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INTEGRATED WATER MANAGEMENT – PUSHING THE BOUNDARIES

Nicholas Apostolidis

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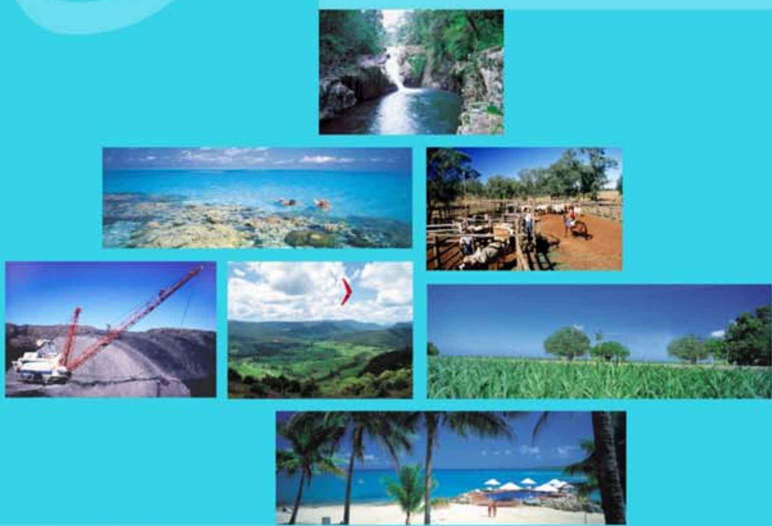

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INTEGRATED WATER MANAGEMENT – PUSHING THE BOUNDARIES

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Abstract

The lack of sufficient water to meet increasing water demands combined with stressed aquatic ecosystems is now becoming a major constraint to new urban developments and hindering economic growth opportunities throughout Australia.

Faced with one of the worst droughts in history and increased pressures from regulatory authorities to reduce the amount of wastewater pollutants being discharged to the local waterways has challenged many Australian water utilities to look at a more integrated approach in the way they deliver water, wastewater and stormwater services to new and existing urban developments.

This paper will present some recent case studies where a combination of new technologies, improved understanding of water use and commitment to integrated water management has resulted schemes with far greater self sufficiency, smaller ecological footprint and lower life cycle costs. The case studies cover small villages to major new urban developments serving over 150 000 people. The case studies challenge the conventional approach to urban water management planning and offer a model for use throughout the world.

Key Words: Total Water Cycle, Reuse, Smart Sewers, Demand Management, Integrated Water Management

Introduction

A number of regions in Australia are currently facing the worst drought in history. The traditional solution in the past has been to find a new source of water and build more infrastructures to meet the ever-growing water demands. At the other end of the water cycle, many of our waterways have limited capacity to accept more waste loads from the growing population and the regulators are responding by continuing to tighten the discharge standards close to the technological limit of wastewater treatment plants.

Being one of the driest continents on earth, the number of additional new sources is limited moreover; Australians place a very high value on the quality of their waterways. As result many authorities have come to realise that past practices are not sustainable and there is a need to look at a more integrated approach to the way water, sewerage and stormwater services are provided for new urban developments.

The concept of integrated water management is not new; it has been applied in numerous cases involving generally small communities. In the case of the Gold Coast City Council, the concept is being applied to a new major urban development that will serve some 150,000 people and ultimately to other new growth areas that are projected to add another 1 million people to the city.

This paper will outline how the concept of integrated water management has been applied on three case studies and how it could be used more widely in future for new urban schemes.

Integrated Urban Water Management – What Is It?

Traditionally, the various components of the water cycle have been considered independently, ie potable water is brought into a catchment to meet water demands, wastewater is collected, treated and discharged, and stormwater is collected and discharged. It is becoming increasingly apparent to water authorities around the world that this is not sustainable, and that the interdependences between the elements of the water cycle need to be recognised and harnessed.

