ladson A. (in press) Modelling of subsurface flow wetlands based on the kinetics of seven key pollutants. Accepted for poster presentation at: 11th International Conference on Wetland Systems for Water Pollution Control. To be held in: 1-7 November 2008, Ujjain, India*

Urrutiaguer, M., Lloyd, S. and Lamshed, S (in press) Determining WSUD project benefits using a multi-criteria assessment tool, 11th International Conference on Urban Drainage, Edinburgh, Scotland, UK, 31 August - 5 September 2008

Zinger, Y., Deletic, A., and Fletcher, T.D. (2007) The effect of various intermittent dry-wet cycles on nitrogen removal capacity In biofilters systems, Rainwater & Urban Design 2007 Conference, Sydney, August 2007

# Updated Reference listed as 'In press" in 2006-2007 FAWB Annual Report

* Publication related to FAWB activities and involving FAWB participants, but not directly arising from FAWB Projects.

## APPENDIX

**Summary of Performance against Program Milestones, Program Objectives and Approved Business Plan**

**Financial Information, Audit**

## Summary of Performance against Program Milestones, Program Objectives and Approved Business Plan

## Index

*Schedule 2*

**Part A - Summary**

Completed details included as 'Attachment A'
(Includes supplementary information as requested by DIIRD)

**Part B – Performance Report**

Completed details included as 'Attachment B'

**Part C – Budget Report**

Completed details included as 'Attachment C'

*Schedule 3*

*Program Milestones for the Year*
Completed details included as 'Attachment D'

## Attachment A

*Schedule 2 – Milestones (to 30 June 2008)*

**Part A – Summary (Includes supplementary information as requested by DIIRD)**

*Ongoing recruitment details (i.e. wherever relevant expats returning, experts appointed, etc)*
Belinda Hatt commenced as Project Leader, Project 3, in late July 2007.

*Education and skills related activities*
Please refer to the sections in the main report on:

- 'Commercialisation, Public Relations and Communications'
  - Presentations, Seminars, Workshops 2007-2008
- 'Education and Training' in the main report which summarises activities including:
  - Annual Research Workshop
  - Table of Postgraduates
  - Table of Higher Degrees completed and Destinations of Postgraduates
  - Table of Visiting Scholars

*Description of infrastructure purchases as part of the Program for capital expenditure (eg new buildings, fit-outs, equipment etc);*
Nil

*Nature and value of "deals" finalised (eg grants, commercial contracts, financial commitments from Stakeholders);*
Please refer to the item 'Commercialisation', 'Research and development contracts negotiated', under the section on 'Commercialisation, Public Relations And Communications' in the main report.

*Links with prestigious national and international partners and Stakeholders;*
Please refer to the section in the main report on Cooperative Linkages:

- Local links
  - Participants and Collaborators
  - Joint activity – Annual Workshop 2007
- International collaborative links
  - Institute for Infrastructure, University of Innsbruck, Austria
  - INSA de Lyon (Lyon France)
  - Technological University, Delft, The Netherlands
  - Public Utilities Board of Singapore (PUB) and the National Parks Board of Singapore (NParks)
  - York University, United Kingdom

*Short layman's descriptions of key developments, new technology applications and problems that have been solved through the project activities. This might include new discoveries, new treatments, environmental solutions etc.;*
Please refer to the section in the main report on Research, including Key Messages and other Achievements for 2007-2008 for FAWB Projects and Activities in:

- Project 1: Technology
- Project 2: Policy and Risk
- Project 3: Adoption Tools
- Project 4: Demonstration and Testing

*Media articles*
Six media articles were recorded for 2007-2008 as set out in the Table 'Media References 2007-2008' in the main report section on 'Commercialisation, Public Relations and Communications'

*Awards and acknowledgements for the Program and people involved.*
Assoc Prof Rebekah Brown

FAWB Project Leader Dr Rebekah Brown was announced in December 2007 as the joint winner of the Monash University Vice-Chancellors Award for Early Career Researcher of the year for 2007.

Dr Brown was also promoted to Associate Professor in the School of Geography and Environmental Science at Monash University, effective from January 2008.

Assoc Prof Ana Deletic

The FAWB Board congratulated Assoc Prof Ana Deletic on her outstanding achievement in winning the 2007 Dean's Award for Excellence in Research. The award was given in recognition of distinguished research in the Faculty of Engineering.

**Faculty of Engineering Dean's Awards- (L-R) Dean Prof Tam Sridhar, Dr Huanting Wang, Vice-Chancellor Prof Richard Larkins, Assoc Prof Ana Deletic, Dr Kris Ryan and Ms Jill Crisfield.**

Dr Belinda Hatt

The Board was also delighted to congratulate Project Leader Belinda Hatt on being awarded her PhD. The title of Dr Hatt's thesis was: "Filtration technologies for stormwater harvesting".

*Value ($) of deals done*
Please refer to '*Nature and value of "deals" finalised (eg grants, commercial contracts, financial commitments from Stakeholders)'* as above.

*Links with prestigious overseas partners*
As noted above, please refer to the section in the main report on Cooperative Linkages for:

- International collaborative links
  - Institute for Infrastructure, University of Innsbruck, Austria
  - INSA de Lyon (Lyon France)
  - Technological University, Delft, The Netherlands
  - Public Utilities Board of Singapore (PUB) and the National Parks Board of Singapore (NParks)
  - York University, United Kingdom

As noted under 'Presentations or Briefings to Government, Industry, Research and other Organisations', links were also established by FAWB with Tongji University, Shanghai, China, through the visit of Prof Zhou Qi, Dean of School of Environmental Science and Engineering at Tongji University,Shanghai, China.

Design of biofilters

In June 2008, FAWB prepared a report on 'Advancing the Design of Stormwater Biofitration' which summarised the key findings to date on soil filter media and other aspects of biofilters. The report was prepared for workshops being held in various States including WA, NSW, and SA.

A pivotal part of the 'Key Findings' of FAWB's work related to the design or configuration of biofilters. Details on the findings on 'Biofilter Design' as set out in Section 3., 'Key Findings', of the report, follow:

3.1 Outline of the Biofilter Design

Two main configurations of biofilters are recommended, depending on the objectives of the system (eg target pollutants, site opportunities and constraints, etc.) They are:

- Standard biofilter design (Figure 14)
- Biofilter with a submerged zone (Figure 15)

The bioretention systems can have different shapes. Systems should be unlined to promote exfiltration wherever conditions allow (eg the systems are built far enough from foundations). Any reduction in volumes due to exfiltration will translate to a mean reduction in pollution loads, and will also reduce the impacts of changed hydrology inherent in urbanised catchments.'

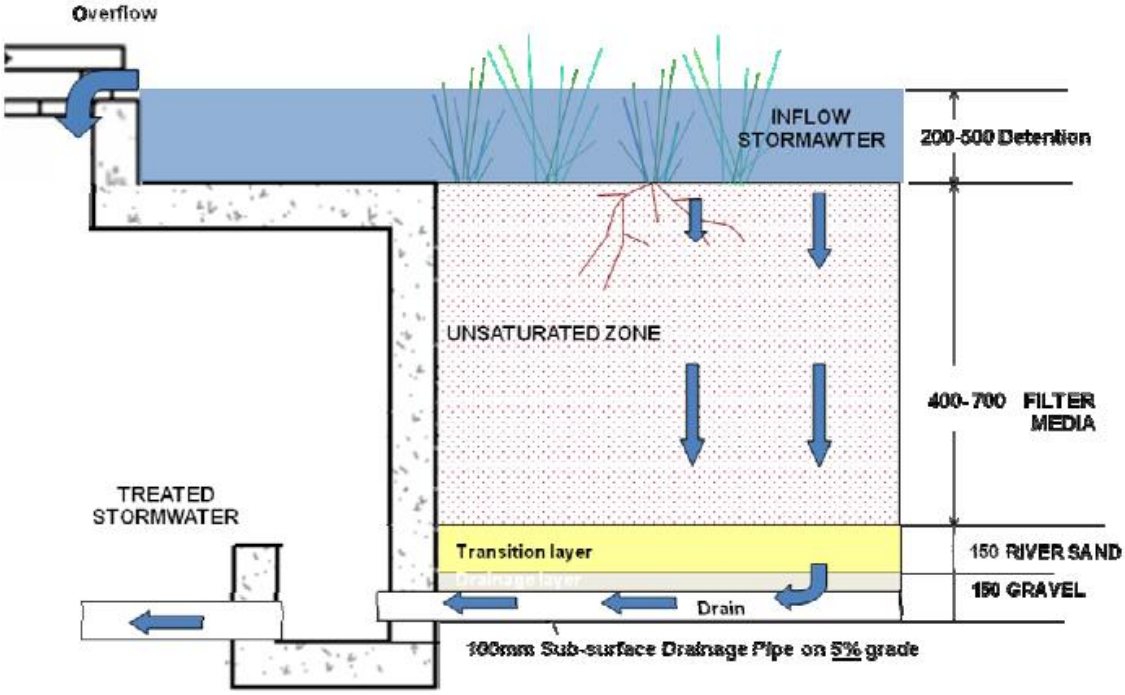


Figure 14. Conceptual outline of the design of a standard bioretention system

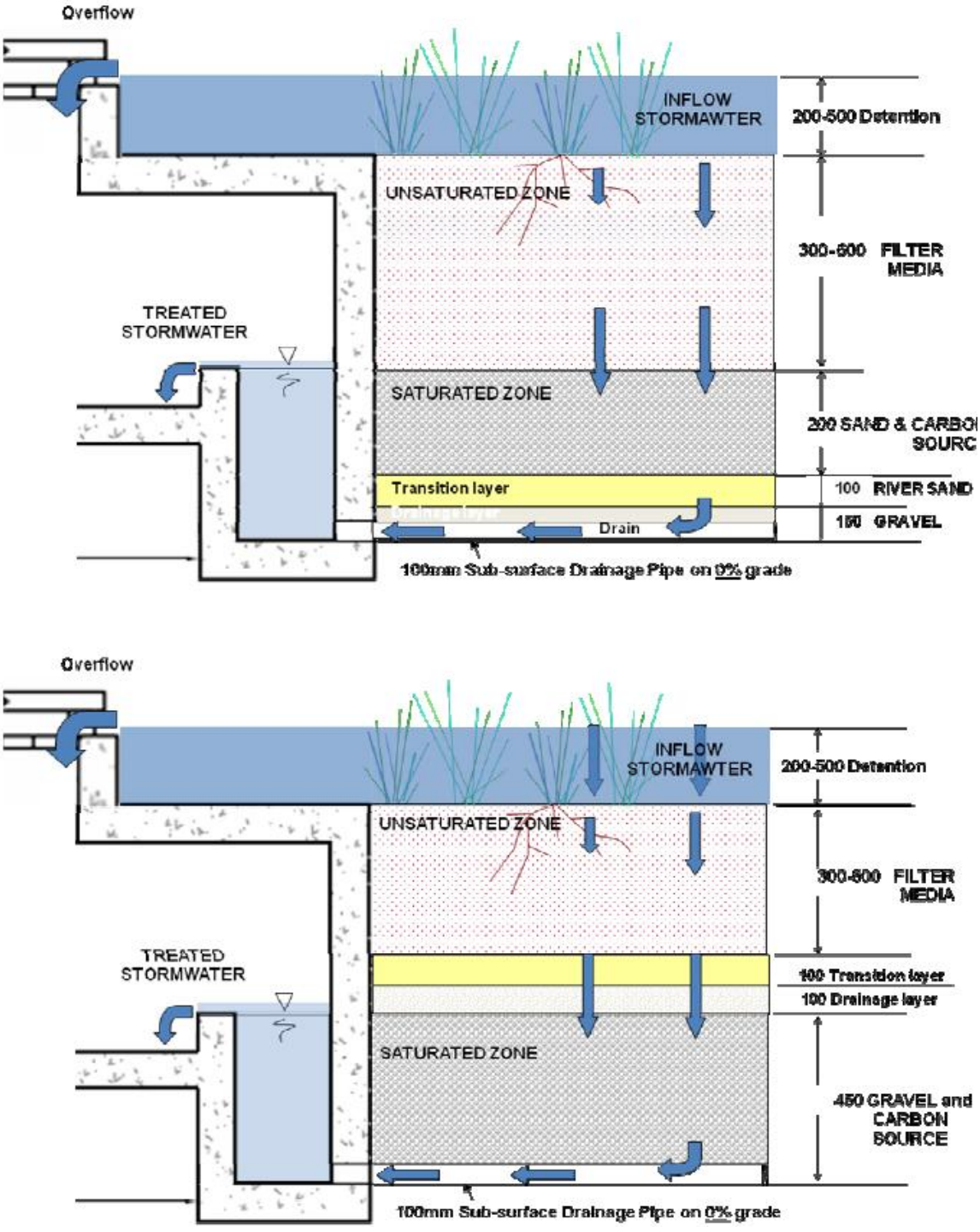


Figure 15. Conceptual outline of the design of bioretention systems with a submerged zone

