Aqua Australis

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The biggest waste of water in the country by far. You spend half a pint and flush two gallons.
Prince Phillip 1965

The Hydrological Society of South Australia, c/- Water Resources Group, Department of Environment and Natural Resources, GPO Box 1047, Adelaide, South Australia 5001. Email bvanderwel@denr.sa.gov.au

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Stormwater in the next millennium: exportable innovations in stormwater management.
Seminar, pre-conference tour and trade exhibition organised by the Hydrological Society of South Australia 23 October 1997 at the University of South Australia, the Levels.

Register with
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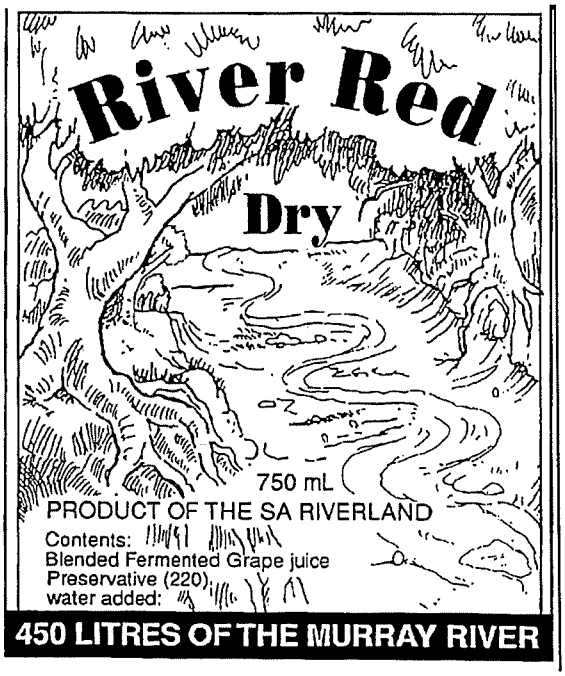
$65 early registration



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Chairman's Message

Drought and floods are getting an increasing media coverage. The world is awash with reports on them. However the amount of money in collecting basic data is dwindling. Sections that used to do a wonderful job in maintaining and operating data collection facilities have been decimated. The need to collect information on water resources needs to be given a high priority by government departments and catchment boards. Funds need to be directed so that researchers and data collectors can both collect and analyse water quality and quantity information. Value can be added to the data if analysts are given sufficient funds either in the form of postgraduate scholarships for academic institutions and employment of young graduates in government and consulting firms.

The quality of the information that is being archived also needs to be examined. As a variety of collectors are employed the variation in both quality and quantity data is increasing. Users of this information should be concerned at the quality of the data but generally a user is just happy to have a bit of data. Is that satisfactory? I think not and there needs to be a much more concerted effort at bringing common standards into data collecting agencies and groups. The elimination of funding for any gauging stations needs to be rigorously examined. The high cost-benefit nature of hydrological information has been proved in a number of studies. Let us get the value from our data.

The ENSO continues onwards ensuring drought persists in the eastern states. The rainfall in SA however appears to be linked to both the Indian and Pacific Ocean Sea surface temperatures. Funding investigations on these relationships is surely needed. The local media needs to become correctly informed about how best can we improve the lot of the farmer trying to make decisions on seeding, how best to save pumping costs by water supply operators by streamflow and water quality prediction, how best to restrict flood damage by comprehensive flood forecasting, how best to improve water quality from urban catchments.....data would be helpful.

Trevor Daniel

PRIZES FOR HYDSOC ARTICLES

Prizes of $ 50 for the best articles in Aqua Australis not published elsewhere have been awarded to:

Peter Smith: *Letter from Chile* and David Kernich ℓ for *litre*

Water resources accounting

The Australian Bureau of Statistics has sought comments on a proposed methodology of water resource accounting as part of the National Land and Water Audit. The methodology appears similar to financial accounting: the resource is valued as that in storage at the accounting year end, plus that used (consumptively), with adjustments for changes in measurement technology as years progress (the inaccuracies in estimating ungauged entrapment alone may swamp the validity of the assessment).

This methodology does not seem to address the fundamental needs of natural resource accounting, namely to attach a value beyond the consumptive use. What is the value of water to maintain biodiversity? What value are water-related aesthetics and recreational activities? Should a non-anthropocentric approach to valuing water flows be taken?

Anyone who thinks the Hydrological Society should have an opinion on water resource accounting should contact the editor on tel (08) 8204 9129; fax (08) 8204 9144.

THE OLARY FLOODS - FEBRUARY 1997

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1. Introduction

Early February 1997 saw the occurrence of heavy rainfalls spread over a wide area of South Australia's north. In some areas the rainfall produced extremely large floods. One of the worst hit areas was near Olary, on the road to Broken Hill.

Extreme rainfall occurred, with falls of up to 330mm in three days, and in one 6 hour period on Friday 7 February up to 200mm of rainfall occurred. The rain produced floods that washed away long sections of the railway and inundated long sections of the road. Damages reported were of the order of $6m to repair the railway and $1.5m for the road. Damage to rural infrastructure was also significant.

The rainfall was caused by a tropical air mass that spread over much of South Australia for a number of days. The atmosphere was very unstable and thunderstorms were the main rain producer. Consequently the event was characterised by very localised, very intense rain episodes. By contrast the 1989 floods occurred as a monsoon low which tracked quite rapidly across the state. It rained at a fairly steady rate over large areas, with a long duration (up to 24 hours).

2. Rainfall

Figures 1 and 2 show the estimated peak 6 hour and total 3 day rainfall in the Olary Creek catchment near Olary. The catchment shown covers an area of approximately 1700km^2.

From Figure 1 the largest six hour rainfall recorded was 217mm, equating to an average intensity of approximately 36 mm/h. This is more than twice the estimated 500 year Average Recurrence Interval (ARI) rainfall at this location using the procedures from Australian Rainfall and Runoff. Australian Rainfall and Runoff procedures indicate that the intensity is probably in excess of 10,000 years ARI, but the accuracy of the recurrence interval of these extreme events is very doubtful. This can be seen in Figure 3.

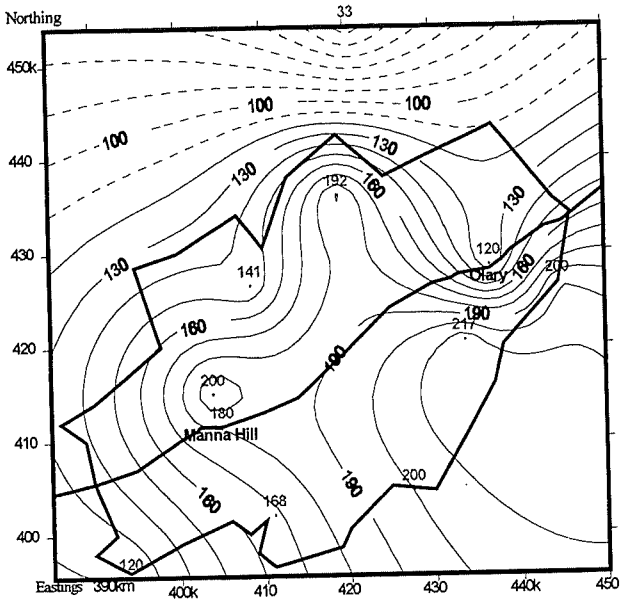

Figure 1: Estimated Rainfall (mm) for 6 h duration on 7th February 1997 (needs further verification)

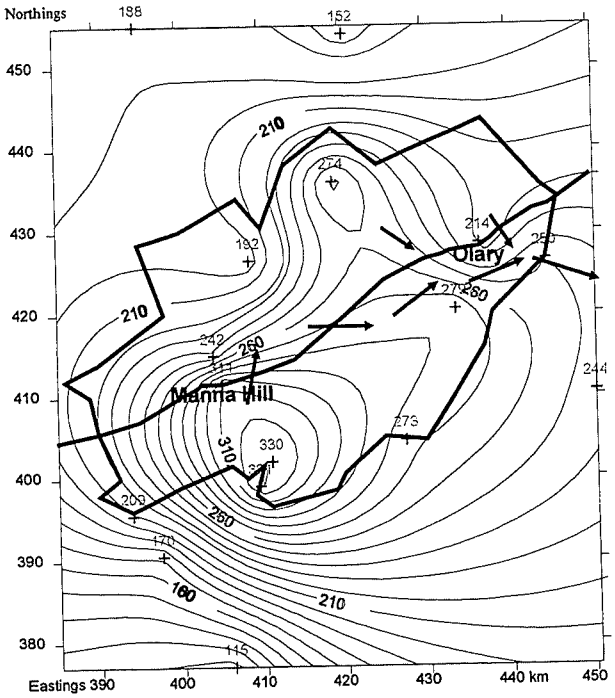

Figure 2: Estimated Total Rainfall (mm) for Event 6-8th February 1997. Arrows indicate flow paths.