Integrated water management involves a more holistic approach to the way water, wastewater and stormwater infrastructure is provided for urban communities. By adopting an integrated approach it offers opportunities to deliver services more economically yet with a smaller ecological footprint. For example the use of rainwater and/or dual water reticulation would help to reduce potable water demand deferring the need for additional water sources and at the same time reducing the impact on the receiving waters.

Case Studies

The following paper presents three recent case studies that have embraced the concept of integrated water management. The case studies represent three different scales of urban development commencing with the author's own house, a small village serving 40 people and a major regional scheme

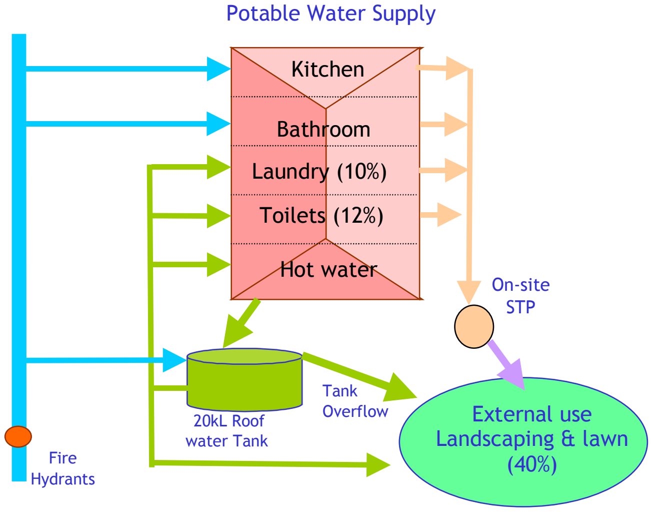

Figure 1.
Schematic of The Gap House water and sewerage system

projected to serve up to 150,000 people.

All three case studies are located in South East Queensland, one of the fastest growing regions in Australia. For the purposes of this paper the three case studies have been designated:

- Case 1 – The Gap House
- Case 2 – Manly Ecological Village
- Case 3 – Pimpama – Coomera Scheme

Case 1 - The Gap House

There are many houses in this region with similar features to the The Gap House predominantly in the fringes of major urban areas where reticulated sewerage and to a lesser extent reticulated water is not provided. Moreover, there are several properties with even more integrated water features (The Heathly Home, Gardner et al 2002). The Gap House is included in this paper partly because the information is readily available to the author but more importantly to illustrate the hypothesis of this paper that there are significant benefits to be gained by incorporating these features at a regional scale.

The Gap House is only one year old. It is located within 10 km of the Brisbane CBD. Being a large block subdivision (6000m^2) the area is not serviced by reticulated sewerage. The subdivision is served by reticulated water. Some 4000m2 of the block is bushland and is not irrigated. A schematic of the water and sewerage system serving the house is provided Figure 1 below:

As can be seen The Gap House includes a 20,000 Litres rainwater tank and an on-site treatment plant. Local regulations required the owner to provide the on-site system with the effluent to discharge to a 250m2 irrigation area using buried dripper pipes. The owner at his own cost included the rainwater tank and extended the irrigation system to irrigate all the gardens via an underground dripper system feeding each new plant and a new lawn area.

Table 1. Comparison of Water Use in New House and Previous House

	Annual Water Use (Litres)	
	The Gap House 2003	*Previous House 2002*
Reticulated Water Meter Reading	320,000	650,000
Estimated break up of water Use		
Indoor	270,000	364,000
Outdoor	46,000	286,000
Rainwater Tank Supply	110,000	
Effluent	240,000	
Total	**666,000**	**650,000**

The rainwater tank is used to supply the hot water system, the laundry, and toilet flushing. The rainwater tank has provision for topping up with reticulated water form the Brisbane City system. Reticulated water is also used for kitchen, and cold water in bathrooms. All bathrooms are fitted with water saving shower roses. Two adults and three teenage children occupy the household.

Table 1 compares annual water use between the new The Gap House and the previous house also in the same suburb. The previous house was within a sewered area and had reticulated water. The house was smaller but had similar size landscaping area and no water saving devices. Table 2 compares the annual cost to the owner between the new and previous house.