*People stories (expatriates returning, visiting experts in a field, local experts, etc)*
During 2007/2008, three eminent international experts visited FAWB and conducted a Research Review as noted under 'Research Advisory Panel – Research Review'. The visiting panel comprised:

- Professor Bob Pitt (the Chair of the panel), Director of Environmental Engineering Programs, Department of Civil and Environmental Engineering, The University of Alabama.
- Dr Frans van de Ven, Faculty of Civil Engineering and Geosciences, Delft University of Technology, and
- Emeritus Professor Barry T Hart, Director, Water Science Pty Ltd

As noted in the main report under 'Cooperative Linkages', 'International collaborative links', there were visitors from:

- Institute for Infrastructure, University of Innsbruck, Austria
- INSA de Lyon (Lyon France)
- Technological University, Delft, The Netherlands
- Dutch Ministry of Economic Affairs delegation to FAWB
- Victorian Cabinet for Bio Tech Cabinet Forum

Mr Craig Wallace, Queensland Minister for Natural Resources and Water and Minister Assisting the Premier in North Queensland also visited FAWB.

As earlier noted, listed under Public Relations and Communications in the main report section on 'Commercialisation, Public Relations and Communications' is a table of 'Presentations or Briefings to Government, Industry, Research and other Organisations 2007-2008'. Nineteen presentations or briefings involving FAWB were given. A substantial number of presentations were to visitors.

*Details of skill shortages or recruitment difficulties and details of any actions to overcome or success stories.*
Nil

*Details of problems solved*
In the June 2008 FAWB document, 'Advancing the Design of Stormwater Biofitration' key findings on soil filter media and other aspects were summarised for the purposes of workshops being held in various States including WA, NSW, and SA.

Section 2.2, 'Project 4: Demonstration and Testing', of the document provides the following information on the approach to a biofilter or 'bio-pod' in Brisbane and how problems were tackled and solved in retrofitting the installation:

**Activity 4.05 Saturn Crescent stormwater garden, Brisbane**

This is currently the only system that has been fully built based on findings from the FAWB program and subsequently tested. The system is a relatively small bio-pod that was retrofitted into the urban landscape. It has a plan area of $20m^2$ and services a $900m^2$ catchment (the full design details of the system design are in Smith *et. al.* (2007)). The current FAWB soil filter media specifications were used, as were plant species recommended by FAWB (the system was initially trialled with some other plant species but later replanted using a FAWB specified plant species, Hatt *et al.*, in press).

The main questions asked were:

1. What is performance of the system built according to the latest findings from our research?
2. What is functionality of retrofitting the bioretention system into an existing urban landscape?

To date, five controlled experiments have been conducted (Figure 13), one before and four after the system was replanted (using FAWB specified plants). A design storm event was prepared and introduced to the system, the outflow rate measured and water quality samples collected and analysed for key pollutants. The hydraulic and treatment performance of the system has been tested as described in Smith *et. al.* (2007) and Hatt *et. al.* (in press).'

*New treatments*
An importance feature of biofilters is the design and selection of the soil media to filter the inflow water. FAWB published guidelines on 'Soil Filter Media' on its website. The information was newly revised and updated in May 2008.

Another new treatment aspect was Practice Note1: 'In Situ Measurement of Hydraulic Conductivity '. This document was added to the website information as part of the guidance to users on the condition assessment and performance evaluation of bioretention systems.

In the June 2008 FAWB document, 'Advancing the Design of Stormwater Biofitration' key findings on soil filter media and other aspects were summarised for the purposes of workshops being held in various States including WA, NSW, and SA.

Section 3.2 of the document provides the following information on soil filter media:

The key findings on soil filter media are:

- A loamy sand should be used that is free of rubbish, deleterious material and toxicants, and not be hydrophobic;
- The hydraulic conductivity should be selected in conjunction with other design characteristics (i.e., the area of the bioretention system and its ponding depth), and climate conditions (i.e., rainfall characteristics). The hydraulic conductivity (Figure 17) of the maximum compacted media should be 100 – 300 mm/hour for a temperate climate and 100 – 600 mm/hr for a tropical climate;

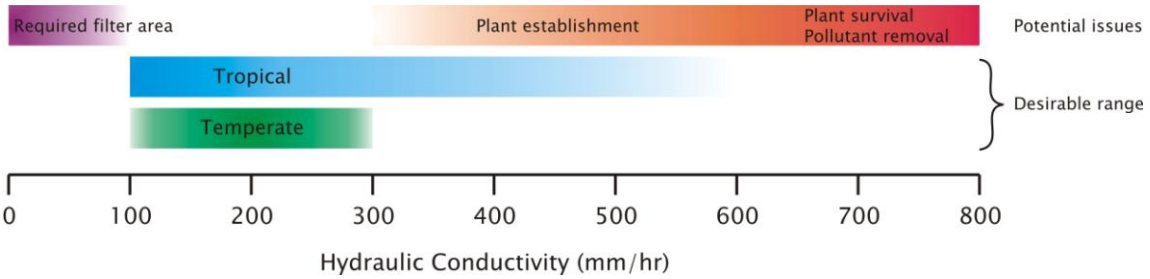


Figure 16. Recommended filter media hydraulic conductivity range and potential issues (FAWB, 2008)

- Particle Size Distribution (PSD): the clay and silt fractions (<5 µm) should be no more than 3% in total (w/w), and the distribution of other fractions should be continuous;
- Organic matter should be kept to a minimum (<5% (w/w));
- The total phosphorus content should be minimised, and be at least less than 100 mg/kg; and
- Soils used in bioretention systems should be structurally stable, particularly in wet conditions.

**Monash Carpark Biofilter**

*Environment solutions*

A pivotal aspect of biofilters is the performance of biofilters as an environmental solution to treating stormwater or wastewater. The treatment performance of biofilters has been also summarised in the June 2008 FAWB document, 'Advancing the Design of Stormwater Biofitration'.

Section 3.6, 'Treatment Performance' of the document provides the following information on treatment performance, in particular, for the removal of pollutants such as Total Suspended Solids (TSS); nutrients, for example phosphorus (Total Phosphorus, TP), nitrogen (Total Nitrogen TN); and heavy metals:

If designed according to FAWB specifications, bioretention systems should be effective for the treatment of stormwater, reducing inflow TSS and TP by more than 90 and 80%, respectively (Table 6 and Table 7).

To achieve this high removal rate of TP, it is crucial that the filter media meets the FAWB soil filter media guidelines. Soils with a high phosphorus content will leach TP, as shown by both the large scale column test (Table 6) and the field tests (Table 7).

On average, 50% removal of nitrogen is also achievable, if the right vegetation is selected (Figure 20 and Table 6). For nitrogen and phosphorus removal, C. appressa and M. ericifolia are very effective, however M. ericifolia will take longer to mature. Selecting filter media which do not have excessive levels of organic matter will also help to prevent nutrient leaching. The main cause of variations in TN removal is variable wetting and drying (with treatment efficiency decreasing substantially after long dry spells, Figure 22). TN concentrations reductions will be maintained at a high level and possibly enhanced by introducing a submerged zone. This zone will provide a water source to sustain plants and microbes during dry spells as well as promote denitrification and therefore a high level of NOx reduction (>90%, Figure 21). However, high load reductions could also be achieved simply by promoting exfiltration (i.e., not lining the system). Therefore, it is recommended that the advantages and disadvantages of lining a system be evaluated (if lining is not required for any other reason than creating a submerged zone).

Removal of heavy metals is consistently high and the standard bioretention system configuration will reduce Zn, Pb, and Cd concentration by more than 90% {e.g. Table 7, \Hatt, in press #780 and see also \Blecken, under review #805; Le Coustumer, under review #810}, and will ensure that the treated stormwater meets at least the ANZECC freshwater guidelines (Blecken et al., under review). Removal of up to 60% of Cu can be expected using the standard design configuration, and over 90% if a submerged zone is incorporated. While the standard design configuration just misses meeting the ANZECC standard for Cu, systems with a submerged zone can be expected to meet these high targets.

Preliminary results also show that bioretention systems may be very effective for the removal of bacteria (E.Coli was used as an indicator), viruses (FRNA phages) and protozoa (C. Perfringens) (Table 8). However, bacteria removal (i.e., E. Coli) is considerably reduced following dry spells. Introduction of a submerged zone improved E.Coli removal (Table 9) by buffering against the impact of dry weather spells, but resulted in a considerable decrease in removal of viruses (FRNA phages, Table 9). The preliminary results suggest that, if bioretention systems are to be used for treatment of harvested stormwater, and very high levels of pathogens in the inflow are present (the cases tested in Activity 1.03), additional disinfection may be required (to achieve water quality for safe use). However, disinfection may not be necessary if inflows have rather modest levels of pathogens (although this is still to be tested).

Importantly, treatment performance will also be reduced if the bioretention system is small relative to its catchment. Whilst no definitive guidance is yet available, a sizing of around 2% of the catchment area appears to give satisfactory treatment performance.