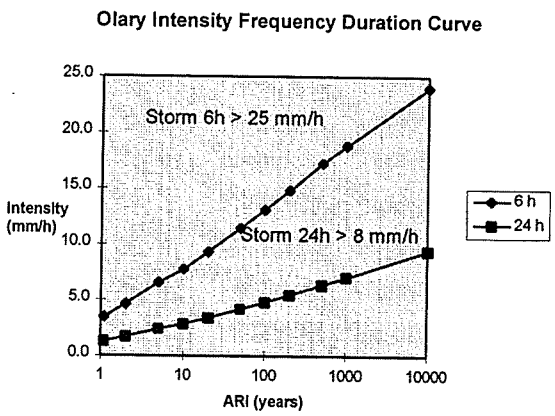

Figure 3: Comparison of ARI from AR&R and Rainfall at Olary for 6 h and 24 h

The rainfall can be compared with the Probable Maximum Precipitation (PMP). Probable Maximum Precipitation (PMP) is defined by the Manual for Estimation of Probable Maximum Precipitation (1) as:

"...the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends."

Over an area of 1000km^2 (the maximum area for which PMP can be estimated by the procedures contained in Bulletin 53 of the Bureau of Meteorology) the mean rainfall depth of the 6 h PMP storm is 360mm. This can be compared with the mean rainfall in the Olary Creek catchment of approximately 180mm.

The depth-area relationship of the rainfall can also be compared with those in Australian Rainfall and Runoff. The relationship in Australian Rainfall and Runoff was derived from US data, and recommends different relationships for humid and arid areas. The Olary area lies within the arid area as defined in Australian Rainfall and Runoff.

Figure 4 shows the relationship derived for the Olary storm. It can be seen that the relationship lies very close to the humid area relationship of Australian Rainfall and Runoff. If this event is typical of large storm events in Australia's arid areas then the use of the American derived arid area relationship in Australian Rainfall and Runoff must be questioned.

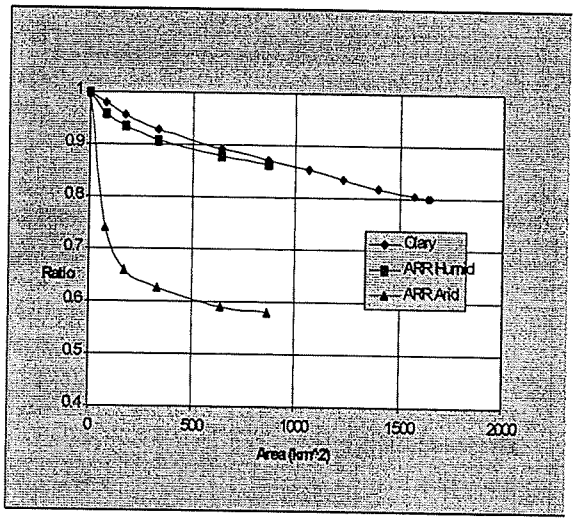

Figure 4: Rainfall Depth - Area Relationship

3. Runoff

The peak flow that occurred in Olary Creek as a result of this storm has been estimated. A cross section just south of Olary was surveyed as were debris marks for an estimate of the flood water surface slope.

This work indicated a peak flow of the order of 5600 m^3/sec at Eringa Rd for Wiawera Creek. A Manning n value of 0.04 was used for the estimate which gave velocities of the order of 1.8 m/sec, with a channel grade of 0.2%. All vegetation was stripped from the bed of the flood plain as were all overhanging branches of eucalypts along the main river channel. Both these observations indicated high velocities in the flood plain and river channel, as did the extreme damage to man made structures in the flood plain.

It must be noted that small changes in flood level of say 0.3 metre can change the estimate of flow by 15-20%.

Information regarding water levels over time at Wiawera Station was used to estimate an event hydrograph (see Figure 5). At Wiawera Homestead on Olary Creek the flow was estimated to be 5500 m^3/sec. The hydrograph indicated a mean runoff depth of 125mm, which can be considered reasonable, given the mean catchment rainfall.

The estimated flow of 5600 m^3/sec can be compared with the PMF (Probable Maximum Flow). A quick method of deriving PMF as outlined by Nathan et al (2) gives a flow of 9700 m^3/sec.

It is useful also to compare these flows with estimates for a river closer to Adelaide. The Gawler River has an estimated 100 year ARI flow of 420 m^3/sec, from a catchment area of 1070 km^2. If the Olary Creek flow is factored to account for the different catchment area then the flow in the Gawler River would have been of the order of 4600 m^3/sec, in other words more than 10 times the 100 year ARI flow. A flow of this order in the Gawler River would have been catastrophic. However the meteorologists tell us that it is possible for a storm such as the Olary storm to occur on the Gawler River catchment.

We are fortunate that the episodes of extreme rainfall in the north over the last decade (1989 and 1997) have not extended further south to the catchments near Adelaide.

4. Runoff Modelling

To determine whether the derived hydrograph was a reasonable estimate it was decided to model the event using a runoff routing model. The chosen model is the RRR model as described by Kemp (3).

This model has the advantage in that it can handle several runoff processes occurring simultaneously on the catchment, which no other runoff routing model can do. Examination of the hydrograph reveals a very sharp peak near the start of the runoff, with a long tail over several days. This is indicative of more than one process occurring.

The RRR model splits the modelled storage within the catchment between runoff processes that occur as water moves towards channels and the channel storage itself. Any number of runoff processes can contribute to the channels. Each process has an initial loss, a continuing loss and a storage parameter k_p. The channel has a storage parameter k. It is assumed that the channel storage is linear (lag does not vary with flow) whereas the process storages are generally non-linear, with the lag due to the storage varying with the flow through the storage.

In order to compare storage parameters from catchment to catchment two generalised parameters must be introduced. The first is the channel characteristic velocity, v_c which is related to the channel storage parameter k by the following relationship:

$$v_c = \frac{d}{(36\,k)}$$

where

v_c is the channel characteristic flood wave velocity (m/sec)

d is the longest flow path length in the catchment (km)

k is the channel storage parameter (h)

The second is a series of catchment characteristic lag parameters, c_p. These are related to the runoff storage parameter k_p (for each of the runoff processes) by the following relationship:

$$c_p = k_p A^{m-1}$$

where

A is the catchment or sub-catchment area (km^2)

m is the exponent in the storage equation $S = 3600 k_p Q^m$

Given the lack of pluviometer data several assumptions must be made regarding the rainfall applied to the model. The assumptions were as follows:

- 6 hour duration storm
- 180mm mean catchment rainfall
- temporal pattern as for a 6 hour storm, zone 6 of Australian Rainfall & Runoff

The calibrated model parameters are as follows:

For the channel:
k = 0.5, giving
v_c=3.9 m/sec

For the runoff processes (two of

which were identified):

Process	Initial Loss (mm)	Continuing Loss (prop)	k_p	c_p
1	30	0.43	6	1.4
2	80	0.43	0	na.

The estimated hydrograph and the RRR model fit are shown on Figure 5.

Comparison of these results with the results of the calibration of the RRR model on other catchments in South Australia indicate that these calibrated parameters lie within the expected bounds. The characteristic channel velocity v_c is higher than expected, but this may be due to the mismatch in the actual and assumed temporal pattern. The process 1 c_p is similar to that associated with base flow in other catchments. The proportional loss is lower than for events calibrated on other catchments, but this can be expected given the extreme rainfall.

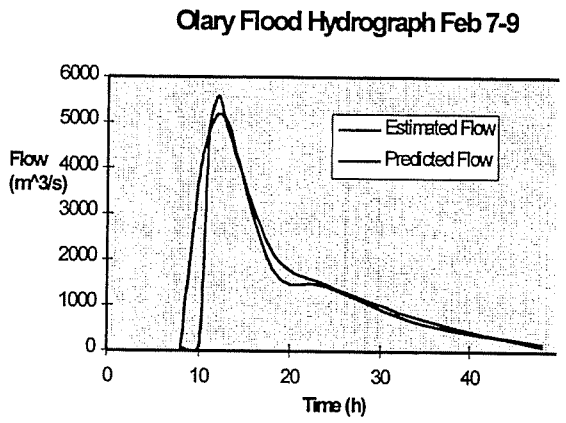

Figure 5: The derived hydrograph and the RRR model fit

Of interest is the second process modelled, where the process storage parameter k_p is zero. Zero process storage indicates overland flow is occurring, the catchment storage then being effectively that of the channel system.