Table 2. Comparison of Costs to Owner Between New House and Previous House

	Annual Cost ($)	
	The Gap House 2003	*Previous House 2002*
Water Charge	$360	$633
Sewerage Charge	-	$450
On- Site STP annual maintenance fee	$80	-
Power cost for pump	$42	-
Annual cost of capital	$980	-
Total	**$1462**	**$1083**

The above example shows that while The Gap House has resulted in 50% reduction in water use and zero contribution to waste loads of the City's wastewater system the owner has not recovered the full benefits The Gap House has achieved for the City. The reason for this is that a household on its own will have a negligible impact on the bulk water supply systems and on the overall wastewater system. However, if every household implemented the same measures their combined impact would be significant, easily measurable and credits can be determined for implementing such measures. Brisbane Council recognised this issue and recently offered a $500 rebate to households that installed a rainwater tank.

Case 2 – Manly Ecological Village

This development has attempted to push the boundary in new urban living beyond integrating water management but also considered transportation and social dimensions. The development arose when Brisbane City Council called for expressions of interest to develop an area where conventional water and sewerage infrastructure were very difficult and costly to implement. To connect this development to the City's sewerage system would have required the construction of a pump station and 6km pressure main and associated sulphide control facilities valued in excess of one million dollars. Figure 2 shows a schematic layout of the village.

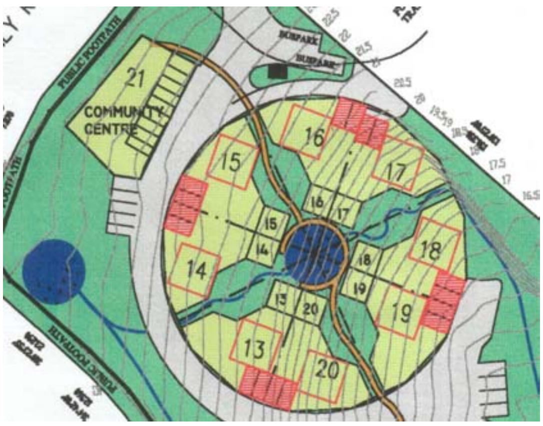

Figure 2. Schematic Layout of the Manly Ecological Village

A schematic layout of the water balance is shown Figure 3.