## Attachment B

*Schedule 2*

*Part B – Performance Report*

| **B. PERFORMANCE REPORT** | | | |
|---|---|---|---|
| **Facility for Advancing Water Biofiltration** | **Progress Achieved v Planned Program Milestones** | | **OUTLOOK**<br>**List any issues impacting the progress of planned activities or changes in milestones and dates.** |
| | **Program Milestones/ Performance Indicators/ Activities Planned**<br>**(September 2006 Quarter)** | **For specified activities planned**<br>**Result Achieved/Not achieved** | |
| Task 1 – Management | | | |
| M1.1 Establishment of UJV 1-Aug-05 | A1.1 Establishment of the Board | Board established under Unincorporated Joint Venture Agreement. | |
| | A1.2 Appointments of CEO, BM, RM, MTCM, | Appointments of CEO, BM, RM, confirmed at Board meeting of 16 Sept 2005. MTCM appointment deferred. | |
| | A1.3 Appointment of RAC | Research Advisory Committee established under joint venture agreement. Met as Review Panel, Sept 2006. | |
| | A1.4 Signing the UJV contract and collaboration agreements | UJV Agreement signed 2 August 2005. Collaboration agreements signed over period December 2005 to May 2006.<br><br>Joint Venture Agreement between Monash and Ecological Engineering (EE) amended on 31 March 2008 by which the parties agreed that EE may assign its interest to EDAW. (EE and EDAW are parties to the Acquisition Deed for the transfer of EE's business to EDAW.)<br><br>Novation Deed signed on 31 March 2008 between EDAW (Aust) Pty Ltd, EE and Monash by which the parties agreed to novate the Joint Venture Agreement. Under the Novation Deed, EDAW will be bound by the Joint Venture Agreement as it relates to EE and will enjoy all the rights and benefits conferred on EE under the Joint Venture Agreement.<br><br>The consent of the Minister for Innovation to the novation of the Joint Venture Agreement was noted in the Novation Deed. | |
| M1.2 Decisions on the main business matters (Quarterly) | A1.5 Regular Management Board meetings (Quarterly) | Board meetings held 16 Sept 05, 24 Nov 05, 21 Feb 06, 25 May 06, 7 Sept 06, 23 Nov 06, 16 Feb 07, 24 May 07, 6 Sept 07, 27 Nov 07, 14 February 2008 and 22 May 2008. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned Result Achieved/Not achieved** | |
| Task 1 – Management *(Cont'd)* | | | |
| M1.3 Reports of SAC (Stakeholder Advisory Committee) (4 times in first year) | A1.6a Regular meetings of SAC | SAC meetings held 4 Aug 05, 10 Mar 06, 18 Aug 06. 4th meeting held 20 April 07. 5th Meeting held on 13 Nov 07 as dinner meeting prior to Annual Workshop next day, 14 Nov 07. 6th Meeting held 11 April 2008. | |
| Reports of RAP (Research Advisory Panel)( Once each year) | A1.6b Annual meetings of RAP | Formal panel met on 25 and 26 September 2006. Research Review sessions held during 12-13 and 14 November 2007 with Panel meeting over 12-15 November 2007. | |
| M1.4 Appointment of the staff (Oct 05) | A1.7 Appointment of other staff: RF in plant sci., PhD in soil sci., MSc in crashworthiness, RF in arts, RA for field tests, Lab technician, Programmer | Staff appointed as required in Revised Business Plan.<br>MSc in crashworthiness no longer applicable. Programmer not required.<br>Project Leader, Project 3, appointed. | |
| M1.5 Submission of Progress Report | A1.8 Annual audit<br>A1.9 Reporting to DIIRD (Quarterly) | Annual Audit completed and submitted with October 2006 and October 2007 reports.<br>Reports submitted for four quarters to 30 June 2006; four quarters to 30 June 2007; 30 September 2007, 31 December 2007, 31 March 2008 and this quarter. | |
| Task 2 – Technology Development | | | |
| M2.1 Detailed technology development plan (Oct 05) | A2.1 Refining the research plan | Project research plans submitted October 2005 to Management Board and approved November 2005. Supplementary plans to research plan were completed in May 2007, based on a review of outcomes to date. | |
| M2.2 Design for long term sustainability (30 June 07) | A2.1 Refining the vegetation | On-track: Vegetation trials have are now published in Water Research. The results show that for nutrients particularly, there are key differences in uptake capacity, between species. Delay in writing up of 2nd paper (due to analysis delays), but task is progressing. | |
| | A2.2 Refining filter types | All sampling has ceased.<br>Key findings to date:<br>- TSS removal consistently above 90%, P above 75% and heavy metals above 95%. Nitrogen removal varies substantially with vegetation type (best for Carex and Melaleuca).<br>Further statistical analysis is being undertaken In particular, we are using data from the last two columns to determine:<br>1. The influence of drier conditions on performance<br>2. Effectiveness of retrofitting anaerobic zone; so far this has shown that N removal is increased, but because the anaerobic zone includes soil, it results in a leaching of P. In reality, this would not occur (because the anaerobic zone would not include the soil component)<br><br>Project 1 team is also working with Melbourne Water to test alternative filter media (using washed sand as a base, ameliorated to suit plant requirements). Melbourne Water is providing $85k for this research. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned Result Achieved/Not achieved** | |
| M2.2 Design for long term sustainability (30 June 07) *(Continued)* | A2.3 Refining design for long term sustainability | Batch tests on the column filter media are currently completed. (undertaken by Anke Wendelborn), and analysis has begun; Gavin Mudd is undertaking this. | |
| M2.3 Design for multi-functionality (30 Sept 07) | A2.5 Biofilters for urban developments | Progress against A2.5 is reported in Project 3 (under Milestone Activity 4.3). | |
| | A2.6 Biofilters for stormwater re-use | Results to date (3 runs) show that most design configurations give very good removal (around 95-99.99%), with the exception being those with carbon + saturated anaerobic zone (which result in removals of only 40-60% often). Drought conditions results in a flush of E.coli upon rewetting, whereas the opposition occurs for the coliphages and protozoa. Journal publication of these results is being written. | |
| | A2.7 Biofilters for road safety | Component on crashworthiness and road safety biofilters no longer applicable. | |
| Task 3 – Adoption Facilitation (Policy and Risks) | | | |
| M3.1 Detailed adoption facilitation work plan (30 Oct 05) | A3.1 Refining the adoption facilitation work plan | Outline included in updated Business Plan submitted October 2005.<br>Policy and Risk Project Plan approved by Management Board, Nov 2005. | |
| M3.2 Regulatory, policy and strategic guidance (30 April 06) | A3.2 Regulatory and policy | Project 2 Report on mapping the institutional transition to adoption of WSUD in Melbourne completed.<br><br>Final report published June 2007.<br><br>Industry launch of working document and workshop on 'Transition to WSUD' held 15 Feb 2007.<br><br>Launch and Seminar on Final Report held in Melbourne for government and industry representatives, 23 July 2007.<br><br>Paper presented at 2007 Novatech Conference, France. Final Report available on FAWB website. | |
| M3.4 Assessed risk perception, liability and opportunities (30 Jan 07) | A3.3 Risk perception, liability and opportunities | Online survey conducted and data analysed. Draft copy circulated at FAWB Annual Workshop, November 2007. Final copy launched at National Urban Water Governance Program (NUWGP) Annual Forum in Perth, 7&8 February 2008. Summary report: *'Perceptions of institutional drivers and barriers to sustainable urban water management in Australia. Survey results of urban water professionals across Brisbane, Melbourne and Perth'* available on NUWGP website. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned Result Achieved/Not achieved** | |
| Task 4 – Design Tool Development (now - Adoption Tools) | | | |
| M4.1 Detailed adoption facilitation work plan (15 Nov 06) | A4.1 Refining the design tools work plan | Project 3 Research Plan discussed at 18 August 06 Stakeholders Meeting and approved at 7 September 06 Board.<br><br>Project 3 title is now 'Adoption Tools'<br><br>Project 3 was discussed at the Stakeholders Meeting of 20 April 2007, and at Annual Workshop, 14 November 2007<br><br>The framework of the adoption guidelines has been developed and endorsed by the team. Project Leader Belinda Hatt presented the framework at the annual workshop in 2007. The presentation was followed by a vigorous discussion (involving FAWB's main industry stakeholders).<br><br>Further details on proposed industry and research activities and issues for Project 3: 'Adoption Tools' were outlined and discussed at Stakeholders Meeting No 6 on 11 April 2008. | |
| M4.2 Software for design of biofilters for a wide range of applications (30 Dec 07) | A4.2 Development of software (Design algorithms) | The conceptualisation of the algorithm has started. The model will draw on results from Project 1, and will be tested using results from Project 4.<br>A database to store all the data from Project 1 and 4 activities has been developed.<br>Quantification of the relationships between design elements and pollutant removal has begun and a "first cut" set of algorithms for nitrogen removal, based on filter media type, vegetation and presence or absence of a submerged anoxic zone, has been developed.<br>The next step is to incorporate the influence of other design elements and hydrology into the design algorithms as well as to develop algorithms for suspended solids, phosphorus and heavy metals. | |
| M4.3 Design recommendations (30 April 08) | A4.3 Development of design recommendations | Details of the framework were outlined to the Review Panel and discussed at the Annual Workshop, November 2007. Several meetings have been held and the framework of the guidelines has been drafted. A focus group and workshop to further develop the guidelines was held on 25 February 2008. 11 selected participants from consulting, local and stage government attended.<br><br>The revision of the filter media guideline specifications has been finalised. The revised guidelines were made available on the FAWB website on 14 March 2008. Practice Note 1: 'In Situ Measurement of Hydraulic Conductivity' was developed and added to the FAWB website in May 2008.<br><br>Training workshops were held at: Adelaide, SA, 3-4 June 2008, Sydney, NSW, 10-12 June 2008, Perth, WA, 17-18 June 2008 and Albany, WA, 19-20 June 2008. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned**<br><br>**Result Achieved/Not achieved** | |
| Task 5 – Demonstration and Testing | | | |
| M5.1 Detailed demonstration/testing plan (24 Dec 05) | A5.1 Refining the demonstration and testing plan | Demonstration and Testing Project Plan approved by Management Board, Nov 2005. | |
| M5.2 Novel systems installed (Jan 08) | A5.2 Building of novel systems | FAWB is actively helping VicRoads and Melbourne Water to include novel designs into their tenders for biofilters<br><br>With the Monash University carpark biofilter, in order to test the revised FAWB filter media specifications, the middle cell of the biofilter has been excavated. The excavated media has been analysed for heavy metal concentrations at surface and at depth. Replacement filter media which complies with the latest specifications is currently being sourced and tested. The cell will be planted out with 100% *Carex appressa* .<br><br>Further infiltration testing of the Monash University carpark biofilter. has recently been completed to determine the role of vegetation in assisting the recovery of hydraulic conductivity. Results from this study are being compiled for a paper submitted to the 11th ICUD conference in Edinburgh August 2008.<br><br>Two trial trenches in the Second Ponds Creek (Western Sydney) biofilter have been revegetated to ascertain whether vegetation, coupled with filter media developed from the FAWB specifications, will improve performance at this site. Final planting of *sporobolus virginicus* has been completed with hydraulic testing to commence once vegetation is established. | |
| M5.3 Field data on filter performance (May 08) | A5.3 Field testing of existing and innovative biofilter designs | Field and lab tests have been completed on existing designs. 41 biofilters were tested for hydraulic performance and metal accumulation in Sydney. Brisbane and Melbourne. Metal analyses are still underway to determine levels of toxicants in soils.<br><br>The data analyses on hydraulic performance are finished. A report on this work ('*Hydraulic performance of biofilter systems for stormwater management: lessons from a field study'*) has been produced for Melbourne Water. Copy included in FAWB website, 1 April 2008.<br><br>FAWB has been active in the monitoring of an innovative Brisbane biofilter pod. In October 2007 FAWB conducted a third and fourth storm simulation. Flow and water quality data were collected. With the maturation of the system, and the replacement of the *Dianella* with *Carex*, improved nutrient reduction was achieved. The system already efficiently removed sediment, heavy metal and phosphorous with moderate reductions in nitrogen. However with the implementation of *Carex* the system has now been shown to remove 80% of Nitrogen. Plans are being developed to reconfigure the system with an anaerobic zone | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned**<br><br>**Result Achieved/Not achieved** | |
| Task 6 – Marketing | | | |
| M6.1 Strategic Marketing plan established ( 1Nov 05) | A6.1 Industry/focus group market research - establish market needs and environment (with collaborators) | Agreements with seven FAWB Collaborators, completed: Landcom NSW, Manningham City Council, Melbourne Water, VicRoads. Brisbane CC, Auckland Regional Council (to 30 June 2006), and Adelaide & Mount Lofty Ranges Natural Resources Management Board (see also A7.2) | |
| | A6.2 Establish strategic marketing plans and operational objectives | Strategic Marketing Plan submitted with DIIRD report (Jan 2006)<br><br>Revised Strategic Marketing Plan: 'Strategic Marketing and Stakeholders Management Plan' submitted with Jan 2007 report. | |
| M6.2 Strategic Marketing plan implementation commenced (1 Jan 06) | A.6.3 Internal marketing - establish consistent and robust messages and cultures within the Facility team and collaborators/partners | Board meetings, Stakeholder Advisory Committee meetings, and Annual/ Research Workshops (Dec 2005, Sept 2006, Nov 2007) have been used to enhance internal marketing. | |
| | A6.4 Utilise email newsletter and promotional material (including static website) to establish Facility branding, profile and positioning | FAWB logo established with letterhead and business cards produced.<br><br>FAWB website came online on 31 March 2006. Brochure 'About FAWB' added 1 June 2006.<br><br>Total of 2,731 successful website hits were recorded for 2005/2006. Total of 23,632 hits to 30 June 2007 for 2006/2007. Total of 43,541 hits for the 12 months to 30 June 2008.<br><br>FAWB was a sponsor of the International Conference on Urban Drainage Modelling (UDM) and Water Sensitive Urban Design (WSUD), 3-7 April 2006. A FAWB display booth was prepared and set up at the UDM/WSUD Conference. The display featured project information and an experimental set-up of a biofilter column.<br><br>Launch of FAWB held 17 October 2006 with over 350 invitations issued including invites to all Victorian Local Gov Councils.<br><br>Parliamentary Delegation Tour held by FAWB at Monash 26 February 2007.<br><br>Closer links with the Victorian Government were developed with the visit by members of the Victorian Cabinet for Bio Tech Cabinet Forum to Monash, on 12 February 2008. Assoc Prof Ana Deletic, Research Manager FAWB; and Belinda Hatt, Project Leader FAWB; gave a presentation to the delegation on FAWB, work on sustainable water resources, and proposals for the future, including further research on biofiltration. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned**<br><br>**Result Achieved/Not achieved** | |