Video taken from the verandah of the Olary Hotel reinforces the fact that overland flow is occurring, as it can be seen that the whole of the ground surface is covered by flowing water. This assumption was also validated by inspection of some of the hillside slopes.

It is thought that overland flow does not occur frequently in catchments, but may occur more in arid areas. However in extreme events the Gawler River catchment may produce overland flow, with a subsequent marked increase in peak outflow from the catchment for the same rainfall input.

If this is the case then "normal" catchment behaviour should not be used to extrapolate to extreme events.

5. Issues

Several issues can be raised as a result of the investigation of the Olary floods.

The reliable estimation of rainfall and stream flows resulting from a storm event such as this is very difficult, and with current technology will not improve. Flows within the catchment would have been sufficient to wash most stream gauging stations away. A pluviometer or two would be useful, but these have been known to become submerged during extreme events, and stop recording as indeed was one of the manually read gauges. Manually read rain gauges do not provide a complete picture, as the network is generally sparse and normally not read frequently enough during extreme events, when emergencies are happening.

The ARI of the storm rainfall and resulting flow will remain a very broad estimate, as these events occur so rarely.

Analysis of the depth-area relationship for the Olary storm indicates that the relationship to be used for design purposes should be the humid area relationship of Australian Rainfall and Runoff, not the arid area. This is reinforced when it is considered that the 1997 rainfall was localised, not general rain as in 1989.

The investigation of the event indicates that the Olary Creek catchment experienced overland flow, resulting in much higher peak flows than would occur

with more frequently occurring "normal" processes. It is possible that any catchment may change its behaviour with extreme rainfall, and produce flows well in excess of those predicted with currently available runoff routing models, or flood frequency analysis of "normal" events.

Finally we should not be complacent regarding catchments in the more settled areas of the state. There is no meteorological reason why such rainfall could not occur near or over Adelaide, or physical reason why catchments near Adelaide would not behave like the Olary Creek catchment under extreme rainfall.

6. Acknowledgements

The authors wish to thank the residents of the Olary area and the Bureau of Meteorology for the contribution of rainfall data and information used to derive the hydrograph, and to Mr Bill Lipp of the Department of Transport for his comments and suggestions on this paper.

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Recharge dams in Oman

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Many arid countries, including countries of the Arabian Peninsula depend on desalination for augmentation of their meagre water resources. The desalination is indispensable when it comes to a guaranteed supply of water at a cost. However, technologies which lead to more efficient use of natural water resources should not be overlooked. Groundwater recharge is one of the most effective tools in this regard.

In hot and arid climates evaporation can exceed rainfall by several orders of magnitude. Surface storage of infrequent floodwaters in such a situation is impractical due to large evaporation losses. It is better to store them underground. In many countries, including the Sultanate of Oman, groundwater has been over-exploited in many aquifers, especially after the appearance of powerful pumps. As a result, depletion of groundwater has occurred in many areas and in several parts of the country the resulting sea water intrusion in coastal areas has become a problem. On the other hand, during rain events, a large part of surface water flows are quickly drained to the sea or desert. To minimise these losses, which could play in important role for the replenishment of ground water, the Government of the Sultanate of Oman undertook a program for the construction of recharge dams as well as some other small retention and water conservation schemes.

The Sultanate of Oman is situated in the south-eastern corner of the Arabian Peninsula. It is characterised by an arid climate, with hot and dry summers and mild winters, except the region in the south of the country which is effected by monsoon climate during the month of June to September.

The northern part of Oman is mostly mountainous. The massifs of Al Hajar

Al Gharbi and Al Hajar Al Sharqui are the source of run-off after rains, either toward the sea or the desert. The Sultanate receives, on average, 100 mm rainfall per year, ranging from some 350 mm in the mountains to 10 mm in the desert. The evaporation ranges from 1700 to 3000 mm. There are no permanent rivers: some wadis flow occasionally to the sea during floods, usually lasting several hours, every few years.

The recharge dams in the Sultanate of Oman are located on wadi gravel deposits, with the objective of retaining floods and allowing increased infiltration into the gravel aquifer, by slow releases into the downstream wadi channel. The period of water detention in the reservoir is usually less than 14 days, which is dictated by health requirements (limiting mosquito breeding).

The types of dams are governed principally by the construction materials available. Thus, the structures are typically in the form of permeable sand and gravel embankment dams with gabion mattress protection upstream, or a gabion weir type structure.

An average recharge dam in Oman drains an area of 550 square kilometres, and has a crest 3400 m long and 10 m high. Its spillway is designed to pass 0.5 of Probable Maximum Flood, which, in this area, has a very high value of 20-30 cubic metres per second per square kilometre of the catchment.

Due to topography, recharge dams have relatively small capacity reservoirs, ranging from 0.13 to 17.5 million cubic metres. On average, the capital cost of storage is $A 2.00 per cubic metre.

Contrary to popular belief, recharge mainly occurs not in the reservoir, which quickly becomes silted: the reservoir bed becomes sealed, and the recharge through the bed becomes low. However, water released from the reservoir is already settled, and with easiness infiltrates into gravel aquifers downstream of the dam.

Each dam which has an ungated spillway reduces the incoming flood peak. How much the peak is reduced depends on size of the reservoir and the magnitude of the flood. The current tendency is to design storages which are able to contain a flood which can occur, on average, once every five to ten years.

Most of the cost associated with the operation of the recharge scheme is the capital expenditure for construction of the recharge scheme. Maintenance costs on average amount to some 3% of capital costs annualised over 30 years.

The overall cost of one cubic metre of water captured by recharge dams is $A 0.20. This compares favourably with the unit cost of desalinated water, which is the only available alternative source of additional water in the Sultanate. These costs are $A 2.50 per cubic metre at a discount rate of 7%, with $A 1.50 due to direct operational costs and $A 1.00 due to capital costs.

It is impractical, or even difficult, to construct recharge dams which would intercept every flood that may occur. During the investigated period, 1985-1997, some 500 million cubic metres of water was lost to the sea, compared to 370 million cubic metres retained in recharge dams.

Several data collection and modelling studies determined that the actual recharge is some 75% of water stored in the dam, which is of the order of magnitude suggested by the feasibility studies. A number of evaluating studies completed recently have demonstrated that the recharge dams serve their purpose well and contribute to the harmonious development of the country.

WATER RESOURCES ACT 1997

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The **Water Resources Act** 1997 (SA) (***the Act***) came into operation in South Australia on 2 July, 1997. This article will focus on issues arising from the system of registration of water licences introduced by the Act.

The Act abolishes the common law rights known as "Riparian Rights" throughout the State and replaces them with a statutory right to draw water. The Act continues the notion of a prescribed watercourse, lake or well and creates the concept of **a surface water prescribed area**. In each case, a person needs a water licence to draw water. (In addition, the Act provides that a person must not perform certain "water related" activities such as the construction of dams, the draining of water from a well or the construction of a well, unless the person holds a permit to do so).

The Act provides that a Minister may grant a water licence to a person to take water. The licence must set out from which water resource the water is to be taken, and it must also state the **water allocation** which attaches to the licence. This concept of a water allocation is new to the 1997 Act.

For the purposes of the Act, a water licence is "personal property" which vests in the licensee. This means that a licensee is able to grant security over the water licence to a financial institution so that finance may be obtained.

The type and nature of security granted by a licensee will depend largely upon whether the licensee is an individual or a company.

The Act introduces a Register of Licences (and permits) which is to be maintained by the Minister. The Register contains such information as the Minister thinks fit.

The Minister must, on an application by the holder of a licence (and payment of a prescribed fee), note on the Register the name of a person who has an interest in the licence or the water allocation of the licence and the nature of that interest. This has the effect of providing a system of registration of security interests.

To transfer either a water licence or a water allocation of a licence, Ministerial consent is required. The effect of having an interest noted on the Register is that the Minister is prevented from transferring the water licence or the water allocation of the licence **without** the written consent of the person whose interest has been noted.

This would provide some comfort to financial institutions that a water licence or allocation is transferable without its knowledge and consent.

The Act however, is unclear as to what constitutes an interest in a licence.

When the *Water Resources Bill* was before Parliament, The Minister for Environment and Natural Resources stated that "the bill allows full transferability of both licences and water allocations endorsed on them. It also creates a register of licences through which third party interests in a water licence (such as the interest of mortgagors) can be protected and through which an effective market in water allocations can evolve".

It is likely that, over time, both the water licence and the water allocation attached to a licence will become valuable assets to which security may be granted by a licensee. The writers believe a market for the trading of water licences is just around the corner.

The writers expect that water licences and water allocations will become extremely valuable and important assets to sectors of the South Australian Agricultural Industry. When one considers the rate of expansion of the wine industry in South Australia and the need for water to irrigate vineyards, a distinct commercial advantage is likely to rest with a grape producer who also holds a water licence and water allocation. It is expected that financial institutions will recognise the significant value of a water licence.