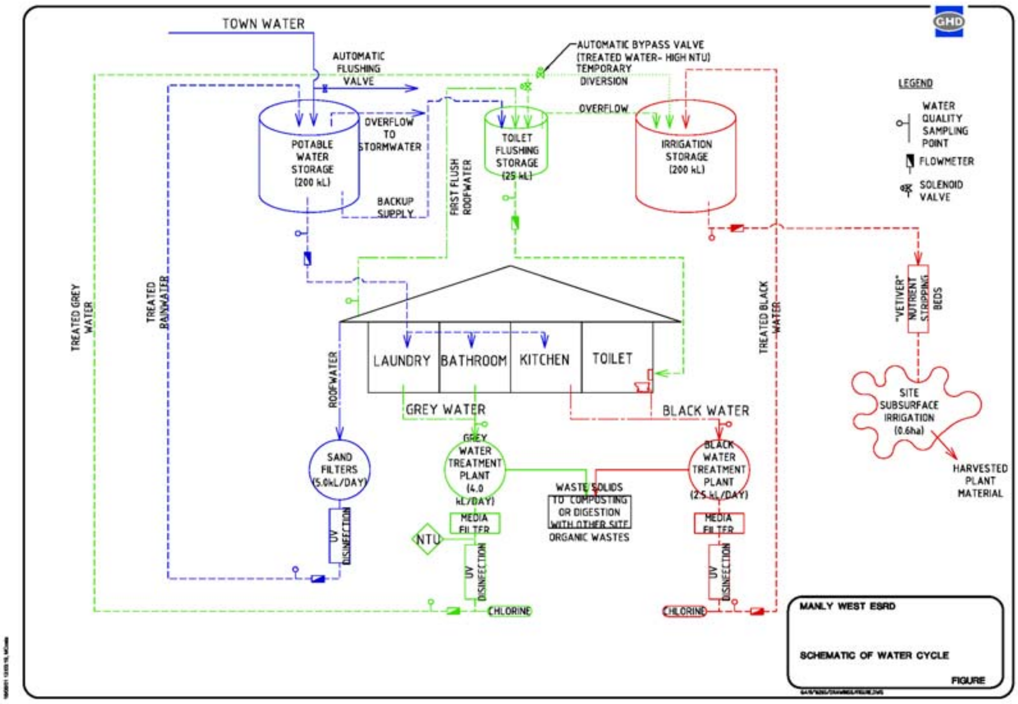

Figure 3. Schematic Manly Ecological Village Water Balance

As can be seen rainwater from all the houses is proposed to be collected in a central tank, filtered and disinfected and returned to the houses for use in the kitchen, laundry and bathroom. The rainwater tank can be topped up by reticulated water from the city system in periods of extended dry spells.

The wastewater is treated in two parts; grey water from the laundry and bathroom is collected separately and treated using an on on-site system, filtered, disinfected and returned to the house for toilet flushing via separate toilet storage.

Waste from kitchen and toilets is termed black water and this is treated in a second on site system, filtered disinfected and discharged to an effluent storage for irrigation of site landscaping using underground dripper systems.

Stormwater from the site is passed trough a series of ornamental ponds that store excess stormwater runoff and provides some treatment before released the receiving environment. Water from the ponds can also be used to supplement irrigation of landscaping.

Table 3 summarises the annual water balance for the Manly Ecological Village. As can be seen the village is able generate 84% of the water needs from within the development site. On an average year only 16% of the water needs of the village need to be imported primarily to meet the internal potable use when the rainfall is not sufficient to meet the potable water demand. Compared to current standards of service the total village water demand is about 93% lower.

Table 3. Summary of Water Balance for Manly Ecological Village

Source / Destination	*Annual Water Use (ML/yr)*	
	Supply	*Use*
Precipitation – first flush	0.54	
Precipitation - balance	2.80	
Town water	0.30	
Net Internal Use (1.7 ML-1.52 ML from grey water)		0.18
External Use		0.13
Irrigation (to 6000m2)		2.22
Discharge off site		1.09
Excess Irrigation water (to reserve area)		0.02
Total	**3.64**	**3.64**

Table 4 compares the annual household cost associated with the Manly Ecological Village utilising on-site systems compared to transporting the sewerage to the City scheme. It can be clearly seen that the proposed concept is far more economical then the conventional system that would otherwise require considerable transportation costs to connect the village to the City's sewerage scheme.

It is usually these type of drivers that allow schemes like the Manly Ecological Village to flourish. The scheme components involve existing technologies but require households to take on more responsibility in their operation. For many people this requires a change of life style and habits to make such alternative schemes sustainable over the long term. As we see more of these type of developments, the technology will become more cost effective and robust and concerns with on-site schemes will diminish.

Table 4. Comparison of Manly Ecological Village Scheme Costs to Conventional Scheme

	Annual Cost Per Property ($)	
	Manly Ecological Village Scheme	*Conventional Scheme*
Capital cost for transportation of village sewerage to City sewerage scheme	-	$4,400[1]
Sewerage Charge per property		$250
Water Charge per property	$25	$220
Capital cost of On-site Infrastructure at village	$1075	-
On- Site STP annual maintenance fee	$80	-
Power cost for pump	$42	-
Total	**$1222**	**$4870**

[1] The estimated cost to transport the sewerage 5.5 km to connect to sewerage scheme was $1.1m. In some cities the water utility is bound to meet this cost and is paid for all ratepayers not just benefiting.

Case 3 – Pimpama - Coomera Scheme

The Pimpama - Coomera catchment is a major growth area in the Gold Coast City Council. The total catchment area is close to 6,000 hectares and has a projected population capacity of around 150,000 people.