| M6.3 Marketing and promotion activities targeting broader stakeholders including industry practitioners and professional associations (1 Sep 06) | A6.5 Preparation of technical and industry targeted reports to establish understanding and confidence in technology as appropriate | A brochure on FAWB and its activities was prepared with copies being handed out at the International Conference on Urban Drainage Modelling (UDM) and Water Sensitive Urban Design (WSUD), 3-7 April 2006..<br><br>Project 2 Report on mapping the institutional transition to adoption of WSUD in Melbourne published as working document, February 2007.<br><br>FAWB workshop held on 15 February 2007 in conjunction with the release of Project 2 WSUD working document. Final Report published in June 2007. (Launched on 23 July 2007)<br><br>Guideline Specification for soil media prepared to assist planning, design, construction and operation of biofiltration systems. Available on FAWB website July 2006. (See also A7.6). 175 downloads for 2006/07; 754 downloads for 12 months to 30 June 2008. Revised guidelines were published on the website on 14 March 2008 and subscribers notified.<br><br>FAWB prepared a practice note for the In Situ Measurement of Hydraulic Conductivity to assist practitioners with the assessment of the hydraulic performance of bioretention systems. Placed on website 2 May 2008. This test method is designed to complement FAWB's Guidelines for Soil Filter Media in Bioretention Systems and is accompanied by a set of example calculations (also available via the above link).<br><br>Conference papers written for International Public Works Conference (Cairns, Australia, August 2007), NovaTech'07 (Lyon, France, June 2007) (12 papers presented by FAWB-related staff at Lyon). Substantial number of papers submitted to 11th International Conference on Urban Drainage, 11ICUD to be held in Edinburgh, Scotland, in September 2008. Journal papers also prepared and accepted or in review stages. | |
| | A6.6 Establish regular series of presentations and/or technical workshops to create awareness and understanding/implications of research results | In association with Clearwater and Melbourne Water, FAWB prepared and presented four one-day training courses on "Implementing Water Sensitive Urban Design" on:-<br>- 30 August 2006 (Civic Centre, City of Casey, Narre Warren)<br>- 7 September 2006 (The Mansion, Werribee)<br>- 8 September 2006 (Emu Bottom Homestead, Sunbury)<br>- 15 September 2006 (Melbourne Business School, Mt Eliza<br>Industry launch of report and workshop on 'Transition to WSUD' held 15 Feb 2007. Final report launched 23 July 2007 with seminar on findings.<br><br>Workshops on WSUD – 'Design of Rain Gardens' held in conjunction with Clearwater on 4, 5 September 2007(Monash, Clayton Campus)<br>Training workshops on FAWB findings and biofilter design were held at: Adelaide, SA, 3-4 June 2008, Sydney, NSW, 10-12 June 2008, Perth, WA, 17-18 June 2008 and Albany, WA, 19-20 June 2008. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned**<br><br>**Result Achieved/Not achieved** | |
| M6.3 Marketing and promotion activities targeting broader stakeholders including industry practitioners and professional associations (1 Sep 06) *(Continued)* | A6.7 Annual planning/reporting w/shop | Planning workshop held December 2005.<br>Second Annual Workshop held 26 September 2006.<br>Third Annual Workshop held on 14 November 2007. | |
| | A6.8 Contribute articles/presenters to high profile events and publications within the target market | *Articles*<br>1. Article published in CSIRO Ecos magazine, April-May 2006.<br>2. MONASH MEMO: News and information for Monash University staff, 25 October 2006. Article on: 'Biofilter garden unveiled at Clayton - A biofilter garden that collects and filters stormwater has been unveiled at the Clayton campus by the Victorian Parliamentary Secretary for Innovation and Industry, Mr Matt Viney.'<br>3. Stormwater Industry Association Victoria 'SIAV E-News' Thu, 09 Nov 2006. Article on FAWB opening and launch by the Minister for Innovation and Industry, Matt Viney, on 17 October. In the article it was noted that: 'Several SIAV Committee members were at the launch and we will work with FAWB to disseminate key outcomes of this important research.'<br>4.Article , Monash Magazine, Issue 18, November 2006, , Spring/Summer 2006 'Trickle Down Technology'<br>*FAWB Seminars, Public presentations November 2006*<br>a) Assoc Prof Ana Deletic presented a workshop on the 'Facility for Advancing Water Biofiltration' at the Annual Stormwater Industry Association Victoria, SIAV Seminar: 'The Stormwater Alternatives' held Tuesday 14 November 2006 at the Corporate Centre, Manningham City Council, Doncaster<br>b) Assoc Prof Ana Deletic, Dr Tim Fletcher and Dr Rebekah Brown gave presentations on FAWB and its research projects at a seminar held by the Victorian Water Engineering Branch, Engineers Australia, on Wednesday 22 November 2006 at Engineers Australia, North Melbourne.<br>Industry launch of report and workshop on 'Transition to WSUD' held 15 Feb 2007 with presentations by Dr Rebekah Brown, Dr Tony Wong, and Jodi Clarke.<br><br>Article in the 'Monash Memo' 14 March 2007<br>'Parliamentary delegation visits key projects<br>Piece in: National Urban Water Governance Program<br>www.urbanwatergovernance.com Newsletter, April 2007 Number 5, 'Transition to a Water Sensitive City'<br><br>In June 2007, presentations/seminars were given by FAWB CEO, Research Manager and/or Project Leaders to University Research Groups and Gov Industry Agencies in UK, Netherlands and Singapore.<br><br>Article in Monash Memo 25 July 2007<br>'Melbourne as a model for sustainable stormwater management'. (Launch of report by Dr Rebekah Brown and Ms Jodi Clarke, from the University's School of Geography and Environmental Science and Facility for Advancing Water Biofiltration, authors of Transition to Water Sensitive Urban Design: The Story of Melbourne, Australia.) | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK<br>List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/<br>Performance Indicators/<br>Activities Planned<br>(September 2006 Quarter)** | **For specified activities planned<br><br>Result Achieved/Not achieved** | |
| M6.3 Marketing and promotion activities targeting broader stakeholders including industry practitioners and professional associations (1 Sep 06) *(Continued)* | A6.8 Contribute articles/presenters to high profile events and publications within the target market *(Continued)* | Article: 'Device to help improve health of rivers' in 'Port Phillip Leader' 14 August 2007, on project of FAWB PhD scholar Yaron Zinger.<br><br>Article: 'L'Australie, un pays sec gros consommateur d'eau' in the French technical journal 'Hydroplus' (for August – September 2007) following an interview in France with FAWB Project Leader, Dr Tim Fletcher.<br><br>Presentations to Australian Water Association (AWA), Stormwater Industry Association of Victoria (SIAV) seminar on 'Climate change and stormwater opportunities', 22 November 2007:<br>• Ana Deletic, Monash University: Researching for improved Stormwater outcomes<br>• Peter Breen, Ecological Engineering: Cities as Catchments: As Illustrated by Royal Park Wetland and Stormwater Reuse System<br>• Belinda Hatt Monash University: Advancing Stormwater Biofiltration<br><br>Presentation to Tri-University Advanced Research Workshop 2007<br>6, 7 December 2007, Monash University: [The Tri-University workshop is convened by Monash University, Central South University, China, and Wuhan University of Technology, China]<br>• Tim Fletcher, Y. Zinger, A. Deletic , Katia Bratières: Biofiltration Technologies for Treating Polluted Waters: Results of a Large Scale Laboratory Study<br>• Ana Deletic and Tim Fletcher : Urban Water Sustainability; Focusing on Stormwater<br><br>Article: 'Joint winners of Vice-Chancellor's Early Career Researcher Awards' in the Monash Memo, 12 December 2007.<br><br>As noted under A6.4, members of the Victorian Cabinet for Bio Tech 'Cabinet Forum' visited Monash on 12 Feb 08, Assoc Prof Ana Deletic and Belinda Hatt, gave a presentation to the delegation on FAWB, work on sustainable water resources, and proposals for the future, including further research on biofiltration.<br><br>The magazine 'Urban: Sustainable Solution for a Developing Australia', featured a four-page article entitled 'A Storm of Innovation' in its January 2008 edition. The article covered the FAWB report 'Transition to Water Sensitive Urban Design: The Story of Melbourne, Australia' by Assoc Prof Rebekah Brown and Jodi Clarke launched in July 2007. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned**<br><br>**Result Achieved/Not achieved** | |
| M6.3 Marketing and promotion activities targeting broader stakeholders including industry practitioners and professional associations (1 Sep 06) *(Continued)* | A6.8 Contribute articles/presenters to high profile events and publications within the target market *(Continued)* | As part of Monash University's 50th Anniversary Public Lecture Series, the Faculty of Engineering presented a forum on 'Sustainable water futures for Melbourne' on 22 April 2008, at the BMW Edge Theatre at Federation Square. Over 200 guests including Monash alumni, members of the public, guests from the water and energy industry, Monash staff and students attended. FAWB was represented by Assoc Prof Ana Deletic, and Dr Gavin Mudd, two of the four Monash speakers. *(Article in Monash University, Faculty of Engineering website, 6 May 2008)*<br>Assoc Prof Ana Deletic and Dr Tim Fletcher gave presentations on Monash research capabilities in water and energy, including FAWB, at a high level meeting on 6 May 2008 between GE and Monash. GE Global Research, New York; GE Infrastructure; and GE Australia & NZ were represented. | |
| | A6.9 External marketing - build industry conviction/confidence in the research outcomes through practical demonstration and monitoring | Launch of Monash Carpark Biofilter held on 17 October 2006 with substantial invitation list to industry. Over 350 invitations to launch sent out, including invitations to Mayor, CEO and Director Environment/ Infrastructure for all Vic Local Councils Site inspection offered with launch of FAWB at Monash Carpark Biofilter. Considerable interest in Carpark biofilter by audience including local gov reps.<br>Soil spec on website and conference participation also used to build confidence in research outcomes.<br><br>Good Industry representation at FAWB workshop held in conjunction with the release of Project 2 WSUD working document 15 February 2007.<br><br>The Parliamentary Secretary for Industry and Innovation, Mr Tony Lupton, led a parliamentary delegation on a tour of FAWB facilities at Monash on Monday 26 February 2007.<br>Government Representatives briefing and tour of FAWB facilities held 2 July 2007.<br>Over 500 invitations sent out for to local government, consultants and Vic government agencies staff for Launch and Seminar for report on 'Transition to WSUD' held in Melbourne on 23 July 2007. The Parliamentary Secretary for Industry and Innovation, Mr Tony Lupton, launched the report.<br><br>Visit by delegation from Dutch Ministry of Economic Affairs, and Canberra Embassy, 18 October 2007. | |
| M6.4 Industry field days, training courses and site visits delivered and well attended (1Oct 07) | A6.10 Develop industry capacity and confidence to utilise software and other tools developed from research outputs | As in A6.9, Launch of FAWB held 17 October 2006 with over 350 invitations issued including invites to all Vic Local Gov Council. Launch of FAWB and opening of Monash Biofilter combined with tour of biofilter and offered tours of lab-based research facility. Attendance of over 50 at Launch.<br>Parliamentary Delegation Tour held by FAWB at Monash 26 February 2007.<br><br>Workshops on WSUD – 'Design of Rain Gardens' held in conjunction with Clearwater on 4, 5 September 2007(Monash, Clayton Campus)<br><br>Training workshops on FAWB findings and biofilter design were held at: Adelaide, SA, 3-4 June 2008, Sydney, NSW, 10-12 June 2008, Perth, WA, 17-18 June 2008 and Albany, WA, 19-20 June 2008. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned**<br><br>**Result Achieved/Not achieved** | |
| Task 7-Commercialisation | | | |
| M7.1 Revised Strategic Marketing Plan (1 Jul 07) | 7.1 Refine the Strategic Marketing Plan and alignment with Business Plan to support potential commercialisation | Updated and Revised Business Plan forwarded to DIIRD on 31 May 2007. | |
| M7.2 Commercialisation plan completed (1 Sept 07) | A7.2 Establish and recruit key industry stakeholders with interest in development and commercialisation | Agreements with seven FAWB Collaborators, completed: Landcom NSW, Manningham City Council, Melbourne Water, VicRoads. Brisbane CC, Auckland Regional Council (to 30 June 2006), and Adelaide & Mount Lofty Ranges Natural Resources Management Board (see also A6.1)<br><br>Government Representatives briefing and tour of FAWB facilities held 2 July 2007. 14 design and management staff from Depts of Innovation, Industry & Regional Development, Human Services, Sustainability and Environment, and Environment Protection Authority attended.<br>70 industry and R&D participants from consulting engineering, landscape architecture, plumbing industry, and local government were briefed on FAWB projects, activities and technologies at the Rain gardens design training held in conjunction with Clearwater, 4, 5 September 2007.<br>FAWB Stakeholders and other industry collaborators participated in Annual Workshop, 14 November 2007.<br><br>An extensive schedule of presentations to potential water industry partners or stakeholders was undertaken by the FAWB leadership group during April to June 2008 regarding the proposal for future research entitled 'Cities as Water Supply Catchments'. An outline of the program is shown below with the main presenters listed:<br>- 7 April 2008, Over 20 staff of DIIRD, DSE, Treasury and State Cabinet. (Dr Tony Wong, Assoc Prof Ana Deletic)<br>- 24 April 2008, Councillors and Executive of the City of Manningham including the Mayor and the CEO of Manningham City Council(Assoc Prof Rebekah Brown, Assoc Prof Ana Deletic)<br>- 24 April 2008, Dr Phillip Johnstone, Director Sustainability, Recycling and Innovation, Office of Water, Department of Sustainability and Environment, Victoria (Dr Tony Wong, Assoc Prof Rebekah Brown, Dr Tim Fletcher, Assoc Prof Ana Deletic)<br>- 30 May 2008, Melbourne Water senior group including Chair Cheryl Batagol, Managing Director Rob Skinner, and Gen. Mgr Chris Chesterfield . (Dr Tony Wong, Assoc Prof Rebekah Brown, Dr Tim Fletcher, Assoc Prof Ana Deletic)<br>- 2 June 2008, Department of Sustainability and Environment (Dr Tony Wong,Assoc Prof Rebekah Brown, Dr Tim Fletcher, Assoc Prof Ana Deletic)<br>- 4 June 2008, Water Services Association of Australia (WSAA), Executive Director, (Dr Tony Wong, Assoc Prof Ana Deletic)<br>- 5 June 2008, National Water Commission and officers of the Department of Environment, Water, Heritage and the Arts (Follows earlier submission of a full research proposal to the National Water Commission) (Dr Tony Wong, Assoc Prof Rebekah Brown, Dr Tim Fletcher, Assoc Prof Ana Deletic)<br>- 25 June 2008, Department of Innovation, Industry and Regional Development (DIIRD) Executives, (Dr Tony Wong, Assoc Prof Ana Deletic) | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned**<br><br>**Result Achieved/Not achieved** | |
| Task 7-Commercialisation *(Cont'd)* | | | |
| M7.2 Commercialisation plan completed (1 Sept 07) *(Cont'd)* | A7.3 Review in detail identified market needs and context for application. | Identifying market needs and application of biofilter technology continue as pivotal components of Project 4 'Demonstration and testing'. FAWB has tested novel biofiltration systems constructed by Stakeholders in consultation with FAWB, tested a number of existing systems, and engaged industry on the design, construction, operation and maintenance of biofilters. The infiltration capacities of 41 biofilters were tested in situ at 18 sites in Melbourne, Sydney and Brisbane.<br><br>FAWB Stakeholders, Melbourne Water and Brisbane City Council, have noted that: (a) demonstration projects were a key part of the FAWB Business Plan from the Stakeholders' perspective; (b) without demonstration sites and projects, Stakeholders, local councils, and the urban development industry, would not be able to assess facilities and proceed with the adoption of innovative biofiltration technologies. | |
| | A7.4 For each potential commercialisation product, establish detailed plans for management of legal, financial, marketing and production aspects | Possible external collaborations involving the potential protection and exploitation of intellectual property associated with the second generation of biofilter technology, such as the role of the anoxic zone, were considered. FAWB's aim of providing its information to the public domain had been emphasised in discussions. This approach to intellectual property was seen as consistent with the spirit of the STI Grant. Accordingly, it had been decided not to participate in collaborations where intellectual property would be withheld from industry and other end-users.<br><br>FAWB has continued to provide wide exposure of its findings through its website 'Key messages' and training sessions such as:<br>* 4, 5 September 2007 'Rain gardens design' courses held in conjunction with Clearwater.<br>* Workshops on FAWB findings and biofilter design held at Adelaide, SA, 3-4 June 2008; Sydney, NSW, 10-12 June 2008; Perth, WA, 17-18 June 2008; and Albany, WA, 19-20 June 2008. | |