One country, two systems: Saline water use in toilet flushing in Hong Kong and its relevance to arid Australia

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Hong Kong has a population 6.3 million and an average annual rainfall 2.2 m, and one might wonder how its water supply could provide lessons for arid area South Australia, population 0.15 million, rainfall 0.2m.

Since the late 1950s, Hong Kong has had two systems of water supply: one for supplying seawater for toilet flushing and another for fresh water for other in-house uses. This could have application in the use of saline groundwater in arid areas. Offset against this is that the use of seawater renders the sewage unsuitable for reuse, and disposal in septic tank soakage systems may cause salinisation.

Another innovation in Hong Kong has been to form a reservoir out of the sea by constructing a dam between two peninsulas and removing the seawater (constructed 1968). A similar proposal has been suggested to dam part of saline lakes in arid areas. Desalination was tried in Hong Kong, but abandoned after 7 years.

Hong Kong's water rate structure is equitable and encourages conservation.

Margaret Thatcher handed Hong Kong over to the mainland Chinese, because she had perceived that its government only had to turn off the taps to bring Hong Kong to its knees. 70% of water to Hong Kong is imported from the mainland, the rest from local reservoirs. With the establishment in the 1980s of an Environment Protection Department (EPD), the rate of increase in water use has reduced as polluting industries have moved across the border to the less stringent environmental requirements of the Special Economic Zone of Shenzhen.

Consumption of water in Hong Kong is:

- fresh: 115 L/person.day (domestic)
- seawater: 101 L/person.day (including non-domestic)

This compares to Adelaide's domestic consumption of 350 L/p.day. Unlike South Australia, annual consumption in Hong Kong is not highly correlated to annual rainfall, as most people live in high rise flats without gardens.

70 % of Hong Kong is reticulated with seawater. The seawater is screened and chlorinated, much by electrolysis, because the EPD objects to the location of chlorination plants in the urban area, and ozonisation and ultraviolet light do not provide the residual required after storage in-house roof or sump tanks. The seawater is reticulated through ductile iron or concrete lined mild steel pipes with a minimum separation of 300 mm from the fresh water main. Inside the building, PVC piping is used for the seawater. Because the seawater is pumped up to service tanks which are at different elevations to the fresh water tanks, the pressures in the two reticulation systems are different. Inside the apartment blocks the water is stored in tanks to prevent backflow. A tank is not mandatory for the fresh water supply, but encouraged.

The use of seawater is mandatory in toilets, which are single flush 7.5L to 15L. The use of fresh water is prohibited in airconditioning systems, which must be refrigerated or use seawater. Some fire hydrants are located on the seawater mains, but "the damage by dousing with seawater, you might as well have let the place burn down".

Toilet cisterns, piping, pumps, and valves are designed for the corrosive environment. Cisterns are of the valveless siphonic type, requiring no metal parts in contact with the seawater and to avoid clogging by turbidity.

Water quality targets are shown in the table below. The intake target for bacteria probably reflects that the first sewage treatment works is about to be commissioned.

Water is charged for in a four tier structure, penalising excessive consumption. The first 12 kL per 4 months are free, and the

top rate is $HK 9.05/kL. There is no charge for seawater, which is not metered at the house.

Unlike South Australia, the water pricing structure in Hong Kong is more equitable, in allowing free water for basic hygiene requirements. The absence of an access charge encourages water conservation by the consumer and the provision of efficient infrastructure by the Authority. In South Australia the access charge is used as a surrogate tax, a secure revenue stream immune from annual demand fluctuations. The comparison of householder water costs are shown in the graph.

Sewage disposal is charged for according to the freshwater use at $HK 1.20/kL plus a waste strength levy (Restaurants have the highest waste levy at $HK 10/kL). Householders are billed every four months.

For further information visit the homepage of the Hong Kong Water Supplies Department:
http://www.info.gov.hk/wsd/ (English)
http://www.info.gov.hk/wsd/indexc.htm (Chinese)
email: wsdinfo@wsd.gen.gov.hk

$A1 ≅ $HK6

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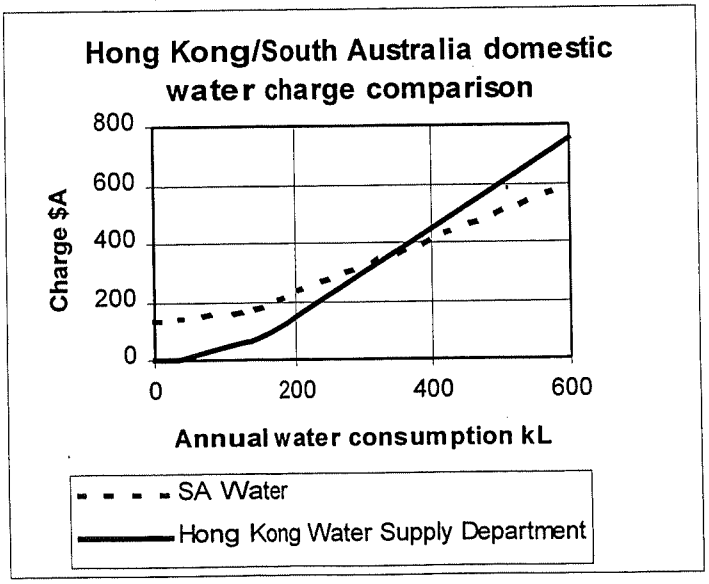
Seawater flushing water quality targets in Hong Kong

Parameter	Unit	Intake	Distribution
Colour	HU	<20	<20
Turbidity	NTU	<10	<10
Threshold odour	number	<100	<100
Ammonia nitrogen	mg/L	<1	<1
Dissolved oxygen	mg/L	>2	>2
BOD_5	mg/L	<10	<10
Synthetic detergents	mg/L	<5	<5
E coli	no/100mL	<20 000*	<1 000#

cf Australian NHMRC standard of median faecal coliform concentration for primary contact recreation 150 no/100mL and for secondary contact recreation of 1000 no/100mL

*Chlorinated seawater used in desalination plants in Saudi Arabia has been found to contain 1200-6000 CFU (Colony forming units), with not much difference from the raw seawater.



RESEARCH UNDERWAY AT THE UNIVERSITY OF ADELAIDE

Dr David Walker
Department of Civil and Environmental Engineering, University of Adelaide
Tel (08) 8303 4319; fax (08) 8303 4359; email dwalker@aelmg.adelaide.edu.au

It is planned to highlight the research being carried out at South Australian universities with regard to hydrological matters. This issue presents a background of two particular projects of research at Adelaide University - monitoring stormwater quality and quantity at the MFP stormwater wetlands, and an improved initial loss model for runoff.

MFP Wetlands

The Department of Civil and Environmental Engineering at the University of Adelaide has been monitoring the stormwater runoff entering the MFP Barker Inlet Wetlands since 1994. Both water quality and quantity are continuously monitored in five stormwater channels entering the wetland. Prior to this year, no outflows have been monitored and thus the effectiveness of the wetlands in treating the stormwater remains largely unknown. Outflow monitoring stations have recently been installed which will provide information on the effect that the wetlands are having on water quality. Three Masters (MEngSc) students are currently working on this project, as outlined below.

Bryan Williams is completing a project funded by MFP Australia and supervised by Mr. Trevor Daniell. The objective of his project was to determine the quality and quantity of stormwater inflows to the Barker Inlet Wetlands from four catchments, and to the Magazine Creek Wetland from the Eastern Parade catchment. Approximately 80 composite samples and 500 sequential samples were analysed for nutrient, heavy metal and polyaromatic hydrocarbon concentrations from the five catchments. The effect of catchment size, land use and channel type on stormwater runoff quality were investigated and compared to other stormwater studies such as the Paddocks Wetland study. Three dimensional parameter correlations, event quality and quantity probability curves, runoff routing models and improvement of stage/discharge rating curves using velocity probes due to the backwater effect of downstream trash racks were all investigated.

In a project also funded by MFP Australia, and supervised by Mr. Trevor Daniell and Dr. David Walker, **Rachel French** is undertaking an analysis of some of the pollutants contained within the stormwater, particularly suspended solids. By gaining an understanding of the generation of sediment within the catchments, suspended solids loads can then be incorporated into the development of a rainfall/runoff/water quality model. By monitoring the quality of water passing through both the inlet and outlet to the wetlands, their effectiveness at removing suspended solids from stormwater will also be determined.