Development of this growth area will result in major increases in demand for water resources and increased wastewater volumes. At present the Gold Coast is facing three major challenges; the worst drought in its history, significant urban growth and increasing pressures from regulators to limit the wastewater discharges to the local waterways that make Gold Coast an international tourist destination.

While the City has in place plans to develop additional water resources to meet the growing demand it also recognizes that this approach may not be sustainable over the long term as it is becoming more difficult (politically and environmentally) to develop new surface water storages. Gold Coast Water, the business arm of Gold Coast City Council that has responsibility for the management and development of the water and wastewater infrastructure, recognized that the current circumstances provided it with a good opportunity to find a more integrated approach to servicing new urban developments in a way that ensures their long-term ecological sustainability.

Specifically, Gold Coast Water is now re-looking at the way that all water related services are to be delivered, including potable water supply, wastewater collection and treatment, effluent management/reuse, and stormwater drainage systems. The logic behind this initiative is that if it can be made to work, then Council will be in a much stronger position in the future to accommodate the growth that will see the City triple in size form 500,000 people at present to over 1,500,000 over the next 50 years.

Opportunities from an Integrated Approach to Urban Water Management

An integrated approach to urban water management offers the opportunity to provide water, wastewater and stormwater services in a manner that is ecologically more sustainable, more equitable and more cost effective to the overall community.

Following a series of workshops with key stakeholder groups the study team identified the following integrated water management initiatives as being worthy of detailed consideration:

- Recycling wastewater to meet the outdoor household uses of urban areas. This reduces water demand and the need for more water supply and associated infrastructure while at the same time reducing the amount of pollutants reaching the waterways;
- Promotion of new materials, systems, construction methods and tighter asset controls to allow the use of smaller pipes for sewerage collection and thus lower construction costs;
- Encouraging demand management within the house to reduce overall water demand and the amount of wastewater that is generated. The encouragement will involve mandatory use of water saving devices and pricing policies that promote water conservation;
- Promoting the use of less person access chambers for gravity collection systems by taking advantage of robotics with close circuit television equipment that allow maintenance and repairs to be carried without requiring person entry;
- Promoting the use of rainwater tanks to reduce demand for water and the size of stormwater pipes needed to convey stormwater flows from urban developments;
- Using the recycled water network to meet fire fighting needs thereby significantly reducing the size of water reticulation pipes needed to meet indoor household needs;

A detailed review of current levels of service and design criteria used for new urban development showed that there are significant opportunities for improvement. These are discussed below:

Opportunities to Reduce Water Demand

Gold Coast Water supplies approximately 350kL[2] of water per property per year (960L/d). The residential water consumption is about 240kL[3] per annum (660L/d). The difference is non-residential uses and water losses from the system. The annual residential water consumption is below the Australian average (260kL) for major water utilities but above most urban OECD countries. There are opportunities to further reduce water demand and GCW is implementing this through its water wise program. Key elements of the demand management program implemented by GCW includes:

- Education; incentives; regulation; pricing
- Encouraging the use of water-efficient appliances
- Water restrictions, drip irrigation, vegetation suited to local environment (planting natives, etc.)

Under the current GCW standards of service the water distribution system and the treatment plants are designed for 1030L/ET/day and the source of supply at 930L/ET/day. A detailed analysis recently undertaken by GCW has found the actual residential water consumption to be 815L/ET/day. The higher figure has been adopted to account for unaccounted for water in the system and to provide some buffer for high use areas and planning.

Table 5 summarises the opportunities for reducing household water demand from current levels.

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[2] WSAA facts 2001

[3] This figure includes multi unit developments. The water consumption for detached residential households is about 300kL or 815L/ET/day.