| Facility for Advancing Water Biofiltration | Progress Achieved v Planned Program Milestones | | OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates. |
|---|---|---|---|
| | **Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)** | **For specified activities planned**<br><br>**Result Achieved/Not achieved** | |
| M7.3 Commercialised products introduced to market (1 Jun 08) | A7.5 Develop prototypes for demonstration & industry testing - work with industry collaborators to refine products to meet target market needs | To be identified, scoped and developed. | |
| | A7.6 Develop market ready products/knowledge in partnership with SMEs and other partners/co-investors | Guideline Specification for soil media prepared to assist planning, design, construction and operation of biofiltration systems. Available on FAWB website July 2006. (See also A6.5). Updated guidelines published 14 March 2008. | |
| | A7.7 Establish clear channels for launch, promotion and delivery of products to market | Links to industry via Collaborators/Stakeholders being pursued.<br>Launch of Monash Biofilter combined with tour of facility Oct 2006..<br>Soil spec on website and conference participation also used to build confidence in research outcomes from July 2006 onwards.<br>Industry launch of report and workshop on 'Transition to WSUD' held February 2007.<br><br>Launch and seminar on 'Transition to WSUD' Final report held 23 July 2007.<br><br>Workshops on Design of Rain Gardens held in conjunction with Clearwater on 4, 5 September 2007 at Monash, Clayton Campus.<br><br>Workshops on FAWB findings and biofilter design held at Adelaide, SA, 3-4 June 2008; Sydney, NSW, 10-12 June 2008; Perth, WA, 17-18 June 2008; and Albany, WA, 19-20 June 2008. | |
| M7.4 Income stream established for Facility (1 Jun 08) | A7.8 Implement industry targeted integrated marketing communications strategy to establish and support product offer in market place. | As noted under A7.3, an extensive schedule of presentations to potential water industry partners or stakeholders was undertaken by the FAWB leadership group during April to June 2008 regarding the proposal for future research entitled 'Cities as Water Supply Catchments'. | |
| | A7.9 Ongoing product support & development. (new product launches or extensions) | Ongoing product support & development falls within the future options for the FAWB joint venture. As discussed by the FAWB Board, a continuing FAWB joint venture could be a partner or participant in a successful 'Cities as Water Supply Catchments' consortium. | |

**Schedule Two**
**MONITORING AND REPORTING –**
**QUARTERLY PERFORMANCE REPORT – AT 30 JUNE 2008**

| **C: BUDGET REPORT** The Budget Report is required to be completed in cash terms (compared to accrual terms) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Budget' denotes planned expenditure as outlined in the Business Plan | Annual Budget ($) | Actual Year to Date Income ($) | Year to Date Expenditure ($) | Year to Date % Variance (provide explanation if >10%) | Total Funds Unexpended To Date ($) | Planned Income for Next Quarter ($) | Budget Next Quarter *Revise where appropriate* ($) |
| STI Allocated Funds | 260,000 | 337,630 | 337,630 | 0 | 0 | 0 | 0 |
| Consortium Contribution Funds | 459,000 | 625,256 | 314,503 | 50 | 310,753 | 0 | 310,753 |
| Total Program Funds | 719,000 (Note 1) | 962,886 (Note 2) | 652,133 (Note 3) | 32 (Note 4) | 310,753 (Note 5) | 0 (Note 6) | 310,753 |

***NOTES TO PART C***

*1. Total Program Funds includes $229k budgeted carry-over from 2006/07 plus $490k budgeted in business plan of 31 May 2007*
*2. Actual income includes $78k from 2006/07 STI in actual total carry-over of $428k from 2006/07 compared with budgeted carry-over of $228k, ie total extra $199k*
*3. Actual expenditure draws on carry-over of $428k from 2006/07 compared with budgeted carry-over of $229k, ie extra $199k*
*4. Variance* =100* (Actual Year to Date Income - Year to Date Expenditure)/ (Actual Year to Date Income).
*(a) STI Allocated Funds Variance*
*Expenditure to 30 June 2008 allocated firstly to 100% of STI Allocated Funds for Year, plus carry-over of $77,630 of STI funds from 2006/07, and balance to Consortium Contribution Funds, giving a variance of 0% for STI Allocated Funds.*
*(b) Consortium Contribution Funds and (c) Total Program Funds Variances*
*Total Program Funds expenditure reflects continuing activity using carry-over funds.*
*5. Total STI funds of $1,460,000 fully expended including $77,630 carry-over from 2006/07.*
*6. Carry-over of $311k from 2007/08 regarded as 'Planned Income' allocated to next quarter. No further Consortium Contribution or STI amounts.*

*The contents of this report, including all attachments, are true and correct in every particular to the best of my knowledge after having made all due enquiries.*
*Signed*:*

**Dr Tony H F Wong**
Chief Executive Officer

*Date: 14 July 2008*
*Name (print):* Dr Tony Wong
*Position:* CEO
*Witness (print):* John Molloy
*Qualification of Witness:* Business Manager

*The report must be signed by the Chief Executive Officer or Chairman of the Board, or other person approved by the Department

## Attachment D

*Schedule 3*

**Program Milestones for the Year 2007-2008**

**Compliance details for each Milestone**

| Milestone | DIIRD Compliance Date |
|---|---|
| • Evidence of completion of experiments directed at long term sustainability of bioretention systems<br>• Completion of commercialisation plan, as outlined in the Business Plan | 15 October 2007 |
| • Evidence of accessibility/sharing arrangements to the facility<br>• Evidence that the adoption facilitation work plan has been completed<br>• Evidence of completion of design for multifunctional biofilters<br>• Evidence of completion of design recommendations and algorithms for design software | 15 January 2008 |
| • Evidence of product development and commercialisation activities<br>• Evidence that the field testing at demonstration sites has concluded | 15 April 2008<br>15 April 2008 |
| • Evidence of accessibility/sharing arrangements to the facility<br>• Evidence of product development and commercialisation activities | 15 July 2008<br>15 July 2008 |

**Program Milestones**
**Period : 1 July 2007 to 30 September 2007**

| Milestone | DIIRD Compliance Date |
|---|---|
| • Evidence of completion of experiments directed at long term sustainability of bioretention systems<br>• Completion of commercialisation plan, as outlined in the Business Plan | 15 October 2007 |

*Evidence of completion of experiments directed at long term sustainability of bioretention systems*

As set out in Schedule 2, relevant Program Milestones for long term sustainability are:

A2.1 Refining the vegetation

A2.2 Refining filter types

A2.3 Refining design for long term sustainability

A2.1 Refining the vegetation

Findings from Vegetation trials are now in press in an article in Water Research. The results show that for nutrients particularly, there are key differences in uptake capacity, between species.