With the installation of three new monitoring stations in early 1997, all significant inflows to one of the ponds, known as 'Pond A' can now be measured, as well as the outflow. A study undertaken by **Sarah Murphy** and supervised by Dr. David Walker and Mr Trevor Daniell will look at this particular pond with regard to water quality improvement and the decay of nutrients in wetlands. By comparing Total Phosphorous and Nitrogen at the inlets and outlet of the pond, it will be possible to determine whether or not the wetland is effective in immobilising these nutrients contained in the stormwater. Nitrogen transformations will also be investigated by analysing a number of nitrogen forms in the water, namely Total Nitrogen, Total Inorganic Nitrogen (NO_x and ammonia fraction) and Ammonia -N. It is anticipated that by breaking down the total nitrogen concentration into its constituent forms that some insight into nitrogen decay processes in the wetland will be gained.

The results obtained will also be used in the calibration of a water quality computer model.

Initial Loss Modelling

Flood discharges and flood levels are jointly affected by storm rainfall and the state of the catchment at the start of a rainfall event. At the present time, the majority of flood discharge estimates in Australia are based on converting a design rainfall event with a given average recurrence interval (ARI) to a flood magnitude of the same ARI. A critical step in this approach is the estimation of the initial loss value. At present the methods outlined in Australian Rainfall and Runoff offer little practical guidance on how the joint probability problems, which arise through the need to assume initial loss values, can be addressed.

An alternative approach is being researched by **Theresa Benham**, under the supervision of Dr Martin Lambert, which supersedes present design techniques and the need to evaluate the probability distributions of initial loss. This new approach should lead directly to the generation of rainfall excess statistics which can be related to existing regional rainfall intensity information to produce a practical engineering design procedure.

The overall objective of this research would be to develop practical methods for including the effect of initial rainfall losses on the flood frequency distribution. The proposal has five specific aims which are to:

1. Develop a continuous simulation model for examining the flood frequency characteristics of a general catchment;
2. Calibrate the parameters of the continuous simulation model to catchments using rainfall and streamflow data from five different Australian states;
3. Validate the approach on selected catchments which have long-term flood frequency records;
4. Fully develop the proposed rainfall excess frequency-duration (REFD) design approach; and
5. Derive the regional rainfall excess frequency-duration (REFD) distributions and temporal patterns for inclusion in the new edition of Australian Rainfall and Runoff.

Melbourne house self sufficient in water

Harvesting roof runoff and recycling grey water has enabled a two person household in Malvern, Melbourne to become independent of the reticulated supply.

Features of the house are:

- connected roof area: 117 m^2
- tank size 20 kL under kitchen floor;
- roof runoff consumption 75 kL/y cf Melbourne average 234 kL/y;
- appliances (5 star energy efficient) include:
  - full size washing machine (output to toilet flushing);
  - dishwasher; and
  - bathroom (output directed to garden using absorption trench irrigation system).

Abstracted from Water Resource Management News, *3 no.1, February 1996 (Water Policy Division, NSW Department of Land and Water Conservation)*

USA utilities implementing tiered water charges to discourage excessive use

60% of USA utilities have some form conservation oriented rate structure. These range from:

- uniform rate (as opposed to declining rate for high water consumption) (46 % adopted);
- seasonal rates (higher charges in peak season);
- inverted block structures (increasing the unit rate at higher levels of use) (25 % adopted); and
- excess-use rates (base usage defined as average use by customer during a specified non-peak period; during peak period amount above this charged at base rate plus excess rate, which could be tiered). Could benefit groups such as large families (less than 1% adopted).

Accompanying the changes to the rate structure was education on the marginal cost of developing new resources, in order to alert consumers to the impacts of increasing use. Important in gaining public acceptance of conservation oriented rate structures were public consultation, and charges based on the actual cost of supplying service.

Abstracted from Water Resource Management News, *3 no.1, February 1996 (Water Policy Division, NSW Department of Land and Water Conservation) who obtained it from* Water and the Environment.

IAN LAING PRIZE WINNERS

Last year the Ian Laing prize was awarded jointly to three of the candidates: Theresa Benham, Julianne Martin and Glenn Passfield. The candidates were asked to submit a copy of their application, that included a statement of their interest in water related studies.

The first submission is by **Theresa Benham**.

In applying for the Iain Lang Prize a description of interests in water related studies was submitted. The following is a brief description of this but included should be the description of the project currently being undertaken for a PhD, as described below.

My interest in water related studies encouraged me to undertake the final year research project in the area of cross-shore sediment transport, which has involved the study of an experimental model, undertaken in a wave flume. Cross-shore sediment transport, a very difficult study area due to the lack of reliable mathematical relationships, is responsible for the continuous change in beach profile which occurs throughout the seasons and is an important phenomenon in the field of coastal engineering. The study involved the monitoring and analysis of wave height, and changes to the beach profile due to varying wave conditions. This is an important area of water and coastal engineering because of the large development which occurs in coastal zones.

I undertook a final year subject in water resources management during which time I carried out a major project into the water supply problems at Hawker, South Australia. This project was chosen as a result of my interest in water management, particularly in Australia. At Hawker there are existing limitations with the present supply system in terms of access to high salinity bore water only, and the lack of a totally reliable fresh water source. Visiting Hawker, I investigated previous water supply schemes and investigations, the current water supply scheme, wastewater disposal mechanisms and strategies to ensure sustainable resource management in the area, by means of discussions with local residents and members of council in conjunction with a comprehensive tour of the area.

During work experience at the Augusta Power Stations (Port Augusta) in 1996, I was involved in the continuation of a study for two proposed wetlands on the site. There were a number of aims in the proposal:

- to increase the aesthetics of the site, covering the existing blackish earth adjacent to the Northern Power Station;
- to collect the majority of the water from the primary ash basin and prevent overflowing of the ash pond; and
- to collect the run-off from one of the sub-stations to create a habitat for native birds and animals in an area where excavation has occurred.

I was also involved in discussions and consideration of proposals relating to the continuation of the bird lake project along the causeway into Port Augusta. During regular visits to the area I have always been keen to find out about recent advances, offer new ideas and participate when possible.

During work experience in 1995 with the Mitcham City Council, I was involved in the production of a report documenting the location and condition of the many stormwater outfalls in the Adelaide foothills. This involved the investigation of numerous erosion and scour problems, with the development of possible solutions. A drainage investigation was also carried out in a section of Blackwood using the rational method and ILSAX computer program. The aim was to determine the design flow through a pipe under a railway line in order to correctly select a suitable sized pipe to replace the existing one. The investigation also involved the analysis of water management (that is, locating where

the water actually flows during storms as contours are not always reliable, and then discussing possible improvements to the system).

During 1995 I carried out work experience at RUST PPK during which time I undertook groundwater investigations which included field sampling at petrol stations and at DSTO. (Salisbury). Analysis of results comprised the application of analytical techniques to practical problems and the composition of a computer programme for groundwater movement, particularly for the investigation of salinity problems.

The second submission is that of **Julianne Martin.**

At the time I applied for the Ian Laing Prize, I was undertaking fourth year of a bachelor degree in Civil and Environmental Engineering at Adelaide University. During my degree I was able to study a wide range of water related topics. These included the mechanics of water flow, coastal engineering, water quality, and a range of water treatment technologies for both drinking water and wastewater. Subjects such as botany and environmental biology provided an insight into the crucial link between water quality, waterways, and the environment, whilst economics and environmental law introduced the concepts of the value of a living object, and the way the law works to protect and prevent abuse of our resources. I have also had many opportunities to undertake and observe practical experiments dealing with water based phenomena.

UNI ADELAIDE WATER RELATED STUDIES
Final Year Research Project: Cross-Shore Sediment Transport in a Wave Flume

This project aimed to monitor the cross-shore sediment transport which occurred in a wave flume in the Robin Hydraulics Laboratory of the University of Adelaide. Cross-shore sediment transport is the movement of sand in a direction perpendicular to the coastline, which is caused by breaking waves and coastal currents. A range of monochromatic waves were produced in the flume to simulate summer and storm wave conditions, and the results were compared to those established in the literature.

Analysis of the sand movement showed that the form of the resulting beach profiles was consistent with the literature, however the profiles were produced by a movement of sand in a direction which was contradictory to accepted theory. The rate of sand movement towards the equilibrium profile was also very quick, and did not seem to vary from summer to winter as expected. The unexpected movement of sand was attributed to a distorted sediment scaling technique, and a possible lateral movement of sand across the flume.

Two Dimensional Modelling of the Proposed Glenelg Safe Harbour

The two dimensional modelling of the southern breakwater proposed as part of the Glenelg Safe Harbour development aimed to verify the armour rock size, the crest level, the seaward slope of the design, and the effect of sand in the sand trap. The results of the tests were then used in conjunction with numerical and three dimensional modelling of the proposed harbour to determine the most economic and stable configuration for the final design of the breakwater.

