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HydroCon
Australasia Pty Ltd

HydroCon consortium wins Australian Research Council grant

The Australian Research Council has announced it will be funding an application by the University of Technology Sydney to '*develop a model for confined water sensitive urban design (WSUD) stormwater filtration/infiltration systems for Australian conditions*'.

The project involves the development of a model to predict the environmental and hydraulic performance of the HydroCon Stormwater Treatment and Infiltration System recently installed at Hindmarsh Park, Kiama and the Mills Park Tennis Centre, Asquith, and shortly to be installed at the Weathertex Industrial Estate, Raymond Terrace.

The project involves a consortium of industry and local government partners – Kiama Municipal Council, Hornsby Shire Council, STORM Consulting Pty Ltd, Blenheim Capital Limited and HydroCon Australasia Pty Ltd.

In commenting on the significance and innovation of the project, the ARC considered that "*the significance* [of the project] *is in the integration of stormwater infiltration and filtration designs for Australian conditions. The innovation arises from the development of a confined system that protects surrounding environs and thus* [is] *suitable for a wide range of applications including sensitive environments. This would be an interesting wide-purpose technology of increased worth and flexibility*."

In commenting on the national benefit of the project, the ARC suggested that "*the project has the real potential to deliver a major advance on diffuse and localised pollution control with the potential for downstream reuse, even in sensitive environments (with) the dual potential for environment protection and water reuse*."

Expected outcomes of the project include the clear demonstration of the capacity for a confined composite HydroCon system to treat stormwater to a tertiary level to protect sensitive groundwater and receiving water resources.

The project, which will be administered through the Urban Water Cycle Division of the Institute for Water and Environmental Resource Management (IWERM) at UTS, will be led by Dr Simon Beecham, and involves two other core members of the Institute, Professor S Vigneswaran and Dr H Ngo. HydroCon's R&D Director, Dr Carsten Dierkes, is also a principal investigator in the research program.

The three year project will commence in January 2004.

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Project Title

Full Title
The development of a model for confined water sensitive urban design (WSUD) stormwater filtration/infiltration systems for Australian conditions.

Short title
Investigation of HydroCon Stormwater Treatment & Infiltration System performance under Australian conditions.

Project Collaborators
University of Technology Sydney
STORM Consulting Pty Ltd
HydroCon Australasia Pty Ltd *
Weathertex Pty Ltd *
The Council of the Municipality of Kiama *
The Council of the Shire of Hornsby *

Project Funding
Australian Research Council (ARC) Linkages Project Grant
University of Technology Sydney
Industry Partners *

Research Personnel
Dr Simon Beecham - UTS
Professor S Vigneswaran - UTS
Dr H Ngo - UTS
Dr Carsten Dierkes – HydroCon GmbH
Ms Alison Dunphy – UTS (PhD candidate)

Introduction

In much of urban Australia stormwater is currently viewed as a waste product that requires increasingly larger financial resources for adequate treatment and disposal into receiving waters. Ironically, the same precipitation falling in "pristine" catchments is correctly regarded as a resource, with funds spent on the "protection" and conveyance of runoff water into storage areas where this same water is treated and delivered to urban areas for potable and non-potable uses.

The growing field of Water Sensitive Urban Design (WSUD) in Australia seeks to bring change to the management of water resources, particularly stormwater, through greater understanding and management of the water cycle. Integral to this change is the

development of systems, policies, procedures and educational tools aimed at ameliorating the consequences of increased development on:

- the relative rise in the percentage of impervious urban areas;
- the reduction in quantity and diversity of flora and fauna in suburban and urban areas (particularly as they relate to the water cycle);
- the increased quantities and greater variety of pollutants, such as heavy metals and hydrocarbons, and;
- the increased demand placed on limited potable water resources for both potable and non-potable use.

The decentralised infiltration of stormwater runoff is a sustainable and economical alternative to the classical "kerb and gutter" drainage approach to urban stormwater management. The infiltration of stormwater assists in returning the urban water cycle to its pre-urbanised state. In addition, the storage and (re)use of filtrated stormwater for non-potable uses reduces the burden currently placed on limited potable water resources.

While runoff infiltration and stormwater filtration and (re)use is advantageous, measures need to be adopted to ensure that atmospheric pollutants and pollutants arising from drained surfaces such as roads and industrial areas are adequately treated to protect both groundwater supplies and the public.