A2.2 Refining filter types

Six sampling runs have been conducted to date, including conductivity testing.

Key findings to date:

1. On average, >90% of TSS is removed.
2. TP is removed effectively ( 80%), even by columns without vegetation.
3. The best nitrogen removal is consistently by Carex, but Melaleuca is now producing similar results (up to 70% removal).
4. Metals are very effectively removed (>90%) by all columns; in general metals are taken up by the soil media.
5. During long dry periods, ongoing production of nitrate can result in a 'flushing' of built up nitrogen during the first wetting event.

6. Addition of an anaerobic zone will increase nitrogen removal somewhat, and will enhance plant survival during drought periods. It will also minimise any leaching of nitrogen which may otherwise occur after a long drought period. Fortunately, the anaerobic zone appears also to increase removal of heavy metals.

The project team was testing:

1. Can the differences observed between species be explained by differences in roof architecture, or by microbial fungal relationships? (using root-imaging)
2. Will species which performed poorly, perform better under drier conditions? (using changed wetting/drying regimes)
3. Will modifying poorly performing columns to include an anaerobic zone significantly improve their performance? (Columns have been modified to have an anaerobic zone retrofitted.)

A2.3 Refining design for long term sustainability

Batch tests on the column filter media are currently now underway (undertaken by PhD scholar Anke Wendelborn), and the results should be available in the second half of 2007.

*Completion of commercialisation plan, as outlined in the Business Plan*

As set out in Schedule 2, relevant Program Milestones for completion of the Commercialisation Plan are:

A7.2 Establish and recruit key industry stakeholders with interest in development and commercialisation

A7.3 Review in detail identified market needs and context for application.

A7.4 For each potential commercialisation product, establish detailed plans for management of legal, financial, marketing and production aspects

Establish and recruit key industry stakeholders with interest in development and commercialisation

Agreements with seven FAWB Collaborators, completed: Landcom NSW, Manningham City Council, Melbourne Water, VicRoads. Brisbane CC, Auckland Regional Council (to 30 June 2006), and Adelaide & Mount Lofty Ranges Natural Resources Management Board (see also A6.1)

Government Representatives briefing and tour of FAWB facilities held 2 July 2007. 14 design and management staff from Depts of Innovation, Industry & Regional Development, Human Services, Sustainability and Environment, and Environment Protection Authority attended.

70 industry and R&D participants from consulting engineering, landscape architecture, plumbing industry, and local government were briefed on FAWB projects, activities and technologies at the Rain gardens design training held in conjunction with Clearwater, 4, 5 September 2007.

Review in detail identified market needs and context for application.
Identifying market needs and application of biofilter technology continue as pivotal components of Project 4 'Demonstration and testing'. FAWB has tested novel biofiltration systems constructed by Stakeholders in consultation with FAWB, tested a number of existing systems, and engaged industry on the design, construction, operation and maintenance of biofilters. The infiltration capacities of thirty-seven biofilters were tested in situ at 18 sites in Melbourne, Sydney and Brisbane.

FAWB Stakeholders Melbourne Water and Brisbane City Council have noted that: (a) demonstration projects were a key part of the FAWB Business Plan from the Stakeholders' perspective; (b) without demonstration sites and projects, Stakeholders, local councils, and the urban development industry, would not be able to assess facilities and proceed with the adoption of innovative biofiltration technologies.

For each potential commercialisation product, establish detailed plans for management of legal, financial, marketing and production aspects
Possible external collaborations involving the potential protection and exploitation of intellectual property associated with the second generation of biofilter technology, such as the role of the anoxic zone, were considered. FAWB's aim of providing its information to the public domain had been emphasised in discussions. This approach to intellectual property was seen as consistent with the spirit of the STI Grant. Accordingly, it had been decided not to participate in collaborations where intellectual property would be withheld from industry and other end-users.

FAWB has continued to provide wide exposure of its findings through its website 'Key messages' and training sessions such as the 4, 5 September 2007 'Rain gardens design' courses held in conjunction with Clearwater.

**Program Milestones**
**Period : 1 October 2007 to 31 December 2007**

| Milestone | DIIRD Compliance Date |
|---|---|
| • Evidence of accessibility/sharing arrangements to the facility<br>• Evidence that the adoption facilitation work plan has been completed<br>• Evidence of completion of design for multifunctional biofilters<br>• Evidence of completion of design recommendations and algorithms for design software | 15 January 2008 |

*Evidence of accessibility/sharing arrangements to the facility*

Introduction

Accessibility/sharing arrangements continue to be strengthened with joint work with stakeholder collaborators, industry and other groups.

In addition to the arrangements and activities set out in the July 2007 report, there has been ongoing access and sharing with collaborators, industry and other stakeholders through:

- Access to FAWB technology through Training workshops for industry, September 2007
- Visits to FAWB, July, October 2007
- Stakeholders meeting, November 2007
- Collaborator and industry participation at Annual Workshop, November 2007

Access to FAWB technology through Training workshops for industry, September 2007

FAWB presented a one-day seminar on biofilters or 'Raingardens', arranged in conjunction with Clearwater, on 4 September 2007 attended by over 70 people from local government, state departments and consulting. The seminar presented a comprehensive summary of the key research findings from Projects 1 and 4.

In conjunction with Ecological Engineering/EDAW and Clearwater, FAWB ran a one-day design workshop on biofilters on 5 September 2007 attended by 30 people. Participants had been invited to bring in their projects as case studies. Working in small groups, the workshop focussed on applying the research insights presented in the previous day to their projects.

Visits to FAWB, July, September, October 2007

In addition to the tours of FAWB facilities at Monash by the participants of the 'Raingardens' workshops on 4 and 5 September 2007, there were visits by:

*Government Representatives, 2 July 2007*
Representatives from Dept Human Services, Dept of Sustainability and Environment, DIIRD and the Environment Protection Authority visited FAWB on Monday afternoon 2 July 2007. The visit by the group of thirteen related to the Parliamentary Delegation tour in February 2007 and the interest shown by Members of Parliament in applying the technology in their constituencies, for example, to redevelopment activities at public hospitals.

*Singapore's Public Utilities Board and National Parks Board, 11 September 2007*
The visit by the Singapore PUB and NParks delegation was associated with a FAWB current initiative in providing technical advice in the establishment of a research facility in Singapore modelled after the research programs of FAWB and the CRCCH for water sensitive urban design.

*Dutch Ministry of Economic Affairs delegation, 18 October 2007*
The visit by the Ministry of Economic Affairs of the Netherlands delegation was associated with the delegation's fact finding mission on the Victorian model for promoting and facilitating technological innovation in industry through its Science Technology and Innovation.

The FAWB CEO, Research Manager and Project Leaders discussed the FAWB research and adoption activities with the delegation.

Stakeholders meeting, November 2007

Also coinciding with the annual workshop was a dinner and the six-monthly meeting of the Stakeholders (Meeting No. 5). This dinner meeting was attended by FAWB project leaders and representatives from five of FAWB's six Industry Collaborators (with an apology from Landcom).

FAWB CEO Dr Tony Wong outlined FAWB activities to the group.

FAWB Stakeholder representatives also participated in the annual workshop held on the next day,14 November 2007, following the Stakeholders' dinner meeting. All current FAWB Collaborators, ie Adelaide and Mt Lofty Ranges NRM Board, Brisbance City Council, Landcom- NSW, Manningham City Council, Melbourne Water, and VicRoads were represented at the workshop.

Collaborator and industry participation at Annual Workshop, November 2007

A total of 18 participants from industry and collaborator agencies attended the Annual Workshop on 14 November 2007. The total attendance, including research participants, was 52.

Participants were briefed on the current FAWB research findings and activities. Participants also contributed actively to the discussions on the research and adoption approaches.

Industry representatives were:

| *No.* | ***Title*** | ***First Name*** | ***Surname*** | ***Organisation*** |
|---|---|---|---|---|
| 1 | Mr | Keith | Downard | Adelaide and Mount Lofty Ranges NRMB |
| 2 | Mr | Stuart | Hoverman | Brisbane City Council |
| 3 | Mr | Alastair | McHarg | Brisbane City Council |
| 4 | Mr | Damien | Gerrans | Ecodynamics |
| 5 | Dr | Peter | Breen | Ecological Engineering / EDAW |
| 6 | Ms | Kerrie | Burge | Ecological Engineering / EDAW |
| 7 | Dr | Sara | Lloyd | Ecological Engineering / EDAW |
| 8 | Ms | Sally | Taylor | Ecological Engineering / EDAW |
| 9 | Ms | Georgie | Wettenhall | Ecological Engineering / EDAW |
| 10 | Dr | Tony | Wong | Ecological Engineering / EDAW |
| 11 | Mr | Jey | Mahendra | Landcom |
| 12 | Mr | Andrew | Allan | Manningham City Council |
| 13 | Mr | Tom | Duncan | Melbourne Water |
| 14 | Mr | Jake | Moore | Melbourne Water |
| 15 | Mr | Toby | Prosser | Melbourne Water |
| 16 | Ms | Jessica | Franklin | VicRoads |
| 17 | Ms | Brooke | Ryan | VicRoads |
| 18 | Mr | Maarten | De Beurs | Yarra Valley Water |

*Evidence that the adoption facilitation work plan has been completed*

As set out in Schedule 2, relevant Program Milestones for adoption facilitation are:

- M3.1 Detailed adoption facilitation work plan
- M3.2 Regulatory, policy and strategic guidance
- M3.4 Assessed risk perception, liability and opportunities

M3.1 Detailed adoption facilitation work plan

A3.1 Refining the adoption facilitation work plan:

Outline included in updated Business Plan submitted October 2005.

Policy and Risk Project Plan approved by Management Board, Nov 2005.

M3.2 Regulatory, policy and strategic guidance

A3.2 Regulatory and policy:

Project 2 Report on mapping the institutional transition to adoption of WSUD in Melbourne completed.

Final report published June 2007.

Industry launch of working document and workshop on 'Transition to WSUD' held 15 Feb 2007.

Launch and Seminar on Final Report held in Melbourne for government and industry representatives, 23 July 2007.

Paper presented at 2007 Novatech Conference, France. Final Report available on FAWB website.

M3.4 Assessed risk perception, liability and opportunities (30 Jan 07)

A3.3 Risk perception, liability and opportunities:

Online survey conducted and data analysed

Draft survey report prepared, and is currently being reviewed. Draft copy circulated at FAWB Annual Workshop, November 2007.

*Evidence of completion of design for multifunctional biofilters*

Program Milestones for Design for multi-functionality

As set out in Schedule 2, relevant Program Milestones for Design for multi-functionality are:

- A2.5 Biofilters for urban developments
- A2.6 Biofilters for stormwater re-use

A2.5 Biofilters for urban developments:

Progress against A2.5 is reported in Project 3 (under Milestone Activity 4.3).