The model was constructed on a scale of 1:26, and used random waves to simulate sea conditions (based on a range of worst case significant wave heights and mean water levels) on each configuration of the breakwater. Wave height, wave run-up, overtopping, and the percentage of rocks displaced were measured during each test to provide an indication of the stability of the breakwater. The results of the tests, showed the breakwater to be very stable in all configurations, whilst allowing a considerable degree of flow both through and over the breakwater.

Irrigation uses huge volumes of water - what is a Megalitre?

Tony Thomson, Irrigation Engineer, Lenswood Centre, PISA
Tel: (08) 389 8839; Fax: (08) 8389 8899; Email: tony.thomson@pi.sa.gov.au

In South Australia the total volume of water used each year for all purposes is 1.1 million megalitre. Most, 0.7 million megalitre, of this precious resource is used for irrigation.

Almost half of the irrigation water is used to irrigate animal fodder crops which produce a low $ return per kilolitre.

Fifteen tonnes of irrigation water are used to produce one small bale (25 kilograms) of lucerne hay providing a gross margin of only 9 cents per kilolitre.

In the Riverland four hundred and fifty litres of irrigation water are used to produce the grapes for one bottle of wine.

In South Australia the water supplier, SA Water, charges 90 cents to deliver each kilolitre of pressurized drinking-quality water.

River Murray irrigators in Government Irrigation Areas are charged 4 cents for each kilolitre they use for irrigation from the River Murray. In addition to the capital cost for pumps, pipes and the irrigation equipment a private irrigator typically pays 4 cents for the electricity to pump each kilolitre of irrigation water.

See picture on page 1

Water promising energy source through biological production of hydrogen

Some green algae and various strains of bacteria can produce hydrogen. The prerequisite for affordable production is that large quantities of cheap electron donors (eg biomass or water) are available.

There are several fundamentally different ways for producing hydrogen biologically:

- photolysis (the breakdown of biomass by phototropic organisms)
- fermentation, which requires no light

Two stage production methods are being developed, in which the residue from fermentation forms the input to photolysis. The production of energy by fermentation to produce hydrogen is less efficient than the production of methane (33% v 85%), but the latter is a significant Greenhouse gas.

These two processes could be applied to wastewater, but much more research is needed. Japan has a 30-year program, and Germany had a five-year program.

Abstracted from Insight, *the newsletter of the International Environmental Technology Centre (IETC) of the United Nations Environment Program (UNEP), Fall 1996. Home page* ***http://www.unep.or.jp***

Potable drinking water supplies dwindling.

Rational water use and water conservation the only sensible solutions

1.5 billion people are without a proper water supply, and 2 billion suffer from diseases transmitted by contaminated by drinking water.

Solving the drinking water problem is above all else a financial and organisational problem, rather than a technical one. Worldwide, there is sufficient capital to make the necessary investments: it is a matter of mobilising them and channeling them into appropriate projects. These investments will not yield immediate financial returns; it is therefore vital that more or less stable political and legal conditions be provided. These conditions can not be instituted immediately. Political bodies and commercial organisations must work in concert to affect strategic changes so as at least to minimise risks.

Strong growth in water supply development is likely to continue until 2005 in the world's emerging economies, according to a report on the world market for drinking water purification and supply by Helmut Kaiser Consultancy, Germany. For a free report contact: Ref 363-01, EBB, Philosphenweg 2, D-72076 Tübingen, Germany; tel +49 7071 67001; fax +49 7071 68086

Abstracted from Insight, *the newsletter of the International Environmental Technology Centre (IETC) of the United Nations Environment Program (UNEP), Fall 1996. Home page* ***http://www.unep.or.jp***

WEB DIRECTORY

EPA (South Australia)
http://www.epa.sa.gov.au
includes:

- frog census
- codes of practice
- legislation
- air quality

abstracted from EPA newsletter 2/1/1997

EPA (Commonwealth)
http://www/erin.gov.au/net/environet.html
includes:

- environment management capabilities data base
- environment technology reference sites
- national cleaner production database
- environment education courses database
- scheduled waste treatment technologies database

If you do not have access to the internet, information on environmental management solutions can be obtained from EnviroLink at freecall 1800 500 299 (outside Brisbane)
fax (07) 3229 8577
email: emiaa@peg.apc.org

You can have your environment management company, cleaner production case study, environment education course or relevant R&D activity appear on EnviroNET Australia.

Contact the EPA on
Email: environet@dest.gov.au
Tel (06) 274 1781
Fax (06) 274 1640

Department of Environment/Global Environmental Technology Enterprise Center (USA)
http://www/gnet.org/gnet/gete/doehome.htm
Discusses major industry-wide environmental themes and links

Environmental Index (USA) for locating environmental science and law sites on the internet
http:www.epa.gov/Region2/htm/library/yoohoo/index.htm

FUSRAP (Formerly utilised sites and remedial action programme) (USA)
http://www.fusrap.doe.gov
For other site addresses see IAWQ Specialist Group on Environmental Restoration newsletter 5 (March 1997) from which these were abstracted.

IAWQ (International Association of Water Quality) **http://www.iawq.org.uk**
The American Water Works Association
http://www.awwa.org
Water Environment Federation
http://www.wef.org

(abstracted from the newsletter of the IAWQ Wastewater Reclamation, Recycling and Reuse Specialist Group March 1997 article by Lluís Sala)

SOFTWARE

Parallel PEST optimisation software, a version that can distribute model runs over a network, now available. PEST communicates through a model's own input and output files, and can be used on any existing model. Contact Dr John Doherty, Watermark Numerical Computing, 336 Cliveden Avenue, Corinda 4075, tel (07) 3779 1664; email jdoherty@gil.com.au; web page: www.ozemail.com.au/~wcomp

Free software catalogue on over 125 groundwater, surface water, bioremediation, air pollution, geotechnical monitoring and other environmental models available from Hydrology, Air Pollution and Geology Software, Scientific Software Group, PO Box 23041, Washington DC 20026-3041 USA;
email info@scisoftware.com;
http://www.scisoftware.com;
tel +1 703 620 9214; fax +1 703 620 6793

*Abstracted from the newsletter of the International Association of Hydrogeologists Australian Chapter **14** 1/2 February/May 1997.*

HARDWARE

Ecosol Pty Ltd launches refined litter trap for side inlet pits.
A "solid pollutant stormwater filter" installed in a working side inlet pit will be available for public viewing on 16 and 17 September 1997 from 11.00 am to 3.00 pm at the Southern end of Shaftesbury Road, Elizabeth Vale. The trap has been designed by Ecosol Pty Ltd for the City of Playford. Contact Mrs Gill Evans (08) 9254 0326.

Information sought on organisations involved in the stormwater and small scale wastewater industry for data base

Doug Smith is collecting information on organisations and professionals involved in urban runoff and small scale water reuse in order to allow:

- networking;
- promotion of synergies;
- research cooperation;
- joint ventures;
- establishment of compatible products; and
- unified promotion interstate and overseas.

Interested researchers, consultants, surveyors, planners, engineers, developers, manufacturers, suppliers, contractors, Local Governments, State Agencies and training institutions should contact:

Doug Smith
14/26 Malaga Crescent
Wynn Vale SA 5127;
tel/fax (08) 8289 2538;
email: dougal@ctel.com.au

HYDSOC SEMINARS

All seminars are at the Charles Hawker Auditorium, Waite Institute, Waite Road, Urrbrae, commencing at 5.30pm for 6.30 to 8.00 pm except as noted. The audience is invited to join the guest speaker at dinner afterwards.

Tentative program for 1997 is listed in the following table. Please take note of changes as advised by the flyer prior to the meeting.

Date	Subject	Speaker
28/8/97	Joint meeting with Scientific Expedition Group (SEG) Seasonal forecasting	Grace and Holton, Bureau of Meteorology
18/9/97	Irrigation	Tony Thomson PISA, Johanne Kneebone DENR Stephen Pugh MESA
23/10/97*	Stormwater seminar	Industry speakers and professional organisations
4/12/97	Chile groundwater	Peter Smith MESA

* National Water Week: Sunday 19/10/97 to Saturday 25/10/97

ENVIRONMENT AND NATURAL RESOURCES, WATER RESOURCES GROUP: 1997 TECHNICAL SEMINAR SERIES

In the South Australian Water Corporation "Learning Centre", Level 8, Australis House, 77 Grenfell Street, Adelaide 10.15 am for 10.30 am to 11.45 am. Please verify the program prior to the date as it is subject to change without notice.