Table 5. Opportunities to Reduce Residential Water Demand

Water Use (L/ET/day)	Initiative	Comment
1,030	Current standard of service	This includes 120 L/ET/day for UFW and 95 L/ET/day for planning buffer. 60% internal use, 40% external
870	Mandatory use of water efficient devices (dual flushing toilets, shower roses, front loading washing machines)	Assume 16% reduction in internal demand (or 20% reduction in shower, toilet and washing machine use)
530	Dual water reticulation	Assume all outdoor use is met by effluent recycling
270[1]	Rainwater tanks	To supply laundry, toilet and hot water service
210	Tighter asset creation controls & better system monitoring	Reduce UFW by 50%
190	Apply 10% planning buffer on reduced demand	

As can be seen there is considerable scope to reduce residential household water demand by as much as 80% that is consistent with the findings in the two previous case studies.

Fire Fighting

Fire fighting requirements have a significant impact on the sizing of the potable water reticulation networks serving urban developments. Under the GCW current levels of service the water distribution system is required to supply a minimum of 15L/s at a pressure head of 12 meters to any fire hydrant servicing residential developments. This requirement essentially dictates the size of the water reticulation pipes that make up to 90% of the water network infrastructure. The fire-fighting requirement has a relatively minor impact on the trunk distribution mains.

Table 6 provides a summary of alternatives to current fire fighting provisions.

Table 6. Alternatives to Fire Fighting Provisions

Fire Fighting Flow in Potable System	Initiative	Comment
15L/s @ 12m	Current Standard of service	
1L/s @ 22m	Home based sprinkler systems	Householder installs internal and roof sprinkler system. Will require minimum 25 mm connection to house. Back-up connection to rain tank and/or pool.
Nil	Fire fighting supplied by dual water reticulation system	Fire fighting requirement provided in dual water reticulation system. May need back up connection to potable water supply at effluent storage.

Opportunities for More Efficient Wastewater Systems

In the last two decades there have been significant improvements in the material used for sewer construction, monitoring systems, cleaning systems and construction methods. Despite these improvements, the design criteria used for sizing and planning new sewerage schemes have remained relatively unchanged.

A significant component impacting on the capacity of sewerage systems is the allowance for stormwater infiltration and inflow (I/I). Under the current standards of service 60% of the pipe capacity is reserved for this component.

By using more flexible, watertight pipe materials and smaller/less maintenance access structures combined with tighter asset creation controls and better system monitoring, there are significant opportunities to reduce the allowance for I/I. Essentially this is a smarter way of servicing urban communities, thus the term **Smart Sewers**.

Table 7 provides a summary of opportunities for more efficient wastewater systems.

Table 7. Opportunities for More Efficient Wastewater Systems

PWWF (L/ET/day)	Initiative	Comment
4125	Current Standard of service	The figure includes 30% allowance for I/I.
3750	Mandatory use of water efficient devices (dual flushing toilets, shower roses, front loading washing machines)	Reduces flows to sewer
2250	Use of smart sewers	Use of watertight, flexible sewer pipe materials, no manholes, tight asset controls and system monitoring. 30% allowance for permanent infiltration
1950	Use of smart sewers	Use of watertight, flexible sewer pipe materials, no manholes, tight asset controls and system monitoring. 15% allowance for permanent infiltration.
Nil	On-site systems	Not permitted under current government legislation.

Other opportunities for more efficient wastewater systems where evaluated but the study team ruled out for the time being as needing further development. The team needed to consider schemes that could be implemented relatively quickly. Two of the initiatives that were discussed include on-site treatment systems and community owned and operated plants. These options have not been discarded from future consideration but have not been developed further in this first phase of the project.

Opportunities through water sensitive urban design

Concern with the water quality impacts from urban stormwater runoff has changed the way stormwater is provided to new urban developments. In the past the primary objective was flood protection and stormwater systems were designed to convey the flows to the nearest watercourse as quickly and as efficiently as possible.

Under the concept of water sensitive urban design (WSUD) the objective is to detain the peak flows to the pre-development levels and to introduce landscaping and water quality treatment systems to reduce the impact of stormwater discharge (both quantity and quality) from urban development on the receiving waterways. This in turn provides an opportunity to use the detained stormwater beneficially for landscaping or other uses.

The concept of WSUD is now being widely accepted by local authorities throughout Australia and it is being incorporated in the planning approvals for new developments.