M4.3 Design recommendations (30 April 08)

*A4.3 Development of design recommendations*

Several meetings have been held and work has started on framing the guidelines. Details of the framework were outlined to the Review Panel and discussed at the Annual Workshop, November 2007.

A2.6 Biofilters for stormwater re-use:

Results to date (3 runs) show that most design configurations give very good removal (around 95-99.99%), with the exception being those with carbon + saturated anaerobic zone (which result in removals of only 40-60% often). Drought conditions result in a flush of E.coli upon rewetting, whereas the opposite occurs for the coliphages and protozoa. The final run of results is yet to be incorporated, and the data will be reported in a journal publication.

Further information design for multifunctional biofilters - Details from Project 4: Demonstration and Testing

Monitoring of the Monash Car Park is coming to its end (FAWB has collected the dataset as planned at the start). FAWB is now planning to retrofit the system and evaluate the impact of anoxic zone retrofits.

The Brisbane pod was again tested in October 2007 and the results are very interesting. The monitored event was preceded by very long dry spell and we found that in this case TN was leaching from the system. This confirmed laboratory findings that even with the right soil specification and plants (ie those that work well for wet periods) the nitrogen removal is not possible after long dry spells. This reinforces the importance of the anoxic zone.

*Evidence of completion of design recommendations and algorithms for design software*

Database for Project 1 and 4 data on design, conceptualisation of modelling algorithms

Project 3: Adoption Tools, Project Leader Belinda Hatt has almost completed a database to store all the data from Project 1 and 4 activities. The conceptualisation of the modeling algorithms has started. The model will draw on results from Project 1, and will be tested using results from Project 4.

Structure of Project 3: Adoption Tools - Presentation by Belinda at Annual Workshop

Project Leader Belinda Hatt outlined the structure of the work on 'Adoption Tools' to the Annual Workshop, 14 November 2007:

*Introduction*

Overall Aim:
- Facilitate implementation of biofiltration technologies into mainstream practice

Key Focus Areas:
- Implementation Issues
- Technical Design
- Practical Implementation

*Technical Design Guidelines*

- Design Algorithms
  - quantify influence of design elements on performance
- Technical Guidance
  - design objectives
  - sizing and layout
  - filter media
  - vegetation
- Specific Guidance
  - e.g. Greenfield, retrofit, climatic regions, catchments with different land-uses

*Guidance for Practical Implementation*

Construction Quality Assurance Protocols
- Draw together experiences from field sites and industry partners

Monitoring and Testing Protocols
- Hydraulic, hydrologic and pollutant removal performance
- What to monitor and how to monitor it
  - e.g. sampling procedures

Maintenance Protocols
- Establishment phase:
  - e.g. weeding and water requirements
- Operation phase:
  - e.g. inspection for signs of hydraulic failure

*Active Adoption*

- Industry training workshops
  - design
  - construction and operation

**Program Milestones**
**Period : 1 January 2008 to 31 March 2008**

| Milestone | DIIRD Compliance Date |
|---|---|
| • Evidence of product development and commercialisation activities | 15 April 2008 |
| • Evidence that the field testing at demonstration sites has concluded | 15 April 2008 |

*Evidence of product development and commercialisation activities*

Product development

FAWB has been focusing on Project 3, 'Adoption Tools', which is aimed at turning the findings from the other three projects (ie 'Technology', 'Policy and Risk', and 'Demonstration Projects') into useful tools for industry. An effort has been put into engaging our industry participants and collaborators in this process. A number of workshops have been organised to support the writing of industry-focused guidelines.

The publication on the FAWB website of the recently revised 'Guidelines for Soil Filter Media in Bioretention Systems', is an example of the further development of this product.

Commercialisation

FAWB has been active in developing proposals for ongoing funding of its activities to support its 'public good' approach to commercialisation.

As noted in 'Schedule 2 – Milestone 13 (Quarter to 31 March 2008), Part A – Summary', recent funding arrangements include:

Smart Water Fund Grant:
Monash Civil Engineering PhD postgraduate David McCarthy, FAWB Research Manager Assoc Prof Ana Deletic, and FAWB Project Leader Dr Tim Fletcher were successful with Monash Epidemiology and Preventive Medicine PhD scholar, Joanne O'Toole, in winning a Victorian Government Smart Water Fund grant. The grant ($249,000 over two years) will be used to conduct a research project entitled "New Technologies for Mitigating Risks of Stormwater Reuse".

Research into Porous Pavements:
FAWB Project Leader Dr Tim Fletcher and FAWB Research Manager Assoc Prof Ana Deletic were successful with other colleagues in attracting and negotiating a research contract with private investors to investigate sustainable water resources aspects of porous pavements. The contract provides funding of $1.2 million.

Cities as Water Supply Catchments:
FAWB leaders are also pursuing collaborative opportunities and funding for research proposals on 'Cities as Water Supply Catchments'. A consortium of interstate researchers with Commonwealth and State funding agencies and industry groups is among the options being discussed.

*Evidence that the field testing at demonstration sites has concluded*

As noted under Schedule 2, Part B, Program Milestone A5.3, 'Field testing of existing and innovative biofilter designs':

Field and lab tests have been completed on existing designs. 41 biofilters were tested for hydraulic performance and metal accumulation in Sydney. Brisbane and Melbourne. Metal analyses are still underway to determine levels of toxicants in soils.

The data analyses on hydraulic performance are finished. A report on this work ('Hydraulic performance of biofilter systems for stormwater management: lessons from a field study') has been produced for Melbourne Water

FAWB has been active in the monitoring of an innovative Brisbane biofilter pod. In October 2007 FAWB conducted a third and fourth storm simulation. Flow and water quality data were collected. With the maturation of the system, and the replacement of the *Dianella* with *Carex*, improved nutrient reduction was achieved. The system already efficiently removed sediment, heavy metal and phosphorous with moderate reductions in nitrogen. However with the implementation of *Carex* the system has now been shown to remove 80% of Nitrogen. Plans are being developed to reconfigure the system with an anaerobic zone.

**Program Milestones**
**Period : 1 April 2008 to 30 June 2008**

| Milestone | DIIRD Compliance Date |
|---|---|
| • Evidence of accessibility/sharing arrangements to the facility | 15 July 2008 |
| • Evidence of product development and commercialisation activities | 15 July 2008 |

*Evidence of accessibility/sharing arrangements to the facility*

Introduction

Accessibility/sharing arrangements continue to be strengthened with joint work with stakeholder collaborators, industry and other groups.

In addition to the arrangements and activities set out in the January 2008 report, there has been ongoing access and sharing with collaborators, industry and other stakeholders through:

- Visit to FAWB, February 2008
- Stakeholders meeting, April 2008
- Other interactions with stakeholders and industry
- Information on FAWB website
- Access to FAWB technology through Training workshops for industry, June 2008

Visit to FAWB, February 2008

*Victorian Cabinet for Bio Tech 'Cabinet Forum' visit to Monash on 12 February 2008*

Members of the Victorian Cabinet for Bio Tech 'Cabinet Forum' visited Monash on 12 February 2008. Assoc Prof Ana Deletic and Dr Belinda Hatt, gave a presentation to the delegation on FAWB, work on sustainable water resources, and proposals for the future, including further research on biofiltration.

Stakeholders meeting, April 2008

Representatives from the FAWB Collaborator organisations: Manningham City Council, Brisbane City Council; Adelaide and Mt Lofty Ranges Natural Resources Management Board, Vic Roads, Landcom - NSW, and Melbourne Water, attended FAWB Stakeholders meeting No 6, held at Monash on 11 April 2008.

FAWB's program of research and adoption was discussed at the meeting.

Key items and presenters included:

- Overview of Research Activities and Report on FAWB Research Review, held November 2007 (Assoc Prof Ana Deletic)
- Research Projects – Progress Update (Project Leaders)
  Project 1 – Technology (Dr Tim Fletcher)
  Project 2 – Policy and Risk (Assoc Prof Rebekah Brown)
  Project 4 – Demonstration and testing (Justin Lewis)
- Outline of proposed further industry and research activities and issues for Adoption Tools, Project 3 (Assoc Prof Ana Deletic and Dr Belinda Hatt)
- Discussion on future collaborative opportunities, particularly beyond June 2008, including research proposal on 'Cities as water supply catchments'. (Dr Tony Wong)

Other interactions with stakeholders and industry

Assoc Prof Ana Deletic and Dr Tim Fletcher gave presentations on Monash research capabilities in water and energy, including FAWB, at a high level meeting on 6 May 2008 between GE and Monash University. GE Global Research, New York; GE Infrastructure; and GE Australia & New Zealand were represented.

As a follow up to the Stakeholders meeting, Assoc Prof Deletic and Assoc Prof Brown were invited to present the findings of FAWB to the Councillors and Executives of the City of Manningham on 8 May 2008.

Mr Craig Wallace, Queensland Minister for Natural Resources and Water and Minister Assisting the Premier in North Queensland met with FAWB staff, Dr Tony Wong, Assoc Prof Rebekah Brown and Dr Tim Fletcher on 22 May 2008. Mr Wallace was briefed on current water issues, including approaches to sustainable urban water management.

Information on FAWB website

A Guideline Specification for Soil Media had been prepared to assist in the planning, design, construction and operation of biofiltration systems. The specification became available on the FAWB website in July 2006. (754 downloads for 12 months to 30 June 2008.) Revised guidelines were published on the website on 14 March 2008 and subscribers notified.

FAWB also prepared a practice note for the 'In Situ Measurement of Hydraulic Conductivity' to assist practitioners with the assessment of the hydraulic performance of bioretention systems. The practice note was placed on the website on 2 May 2008. This test method had been designed to complement FAWB's Guidelines for Soil Filter Media in Bioretention Systems and is accompanied by a set of example calculations.

Overall interest in the FAWB website is reflected in the high level of activity by users. A total of 43,541 hits was recorded for the 12 months to 30 June 2008.

Access to FAWB technology through Training workshops for industry, June 2008

FAWB staff, led by CEO Dr Tony Wong, presented training workshops to stakeholder groups in South Australia, New South Wales and Western Australia.

The two-day workshops provided an update on FAWB research findings and gave training in the design of biofilters.

A report entitled 'Advancing the Design of Stormwater Biofiltration, June 2008' was prepared for the workshops. The purpose of this document was to provide a summary of FAWB's findings to date on biofiltration.

The workshops were held on the following dates, with attendances per day as listed:

| Location, Date | Attendance per day | Participating Organisations |
|---|---|---|
| Adelaide, SA, 3-4 June 2008 | 47, 30 | Stormwater Industry Association, SA; Adelaide and Mt Lofty Ranges Natural Resources Management Board; FAWB; EDAW; Monash / National Wine Centre, Adelaide, SA |
| Sydney, NSW, 10-12 June 2008 | 115, 29, 24 | Sydney Metropolitan Catchment Management Authority; FAWB; EDAW; Monash / Waterview Convention Centre: Bicentennial Park, Sydney Olympic Park, Sydney, NSW |
| Perth, WA, 17-18 June 2008 | 78, 29 | Department of Water, WA; FAWB; EDAW; Monash / Bayswater City Council, Bayswater, Perth, WA |
| Albany, WA, 19-20 June 2008 | 21,16 | Department of Water, WA; FAWB; EDAW; Monash / Midds Bluewater Restaurant, Middleton Beach Albany, WA |

*Evidence of product development and commercialisation activities*

Product development

FAWB has been focusing on Project 3, 'Adoption Tools', which is aimed at turning the findings from the other three projects (ie 'Technology', 'Policy and Risk', and 'Demonstration Projects') into useful tools for industry.

An update on Project 3, 'Adoption Tools' was provided at the FAWB Stakeholders meeting of 11 April 2008. Work to date, and proposed, was discussed.