20 August	Integrated water systems model for the Spencer Gulf Region	*Shiroma Maheepala (CSIRO Melbourne)*
17 September	Aquifer recharge potential in the Spencer Gulf area	*Russell Martin (MESA)*
15 October	Surface water sharing: balancing environment and development	*Michael Good*
19 November	COAG Water reforms	*Elizabeth Young*
17 December	Irrigation in South Australia	*Tony Thomson (PISA)*

CONFERENCES

Date	Title	Organiser	Location	Abstracts close	Contact
6-9/7/1997	Environmental restoration. First international conference	IAWQ/Slovenian Water Pollution Control Association/The European Water Pollution Control Association	Ljubljana, Slovenia	closed	Mrs Alenka Kregar, Cankarjev dom (for IAWQ 97), Cultural and Congress Centre, Prešernova 10, SI-1000 Ljunljana. Tel +386 61 223 988; Fax +386 61 217 431; Email: milenko.ros@ki.si
3-8/8/97	With rivers to the sea: interaction of land activities, fresh water and enclosed coastal seas. 7th Stockholm Water Symposium	Stockholm Water Company and EMECS Centre, Kobe, Japan	Stockholm, Sweden	closed	Stockholm Water Symposium/EMECS Conference 1997, S-10636 Stockholm, Sweden. Fax +468 736 2022. Email sympos@sthwat.se
24-29/8/97	9th National Local Government Engineers Conference: Local Government Engineering, delivering the community's aspirations. International public works	Institution of Engineers, Australia, IMEA	Australia		fax (03) 9690 4217
26-29/8/97	Quality. 39th Annual Conference and Expo	New Zealand Water and Wastes Association	Rotorua, New Zealand		NZWWA Conference, PO Box 15974. New Lynn, Auckland, New Zealand. Tel +64 9827 5757 Fax +64 9827 2008 Email: water@nzwwa.org.nz
26-28/8/97	Pipes Wagga 97		Australia		fax (069) 23 5424
1-6/9/97	IX World Water Congress	IWRA	Montreal, Canada		Aly M Shady, Canadian International Development Agency Tel +1 819 9944098; fax +1 819 9533348
7-12/9/97	Stormwater management - creating sustainable urban water resources		Malmo, Sweden		Engineering Foundation Conferences, New York, USA Tel +1 212 705 7836; fax +1 212 705 7441
7-11/9/1997	Contaminated sediments –restoration and management. International conference	IAWQ	Rotterdam, The Netherlands	closed	Conference Secretariat, PO Box 1558, 6501 BN Nijmegen Fax +31 24 360 1159
9-12/9/97	Stormwater and soil erosion 97	Stormwater Industry Association and International Erosion Control Association	Brisbane, Qld	24/4/97	David Wiskar /Brian Davis fax (07) 3225 2131 tel (07) 3225 2131 mobile 0411 227 741 email: brian.davis@dnr.qld.gov.au
9-10/9/97	Water - an economic good?	ICID	Oxford, United Kingdom		Oxford Conference Management Tel +44 1865 794727; fax +44 1865 794695
16-19/9/97	Landcare. Changing Australia	Primary Industries South Australia	Adelaide	closed	Andrew Curtis, State Landcare Coordinator Tel (08) 8303 0339; fax (08) 8303 9320; email: landcare@pi.sa.gov.au; http://www.pi.sa.gov.au/landcare
21-27/9/97	Groundwater in the urban environment: XXVII Congress	International Association of Hydro-geologists	Nottingham, Britain		Conference Nottingham Ltd tel +44 115 985 6545 fax +44 115 985 6533
22-25/9/97	Management of transboundary waters in Europe		Poland		Economic Information Bureau Ltd tel + 48 9189 1727; fax +48 9189 1728 email: big@bevy.hsn.com.pl
23/10/97	**Stormwater in the next millennium: exportable innovations in stormwater management**	**Hydrological Society of South Australia**	**University of South Australia, The Levels (Adelaide)**	**closed**	**Chris Purton, c/-- BC Tonkin and Associates, 55 Queen Street, Adelaide SA 5001; tel (08) 8223 5583; fax (08) 8223 5237; email: chris.purton@bctonkin.com.au**
23-25/9/97	Integrated catchment/watershed management: technical, scientific and policy advances	Center for Water Policy Research	Armidale NSW		Dr John Pigram, University of new England Tel (06) 7732 420; fax (06) 773 327; email cwpr@metz.une.edu.au

29/9-1/10/97	Advanced integrated resource management: processes and policies. 2nd International conference on integrated catchment management	Centre for Water Policy Research & River Basin Management Society	Canberra ACT		Ron Hodges, 16 Larch Crescent, Mt Waverley Vic; tel (03) 9802 4859; fax (03) 9802 2315; email: rbms@vicnet.net.au
29/9-3/10/97	Towards sustainability. World Conference	IWSA	Wellington, New Zealand		ISWA 1997 Conference tel +64 3 383 3553; fax +64 3 383 0931
30/9-3/10/97	Flow regimes from international experimental network data. 3rd international conference (regionalisation of hydrological parameters and integrated catchment management)	for UNESCO/WMO by National Committee of Slovenia, the Steering Committee of the Alpine Mediterranean Hydrology FRIEND project and IAHS	Postojna, Slovenia	closed	Conference Secretariat c/- Dr Mitja Brilly tel + 386 61 1254 333 fax +386 61 219 897 email mitja.brilly@uni-lj.si
30/9-3/10/97	Pollutec 97		Paris, France		Pollutec/Miller Freeman, 70 rue Rivay, 92532 Levallois-Perret Cedex, France; tel +33 1 4122 0005; fax +33 1 4756 2120
30/9-1/10/97	World water: financing for the future		Istanbul, Turkey		Ursula Lewis, International Herald Tribune Conferences, 63 Long Acre, London WC2E 9jH, United Kingdom; Tel +44 171 836 4802; fax +44 171 836 0717
18-22/10/97	WEFTEC '97	Water Environment Federation	Chicago USA	16/12/96	Federal Office (02) 9413 1288
27-29/10/97	Water world Asia		New Dehli, India		fax +91 11 327 9429
4-7/11/97	Distribution 2000: 4th International distribution utility conference (includes water)	Electricity Supply Association of Australia/Australian Electrical and Electronic Manufacturers' Association Ltd	Sydney NSW		Distribution 2000, Convention Network 224 Rouse Street, Port Melbourne Vic 3207 Tel (03) 9646 4122; Fax (03) 9646 7737; Email: convnet@peg.apc.org
5-6/11/97	What is river health?-Assessing the condition of our rivers		Canberra, ACT		River Health Conference ACTS, GPO Box 2200, Canberra ACT 2601; tel (06) 257 3299; fax (06) 257 3256
5-7/11/97	River flood hydraulics. 3rd international conference		Stellenbosch, South Africa		Ms J Watts, United Kingdom. Tel +44 1491 835 381; fax +44 1491 832 233
11-14/11/97	Environmental protection, pollution control and green production technology		Shanghai, China		Fax +852 2516 5024
12-16/11/97	Pollution control '97		Bangkok, Thailand		Management and Development Company Ltd Tel +66 2 229 3000; fax +66 2 229 3191
16-19/11/97	Climate change and water resources	Australian Water and Wastewater Association et al	Adelaide SA		Convention Secretariat, PO Box 388, Artarmon NSW 2064. Tel (02) 9413 1288; Fax (02) 9413 1047; http://www.awwa.asn.au
24/11-5/12/97	16th Australian groundwater school				tel (08) 8303 8750
24-28/11/97	24th Hydrology and water resources symposium. Water/land Wai Whenua. Focusing on urban development and a sustainable environment	New Zealand Hydrological Society and Institution of Engineers, Australia.	Auckland, New Zealand	28/2/97	The Conference Company PO Box 90-040 Auckland New Zealand Tel +649 360 1240 Fax +649 360 1242 Email: info@tcc.co.nz
10-12/11/97	2nd International symposium on ecology and engineering: Engineering the aquatic environment	CWR/COEI/IAHR	Australia		(09) 380 1015
1-1/11/97	Australian groundwater school	Centre for Groundwater Studies & UTS National Centre for Groundwater Management	Sydney NSW		Trevor Pillar/ Heather Bajcarz; tel (08) 8303 8700; fax (08) 8303 8750; email: cgs.training@adl.clw.csiro.au
2-5/12/97	Managing the water and wastes of growing megacities, especially in developing countries	IPHE	Calcutta, India		SK Neogi, IPHE International Seminar, IPHE Building, CK-58, Salt lake City, Calcutta, India; Tel + 91 33 337 8678; fax +91 33 337 6290