Rainwater Tanks

Within the context of this study the WSUD measure that had the greatest impact on the water and sewerage infrastructure is the use of rainwater tanks. There is considerable interest in the use of rainwater tanks throughout Australia and considerable literature published on the subject.

The key benefits that rainwater tanks offer urban developments include:

- Supplements potable water supply;
- Reduces the peak flow water demand from the household;
- Reduces the size of stormwater reticulation;
- Reduces impact on trunk stormwater systems.

For the purposes of this project it was been assumed that rainwater would be used to supply all non-potable applications. Reticulated potable water would be provided to meet kitchen and bathroom demands and as a backup supply to the rainwater tank during prolonged dry periods in the form a trickle feed supply.

Table 7 summarises the assumed allocation of potable and rainwater for the above options.

Table 7. Proportioning of water demands

Water Use		Proportion	Source
Internal	Kitchen	10%	Potable
	Bathroom	20%	Potable
	Toilet	25%	Rainwater or Reclaimed
	Laundry	25%	Rainwater
	Hot Water	20%	Rainwater
External	Garden use	Varying seasonally	Reclaimed

A daily water balance model was used to evaluate the effectiveness of introducing rainwater tanks. The model used actual rainfall and evaporation data for a ten-year period from 1983 to 1992. This data set was considered to be representative of the rainfall pattern for the site and includes periods of drought and heavy rainfall.

On the Gold Coast, the average rainfall is sufficient to completely replace the potable water supply. However due to the uneven distribution of rainfall and limitations on individual storages, it will be necessary to back up the supply. The required irrigation follows an annual pattern with demand highest in summer and lowest in winter. If the daily rainfall is above a given limit, no irrigation will occur.

The modelling showed that with the external demand being met by reclaimed water, up to 70% of internal demand could be supplied from rainwater tanks. With a 10 kL tank, about 110kL or 57% of the total household demand could be replaced by rainwater. The results are summarised for a range of tank sizes as shown in Figure 4 below.

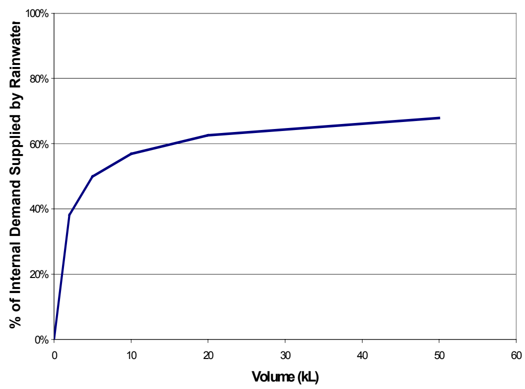

Figure 4. Size of Rainwater Tank Versus Proportion of Internal water Demand Met

To test the feasibility of the above initiatives four scenarios were developed and evaluated using a recent development as a case study. The results for this assessment are summarised in Table 8.

Table 8 Reticulation development costs per household

Summary	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Water	***Conventional.***	***Dual Retic***	***Dual Retic***	***Dual Retic + FF in Effluent lines***
Stormwater	***Conventional.***	***Conventional.***	***Rainwater tanks***	***Rainwater tank***
Sewerage	***Conventional.***	***Smart Sewer***	***Smart Sewer***	***Smart Sewer***
Potable Water	$2,419	$2,021	$2,021	$1,362
Reclaimed Water	-	$1,606	$1,606	$2,021
Rainwater Tank	-	-	$1,500	$1,500
Sewerage	$3,628	$2,643	$2,643	$2,643
Stormwater	$3,000	$3,000	$2,400	$2,400
Total $/lot	**$9,046**	**$9,270**	**$10,170**	**$9,925**

The results show that by taking advantage of new technologies and introducing some of the integrated urban water management initiatives, the additional costs to develop such schemes are not as high as previously assumed. In fact by taking into account the potential savings in the headworks, the alternative scenarios would offer economic advantages over the conventional approach.