Since the last FAWB Stakeholders meeting, Project 3 had:

- Updated the soil filter media guidelines
- Run a focus group with a broad cross-section of industry representatives to discuss and refine the delivery of FAWB's research findings
- Begun developing:
  - Design algorithms
  - Design guidelines & accompanying tools

'Key Adoption Tools' could be grouped under:

- Design Algorithms
- Design Guidelines
- Other Adoption Tools

Design Algorithms

The next steps for work on design algorithms included:

- Nitrogen
  - Upgrade wetting/drying component
  - Filter media additives
- Other pollutants
  - Quantify effect of influential design elements
- Hydrology

Design Guidelines
The structure of the 'Design Guidelines' being developed is:

- Volume 1: Introduction
- Volume 2: Policy & Planning
- Volume 3: Technical Design
- Volume 4: Practical Implementation
- Volume 5: Case Studies

Other Adoption Tools
The following topics were planned under 'other adoption tools':

- Practice Notes
  - In situ measurement of hydraulic conductivity
  - Monitoring protocols
- Fact Sheets
- Training Workshops
  - Design

Commercialisation
Support for 'public good' approach to commercialisation:
As noted in the April 2008 report, FAWB has been active in developing proposals for ongoing funding of its activities to support its 'public good' approach to commercialisation.

Cities as Water Supply Catchments:
FAWB leaders continue to pursue collaborative opportunities and funding for future research.

FAWB staff have led the development of a proposal for future research. The proposal, entitled 'Cities as Water Supply Catchments', combines expertise from EDAW and several faculties at Monash University, and also involves the active collaboration of specialists from The University of Melbourne and The University of Queensland.

An extensive schedule of presentations to potential water industry partners or stakeholders was undertaken by the FAWB leadership group during April to June 2008. (Please refer to above list of meetings in Schedule 2, Part A – Summary)

Other discussions and negotiations on biofilter development and potential commercialisation:
FAWB has been involved in discussions and negotiations with:

- Israeli industry and government on biofilter development, including potential funding by the Jewish National Fund (JNF) for a proposed pilot project for a biofiltration system in Israel.
- The Victoria-Israel Science and Technology R&D Fund (VISTECH) regarding a project to develop novel and robust technologies for the recycling of greywater and stormwater.
- Cardno Grogan Richards for FAWB to undertake a trial of prefabricated biofilters using vegetated columns.

FAWB trial of prefabricated biofilters using vegetated columns:
A key impediment to the more widespread adoption of biofiltration systems is the "fussiness" of their construction, in terms of specification and placement of filter media, and the planting and maintenance of plants. In response to this, Cardno Grogan Richards have, in partnership with Australian Ecosystems, developed a concept which involves "pre-growing" the selected vegetation in FAWB-specified filter media (within a nursery situation).

FAWB has developed a proposal for the testing of Cardno Grogan Richards' pre-established biofilter design so determine whether pre-established biofilter soil media/plant arrangement will work effectively in treating stormwater and maintaining hydraulic conductivity over time. Funding arrangements are under discussion

## Financial Information, Audit

### Signed Audit Opinions on Financial Reports and Information for Year ended 30 June 2008 Including Participants Contributions

Copies of signed Audit Opinions provided by the Director, Audit and Risk Management, Monash University, for the FAWB activities for the year ended 30 June 2008 are set out in this section.

Audit Opinions have been provided with respect to the:

- STI Grant Agreement, as addressed to the Minister for Innovation
- Joint Venture Agreement between the Participants Ecological Engineering and Monash University, as addressed to the Board of Management of FAWB
  .

MONASH University

Audit and Risk Management

Report No: 200848
Audit Ref: GRANTS09

10 September 2008

The Minister for Innovation
Department of Innovation, Industry and Regional Development
Level 35, 121 Exhibition Street
Melbourne 3000

**Audit Opinion – The Facility for Advancing Water Biofiltration**

This Audit Opinion is prepared for the purposes of the Grant Agreement entered into by the Parties and dated 22 August 2005.

Scope
We have conducted an independent audit in accordance with Australian Auditing Standards of the attached Statement of Income and Expenditure provided to us that specifies total cash and in-kind expenditure of $2,710,397 on the Program and an amount of $2,290,597 as Matching Contributions towards the Program in order to express an opinion on it for the purposes of the Agreement.

Our audit involved an examination, on a test basis, of evidence supporting the amount of expenditure incurred, including all Grant funds and the amount of contributions (both cash and in kind) received. This included an examination of the financial records and receipts, and an evaluation of the policies and procedures used to calculate the expenditure of the Program and the Matching Contributions. These procedures have been undertaken to form an opinion as to whether the methodology used to calculate the expenditure and these contributions is in accordance with the Agreement, and that the figures stated are true and fair.

The Audit Opinion expressed in this report has been formed on the above basis.

Audit Opinion
I confirm that in my opinion:

- expenditure of $2,710,397 has been incurred on the Program; and
- the Matching Contributions to the Program are $2,290,597 ($232,333 cash and $2,058,264 in-kind)

in accordance with the terms of the Agreement.

Lee Ward
Director Audit & Risk Management

Monash University, VIC 3800, Australia
Building 202, 710 Blackburn Road, Clayton
Telephone +61 3 9905 6921 Facsimile +61 3 9905 6865
www.monash.edu.au
CRICOS Provider No. 00008C ABN 12 377 614 012

FAWB
Facility for Advancing
Water Biofiltration

A joint venture research facility between Ecological Engineering Holdings Pty Ltd and Monash University
under the auspices of the Victorian Government's Science Technology and Innovation Initiative.

**FACILITY FOR ADVANCING WATER BIOFILTRATION**
**SUMMARY OF INCOME & EXPENDITURE**
**For the Year Ended 30 June 2008**

| | $ | $ |
|---|---|---|
| **CASH INCOME** | | |
| State Government Grants | 260,000 | |
| Contributions - Participants (Monash, EE/EDAW) | 77,000 | |
| Contributions - Collaborators | 155,333 | |
| Consulting Income | 30,000 | |
| Other Income | 12,627 | |
| **Total Cash Income** | | **534,960** |
| **CASH EXPENDITURE** | | |
| Salaries | 246,375 | |
| Salary On-costs | 60,330 | |
| Infrastructure | 75,963 | |
| Scholarships | 18,625 | |
| Equipment | 4,986 | |
| Consultants | 61,317 | |
| Operating Supplies | 147,018 | |
| Travel-Australia | 33,713 | |
| Travel-Overseas | 3,806 | |
| **Total Cash Expenditure** | | **652,133** |
| **Cash Surplus/(Deficit)** | | **$ (117,173)** |

I certify that the Cash Income and Cash Expenditure for the Facility for Advancing Water Biofiltration (FAWB) in this summary statement represents a true and fair statement of Cash Income and Cash Expenditure and has been prepared and provided through the SAP financial reporting of Monash University.

Signed: John D Molloy, Business Manager, Facility for Advancing Water Biofiltration (FAWB) Date: 24/07/2008

| | | |
|---|---|---|
| **IN-KIND INCOME** | | |
| Participant Contributions (Monash, EE/EDAW) | 422,265 | |
| Collaborator Contributions | 1,635,999 | |
| **Total In-kind Income** | | **2,058,264** |
| **IN-KIND EXPENDITURE** | | |
| In-kind expenditure, salary and other | 2,058,264 | |
| **Total In-kind Expenditure** | | **2,058,264** |
| **In-kind Surplus/(Deficit)** | | **$ 0** |

I certify that the In-kind Income and In-kind Expenditure for the Facility for Advancing Water Biofiltration (FAWB) in this summary statement represents a true and fair statement of In-kind Income and In-kind Expenditure and has been prepared and provided through the signed and certified statements of in-kind contributions of the Participants and Collaborators.

Signed: John D Molloy, Business Manager, Facility for Advancing Water Biofiltration (FAWB) Date: 24/07/2008

| **Total Expenditure** | |
|---|---|
| Cash | 652,133 |
| In-kind | 2,058,264 |
| **Total Cash plus In-kind Expenditure** | $ 2,710,397 |

Monash University
Department of Civil Engineering
Building 60, Clayton Campus
Monash University, VIC 3800, Australia
**phone +61 3 9905 4957** fax +61 3 9905 5033
fawb@eng.monash.edu.au www.monash.edu.au/fawb

MONASH University

Audit and Risk Management

Report No: 200848
Audit Ref: GRANTS09

10 September 2008

The Board of Management
The Facility for Advancing Water Biofiltration

**Audit Opinion – The Facility for Advancing Water Biofiltration**

This Audit Opinion is prepared for the purposes of the Joint Venture Agreement between Ecological Engineering and Monash University dated 2nd August 2005; and amended by a Deed of Amendment and a Novation Deed dated 31st March 2008.

Scope
We have conducted an independent audit of the attached Summary of Cash and In-kind Contributions provided to us in order to express an opinion on it for the purposes of the Agreement.

Our audit involved an examination on a test basis of evidence supporting the receipt of cash contributions and the calculation of in-kind contributions provided by the Participants.

Audit Opinion
I confirm that in my opinion:

- cash totalling $77,000 has been received by the Program as $67,000 from Monash University and $10,000 from EDAW; and
- in-kind contributions totalling $422,265 have been provided to the Program as $321,047 from Monash University and $101,218 from EDAW.

The figures stated are true, fair and in accordance with the terms of the Agreement.

Lee Ward
Director Audit & Risk Management

Monash University, VIC 3800, Australia
Building 202, 710 Blackburn Road, Clayton
Telephone +61 3 9905 6921 Facsimile +61 3 9905 6865
www.monash.edu.au
CRICOS Provider No. 00008C ABN 12 377 614 012

FAWB
Facility for Advancing
Water Biofiltration

A joint venture research facility between Ecological Engineering Holdings Pty Ltd and Monash University
under the auspices of the Victorian Government's Science Technology and Innovation Initiative.

**FACILITY FOR ADVANCING WATER BIOFILTRATION**
**MONASH UNIVERSITY and EDAW (succeeding ECOLOGICAL ENGINEERING)**
**SUMMARY OF CASH AND IN-KIND CONTRIBUTIONS**
**For the Year Ended 30 June 2008**

| | $ | $ |
|---|---|---|
| **CASH INCOME** | | |
| Monash University | 67,000 | |
| EDAW (succeeding Ecological Engineering) | 10,000 | |
| **Total Cash Income** | | **77,000** |

I certify that the Cash Income from Monash University and EDAW (succeeding Ecological Engineering), Participants of the Facility for Advancing Water Biofiltration (FAWB), in this summary statement represents a true and fair statement of Cash Income from Participants and has been prepared and provided through the SAP financial reporting of Monash University.

Signed: John D Molloy, Business Manager, Facility for Advancing Water Biofiltration (FAWB) Date: 24/07/2008

| | | |
|---|---|---|
| **IN-KIND CONTRIBUTIONS** | | |
| Monash University | 321,047 | |
| EDAW (succeeding Ecological Engineering) | 101,218 | |
| **Total In-kind Contributions** | | **422,265** |

I certify that the In-kind Contributions from Monash University and EDAW (succeeding Ecological Engineering), Participants of the Facility for Advancing Water Biofiltration (FAWB), in this summary statement represent a true and fair statement of In-kind Contributions from Participants and have been prepared and provided through the signed and certified statements of in-kind contributions of the Participants.

Signed: John D Molloy, Business Manager, Facility for Advancing Water Biofiltration (FAWB) Date: 24/07/2008

| | |
|---|---|
| **Total Cash and In-kind Contributions** | **$ 499,265** |

Monash University
Department of Civil Engineering
Building 60, Clayton Campus
Monash University, VIC 3800, Australia
**phone +61 3 9905 4957** fax +61 3 9905 5033
fawb@eng.monash.edu.au www.monash.edu.au/fawb