4-5/12/97	Management of droughts. 3rd International conference		Valencia, Spain		Iberdrolo Instituto Technologica, Seminario Permanente'Ciencia y Technologia del Agua', edeficio Albia-2 7o, E-48001 Bilbao, Spain; tel +34 4 424 2400; fax +34 4 424 9648; email intec@iberdrola.es
4-5/12/97	Environmental technologies for wastewater management. United Nations International Regional Conference	IAWQ/CRC for Waste Management and Pollution Control/Environment Management Industry Association of Australia	Perth WA	15/8/97	Dr Kurvilla Mathew, Environmental Science, Murdoch University, MURDOCH WA 6150; tel (08) 9360 2896; fax (08) 9310 4997; email: mathew@essun1.murdoch.edu.au
8-11/12/97	Modsim 97		Hobart, Tasmania		Dr AD McDonald, Modsim '98 Congress Secretariat, c/- CSIRO Marine Laboratories, PO Box 1538, Hobart Tas 7001; Tel (03) 6232 5482; fax (03) 6232 5000; email modsim97@ml.csiro.au
2-6/3/98	Water quality and its management	Central Board of Irrigation and Power and Indian Association for Environmental Management and the National Committee of IAWQ	New Delhi, India	31/3/97	CVJ Vamma, member Secretary, central Board of Irrigation and Power, Malcha Marg Chanakyapuri Tel +91 11 301 5984/6567 Fax +91 11 301 6347 Email: cbip@cbipdel.globemail.com
8-11/3/98	Weftec Asia. Conference and exposition on water quality and wastewater issues	Water Environment Federation	Singapore	14/7/97	Fax + 1 703 684 2471; tel +1 703 684 2452; email: confinfo@wef.org
11-13/3/98	Options for closed water systems; sustainable water management. International congress	Wageningen Agricultural University	Wageningen, The Netherlands		Department of Environmental Technology, WAU, Marjo Lexmond, Bomenweg 2, 6703 HD Wageningen, The Netherlands; tel +31 317 4820123; ax +31 317 48 2108; email Marjo.Lexmond@Algemeen.MT.WAU.NL
24-26/3/98	Aquatech Asia 98		Singapore		Rai Exhibitions Singapore Pte Ltd, 1 Maritime Square, No 09-01, World Trade Centre Singapore 099253; tel +65 272 2250; fax +65 272 6744
25-27/3/98	Man and river systems - the functioning of river systems at the basin scale		Paris, France		F Bourgain, Conference Secretariat ENPC, 28 rue des Saints-Peres, 75007 Paris, France; tel +33 1 4458 2822; fax + 33 1 4458 2830; email: bourgain@paris.enpc.fr
20-23/4/98	Headwater '98: hydrology, water resources and ecology in headwaters		Merano, Italy		Headwater '98, c/- European Academy, Weggensteinstrasse 12/A, I-39100 Bolzano, Italy; tel +39 471 30 6111; fax +39 471 6099; email: headwater98@ms.sinfo.interbuisness.it
21-23/4/98	Hydrotop		Marseille, France		Hydrotop, 314 avenue du Prado, 13008 Marseille, France; tel +33 4 9122 7272; fax +33 4 9122 7171
4-6/5/98	Innovative technologies in urban storm drainage: Novatech 98	GRAIE The Rhone-Alps Group for Research of Infrastructure and Water; EURYDICE 92; The Urban Community of Lyon	Lyon, France		Bernard Chocat, GRAIE, BP 2132, 69603 Villeurbanne Cedex, France fax +33 47243 9277 Email: CHOCAT@URGC-HU.INSA-LYON.FR
27-28/4/98	WaterTECH conference promoting technology, science and business in the water industry	Australian Water and Wastewater Association	Brisbane	18/8/97	AWWA, PO Box 388 Artarmon NSW 2064; tel (02) 9413 1288; fax (02) 9413 1047
20-23/5/98	International conference on water quality management in national parks and other protected areas		Primosten, Croatia		Bojan Zmaic, Rakusina 1, 10000 Zagreb, Croatia; tel/fax +385 1 611 9588; email: bzmaic@zg.igh.hr
25-30/5/98	Ecwatech-98		Moscow, Russia		Ecwatech-98 Secretariat, PO Box 173, 107078 Moscow, Russia; tel/fax +7 095 207 6360; email: ecwatech@sibico.msk.ru
21-26/6/98	19th Biennial Conference including wetlands, coastal pollution, diffuse pollution, reservoir management, river basin management, urban drainage, water quality monitoring	International Association for Water Quality	Vancouver, Canada	Full papers 1/7/97	WQI'98 Conference Secretariat, 645-375 Water Street, Vancouver BC, Canada, V6B 5C6; tel +1 604 681 5226; fax +1 604 681 2503
6-10/7/98	Hydrology in a changing environment	British Hydrological Society	Exeter, United Kingdom		Dr Bruce Webb, University of Exeter. Email: B.W.Webb@exeter.ac.uk

7-10/7/98	Pollutex Asia 98		Singapore		HQ Link Pte Ltd, 150 South Bridge Road, No 13-01 Fook Hai Building, Singapore 058727; tel +65 534 3588; fax +65 534 2330; email: hqlink@singnet.com.sg
12-16/7/98	Future groundwater resources at risk		Changchun, China		Dr Zhao Yongsheng/Dr Sui Wiguo, FGR'98 Conference Secretariat, PO Box 298, Changchun University of Earth Sciences, 6 Ximinzhu Street, Changchun 130026, China; fax +86 431 892 8327
9-12/8/98	Environmental geotechnology and global sustainable development		Boston, USA		Dr VO Ogunro, Center for Environmental Engineering Science and Technology (CEEST),University of Massachusetts (North Campus Room E-114), One University Avenue, Lowell MA 01854, USA; tel +1 508 394 3185; fax +1 508 394 4014; email: ogunrov@woods.uml.edu
24-26/8/98	Hydroinformatics '98	Danish Hydraulics Institute	Copenhagen, Denmark		Danish Hydraulics Institute, Agern Alle 5, DK-2970 Horsholm, Denmark; tel +45 45 76 9555; fax +45 45 76 2567; email hic98@dhi.dk
13-19/9/98	Physical, chemical and biological aspects of stream-aquifer inter-relations. XXVII IAH Congress	International Association of Hydrogeologists	Las Vegas, Nevada USA		Dr John van Brahana. USGS, 114 Ozark Hall, University of Arkansas, Fayetteville AR 72701 USA Tel +1 501 575 2570
13-16/9/98	Management of large river basins	IAWQ	Budapest, Hungary	15/12/97	Trivent Conference Office, Szamóca u.6/b, H-1125 Budapest, Hungary; tel/fax +36 1 156 6240; email: trivent@mail.elender.hu
14-16/9/98	Advanced wastewater treatment, recycling and reuse. 2nd international conference	International Association of Water Quality	Milan, Italy	5/9/97	Segretaria Scientifica AWT98, c/- Politecnico di Milano, DIIAR Sez Ambientale, Piazza Leonardo da Vinci 32, 20133-Milano, Italy; tel +39 2 2399 6416; fax +39 2 2399 6499; email milano98@amb1.amb.polimi.it
21-24/9/98	UDM'98: Urban drainage modelling	Imperial College of Science, Technology and Medicine	London, United Kingdom	31/10/97	Dr D Butler, Department of Civil Engineering; Imperial College of Science, Technology and Medicine, Imperial College Road, London SW7 2BU, United Kingdom; tel +44 171 594 6099; fax +44 171 225 2716; email: d.butler@ic.ac.uk
28-31/9/98	**Hydrastorm '98: Urban drainage and hydraulics**	**Institution of Engineers, Australia**	**Hilton Hotel, Adelaide**	**14/2/98**	**Dr David Walker, Department of Civil and Environmental Engineering, Tel (08) 8303 4319; fax (08) 8303 4359; email dwalker@aelmg.adelaide.edu.au**
2-5/11/98	Integrating the urban water cycle	Australian Water and Wastewater Association et al	Sydney NSW	26/9/97	Convention Secretariat, PO Box 388 Artarmon NSW 2064; tel (02) 9413 1288; fax (02) 9413 1047; email: awwa@peg.apc.org
30/8-3/9/1999	8th International conference on Stormwater Drainage	International Association of Water Quality	Sydney NSW		Dr James Ball (ICUSD99), UNSW Water Research laboratory, 110 King Street, Manly Vale NSW 2093; fax (02) 9949 4188; email J.BALL@UNSW.edu.au

HYDSOC BUSINESS

1996/1997 EXECUTIVE COMMITTEE OF THE HYDROLOGICAL SOCIETY OF SOUTH AUSTRALIA

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Membership of the Hydrological Society is still only $ 10 per year (tax deductable for practitioners). Contact Bill Lipp, Treasurer, Hydrological Society of South Australia, Stormwater Services Section, Department of Transport, PO Box 1, WALKERVILLE SA 5081, telephone (08) 8343 2508, fax (08) 8343 2747.

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