Previous environmental monitoring studies undertaken by UTS have shown that WSUD systems are effective at trapping a variety of pollutants conveyed in urban stormwater. However, whilst the HydroCon system has been employed in Germany since 1995, its performance is yet to be proven under Australian conditions. Notwithstanding overseas experience, there is an increasing need to develop an understanding of the pollutant removal processes that occur within these systems. This work has the potential to provide valuable data for pollution retention modelling for software such as MUSIC developed by the Cooperative Research Centre (CRC) for Catchment Hydrology.

Project Summary

The research project involves assessment of the environmental and hydraulic performance of the innovative composite HydroCon Stormwater Treatment & Infiltration System either recently installed or to be installed in a variety of locations in NSW. These locations are:

- Hindmarsh Park, Kiama (constructed)
- Mills Park Tennis Centre, Asquith (constructed)
- Weathertex Industrial Estate, Raymond Terrace (to be constructed Jan 2004)

Each device is designed to capture and separate gross pollutants, including sediments, litter and vegetative matter and provide an increased level of stormwater runoff treatment through mechanical, chemical and biological pollutant removal processes. These processes occur within:

- the pre-filtering diversion pit;
- the specially treated porous concrete HydroCon pipe system, and;

- the underground sand and/or gravel filter.

The treated runoff passing through these devices is required to be of such a quality as to not adversely affect sensitive groundwater and/or receiving water environments, and in some cases, be able to be (re)used for non-potable purposes.

The *Hindmarsh Park Sand Filter* system forms part of a larger initiative by Kiama Municipal Council funded through Stage 4 of the Environmental Protection Authority's Stormwater Trust Grants. The device, surrounded with a filtration media of washed river sand, is intended to capture and treat stormwater runoff generated throughout a 6.54 hectare mixed land-use (commercial, residential and open space) catchment within the greater Black Beach Catchment. Furthermore, it is intended, in accordance with the principles of WSUD, that treated stormwater effluent be stored and (re)used for irrigation purposes along the adjacent foreshore.

The system recently installed adjacent to the car park at the *Mills Park Tennis Centre, Asquith*, receives stormwater runoff directly from the car park, which has a heavy traffic loading. The runoff carries comparatively high proportions of hydrocarbons and heavy metals. Separate sections of the system have been bedded in coarse gravel and washed river sand to enable measurement of the effect of different substrate material on treatment effectiveness. As the entire system is bedded within a filled plateau, the permeability of the surrounding "soil" is relatively high, which will result in lower residence times. The infiltration pipes located in Asquith have been treated with iron oxides to assist in the removal of pollutants through chemical precipitation and ion exchange during the infiltration process.

The proposed stormwater infiltration system for the *Weathertex Industrial Estate, Raymond Terrace* will be located within the open space north of the main buildings on the site. The system will receive roof and some surface flow from the impervious areas surrounding the main pulping and manufacturing plant. Due to the nature of the surrounding activities, surface runoff carries a heavy organics load from the site's wood processing operations and may be expected to contain some oils and/or hydrocarbons resulting from the machinery used around the site. The proposed infiltration system will allow investigation of the ability of the HydroCon system and surrounding media to adequately treat BOD and other pollutants.

Expected Outcomes

The overall objective of the WSUD "philosophy" is to significantly reduce the total runoff and pollutant loads currently discharging from urban areas to receiving waters. The aim is to restore natural hydrological flow regimes and at the same time improve water quality, recreational amenity, aesthetic value, and reduce adverse ecological impacts. An important additional aim is to lower demand on strained potable water supplies for non-potable uses.

Each of the abovementioned projects intends to verify the constructed and proposed devices as an easily maintainable and effective stormwater treatment system, capable of cleansing effluent to a standard such that it may be (re)used for non-potable purposes, including irrigation.

The outcomes of the project include:

- clear demonstration of the capacity for a confined composite HydroCon system to treat stormwater to a tertiary level to protect sensitive groundwater and receiving water resources;
- increased knowledge of the hydraulic and environmental performance of these hybrid systems that will enable the development of an appropriate maintenance schedule to sustain the serviceable life of the system and its components;
- knowledge of the types and quantities of pollutants that occur within the catchment which will enable a targeted approach to stormwater quality improvement within the catchment.
- increased knowledge of the role of microbiological processes in tertiary subsurface stormwater treatment; and
- practical demonstration to the various communities of the principles of WSUD.

Project Plan

The project covers the three year testing period beginning January 2004. However observational monitoring and some initial hydraulic/environmental monitoring may begin in late 2003 at some sites. If required, modular additions to this program in six-month increments are possible providing additional funds become available.