Table 9 compares the whole of life costs of a conventional and one of the preferred IWM scheme. As can be seen the IWM scheme is a more economic option if the headworks are included in the overall assessment.

Table 9 Summary Economic Analysis

	Conventional Scheme	IWM Scheme
Peak O&M Costs ($M/year)	$13.0	$11.1
PV of Cap and O&M Costs (7%)	$539.8	$515.2
Peak Income ($M/year)	-$31.9	-$29.9
NPV (7%)	$296.1	$287.2

Key points to note from the economic analysis are:

- There is little difference in overall capital infrastructure construction costs
- The IWM option has marginally lower capital costs, and lower operating and maintenance costs, than the 'business as usual' case;
- The IWM options potentially have less income than Conventional scheme, as the potable water demand is less and the reclaimed water used to substitute this demand is assumed to be charged at a lower rate;
- In present value terms all the IWM option has a lower cost than the base case, even taking into account the reduced income.

Ecological Footprint Comparison Of Case Studies

A major driving force for considering IWM schemes is the desire to reduce the ecological footprint of new urban developments. A simple system was devised in this paper to illustrate how the ecological footprint measure could be used for assessing such schemes.

The system devised comprises three indicators:

- **Water demand**

  Under this indicator schemes are assessed on the volume of water that has to be extracted from the environment. – A value of 10 would equal the current level of service where all water is sourced from the environment. A scheme that reduced potable water demand by 80% would receive a value of 2.

- **Waste Load to the Environment**

  This indicator measures the volume of waste that is discharged to the receiving environment. The current approach where 85% of the wastewater is discharged to the waterways and no additional treatment would result in value of 8.5. A scheme that recycles all the wastewater and uses the nutrients to grow crops (or supplement potable water demand) is given a rating 1.

- **Stormwater Water Quality/Quantity**

  This indicator assesses schemes for their impact on water quantity and quality in the receiving water from new urban developments. – A new development where all the native vegetation is removed and replaced with paved surfaces and concrete drains will revive a rating of 10. A new urban development with appropriate landscaping and storage that limits water quantity and quality impacts to pre-development levels would receive a value of 1.

Table 10. Summary of Option Evaluation

Case Study	Description	Ecological Footprint				Economic
		Water Demand	WW Load	SW Impact	Total Eco. Foot print	(Annual cost /Property)
1	The Gap House	3	1	5	9	1462
	The Gap House – Old	10	9	9	28	1083
2	Manly Ecological Village	1	1	2	4	1222
	Manly Ecological Village – conventional	10	9	5	24	4870
3	Pimpama-Coomera Scheme	2	3	3	8	1046
	Pimpama-Coomera Scheme - Conventional	10	8	5	23	1126

Clearly there are more sophisticated measures of ecological footprint. These are more comprehensive and usually take into account other factors such as energy, transport, social dislocation etc. The indicators used in this paper are considered sufficient to illustrate the hypothesis in this paper.

The three case studies were assessed using the above criteria and the results are summarised in the Table 10.

Conclusion

The following conclusion has resulted from this paper:

- Integrated water management (IWM) offers significant opportunities to reduce the ecological footprints from new and existing developments;
- Contrary to popular perceptions the adoption of IWM measures need not cost more. In fact with good planning IWM at the start of new urban developments is more likely to produce a more economical solution;
- To realize the full benefits from IWM the concept needs to be embraced at a regional level to make a noticeable impact on headworks.
  - To adopt IWM does not require any new technology it is a management and education issue.

Acknowledgements

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Author Biography

Nick is the water business stream leader and director of GHD, one of the largest consultancies in Australia. The firm employs more than 2300 staff over 550 of which work in water projects.

Nick has over 26 year experience in the water industry throughout Australia and internationally. Nick's particular interest is in strategy development and water recycling. He was chairman of the Queensland Water Recycling Strategy Research and Development Technical Advisory Group.

He recently presented a similar paper at the International Water Association conference in Spain based on the work GHD has been doing for Gold Coast Water in developing a water infrastructure master plan for the Pimpama-Coomera growth area in the Gold Coast.

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