In order to assess the overall effectiveness of the HydroCon system it is proposed to analyse and compare water samples taken from various points throughout and adjacent to the three previously mentioned systems. Water samples for analysis will be collected from:

- the pre-filtering pit (surface flow),
- the flushing inlet at the extreme end of the HydroCon system, and
- three intermediate points within the surrounding media immediately adjacent to the HydroCon system via partially slotted PVC pipes placed along the length of the system (vadose zone).

It is important to optimize the monitoring work to provide only the information required to quantify and qualify the overall system performance. This information can then be used to satisfy relevant authorities that the quality of the effluent from the system is of such a standard as to protect sensitive groundwater/receiving water environments or that it could be (re)used for non-potable purposes, such as open space irrigation, without foreseeable risk to the public.

The initial range of analytes will be dependent upon each individual site and the nature of the catchment that each system services. Analyte positions and numbers will be determined on the basis of discussions with HydroCon, NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) and other stakeholders, throughout the life of the project.

Monitoring of quality of flow into the system (influent), water in the filtering media vadose zone immediately adjacent the HydroCon devices and effluent leaving the systems will occur throughout the duration of the project.

Sampling of surface flow and vadose zone water and groundwater for quality monitoring will be undertaken following storm events. While UTS staff will initially undertake sampling, staff from particular partner organisations may later be involved as appropriate. Samples will be analysed through a UTS-approved technical laboratory. Initially a maximum of 4 events per 6 month period will be sampled. However, if required due to unfavourable/abnormal weather conditions, a higher frequency of sampling may be undertaken towards the latter end of the research project to compensate as conditions permit.

To ensure the protection of the sensitive groundwater environment near systems, groundwater samples will be obtained immediately adjacent to the devices from piezometers installed at intermediate points around each system. Groundwater samples will be compared with those taken at the beginning of the research project.

Samples of residual sediment will be taken from the pre-filtering pit after every 12 months of operation. These will be tested for particle size distributions and various pollutants dependent upon catchment characteristics and will assist in the determination/review of the proposed maintenance schedule.

In order to monitor the migration of pollutants through the systems, particularly the filtration media and into underlying soil matrix, samples from the filtration media immediately adjacent to the HydroCon system will be taken and analysed. There is expected to be limited lateral pollutant migration from the pipe system. As the HydroCon porous concrete pipes contain an impermeable invert, the highest concentration of pollutants is anticipated to be in the media adjacent to the pipes. Pollutant levels within these media/soil samples will be compared with samples taken prior to the commencement of the research project.

As stated previously, an outcome of the project is assessment of the growth and function of microbial communities developing within the surrounding filter matrix. In order to undertake this assessment, UTS will remove for analysis small sections of the surrounding media at approximately 6 monthly intervals ensuring that the carefully bored sections minimize disturbance of microbial communities. If conditions permit, UTS may bore some small sections of the HydroCon pipes to assess the development of microbial communities within the walls of the pipes.

The hydrological efficiency of the system will be assessed through the installation of an orifice controlled outlet in conjunction with a capacitance meter and data logger. Results will be compared with the assessment correlation of catchment size and rainfall measurements taken from a tipping bucket rain gauge to be installed at the site and also nearby government and privately owned rain gauges. A rainfall collection container will be included with the tipping bucket rain gauge for chemical analysis and comparison.

During extended dry periods or extended periods of intermittent light rainfall, the pre-filtering pit may be monitored for the collection and/or growth of unwanted vegetation that may occasionally establish itself within collected sediments.

During sampling events, UTS staff will observationally monitor the operation of the pre-filtering pit, the flushing inlet and the infiltration area to ensure the system is operating correctly. During extended wet weather, project partner staff may undertake a daily system check to ensure the system is free from blockages and is functioning correctly.

Quality Assurance

A Quality Assurance Project Plan will be prepared to cover all on-site operations. Field verification samples will be taken to assess the accuracy of analytical results. These samples will consist of the following:

- field duplicates - taken primarily to check sample and laboratory techniques;
- trip blanks - used to check whether samples absorb any chemicals in transportation between site and laboratory;
- container blanks - taken to check container preparation;
- equipment blanks - taken to check whether the equipment is contributing to contamination of the samples.

A further quality control mechanism will be the implementation of chain of custody records for all samples. The project work will be audited periodically to ensure the stated quality objectives are being met.

Health and Safety

All site personnel will be briefed on appropriate health and safety issues. This will include operational precautions, such as appropriate handling of monitoring and cleaning equipment. All collected pollutants will be handled and disposed of in a responsible manner, and all procedures will be recorded in a site log book.

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