Integrated Water Management, Nyungar Cultural Associations and Regional Sustainability in Urban Developments on the Swan Coastal Plain

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Abstract
A new rating model for Integrated Urban Water Management is proposed for Perth's urban residential developments that reflects an existing culturally embedded indigenous concept of sustainability and ethics, which draws on Perth's Water Sensitive Urban Design work and emphasises the protection of the integrity of receiving waters of wetlands, creeks and the estuary. The importance of keeping drainage inverts above AAMGL in particular will be addressed. The importance of water quality management in terms of managing and avoiding heavy metal and nutrient mobilisation and contact, in terms of groundwater pollution risk, managing for acid sulphate soils and sediment and erosion control will also be considered. To rate highly on this model designs will need to address all of the water management issues adequately at the house lot, neighbourhood and regional scales. Developments which do this will be given a five turtle or YYYYY rating. A number of different scenarios are prepared for each site being considered and finally the preferred scenario is selected. The base scenario assumes that water efficient appliances and systems will be used throughout the development. It is assumed the building guidelines will ensure scheme water use only occurs inside the home with AAA minimum water efficient appliances, rainwater from tanks supplies some internal uses, and that all landscape irrigation is by surface or subsurface drip with non-scheme sources. This alone ensures that the development is using in the order of 50% less water than a conventional development. The other scenarios variously substitute scheme and groundwater use with recycled greywater or total wastewater. Infiltration of stormwater occurs increasingly while moving through the scenarios. Local and regional strategies to improve groundwater quality increase also while moving through the scenarios. Plant species are recommended to enhance local biodiversity and that have water requirements appropriate to the local water balance. This rating process has been applied qualitatively on a case study south of Perth. In this case study the opportunities and constraints that exist for treating and utilising each of these sources are considered.

1. Introduction

A new rating model for Integrated Urban Water Management is proposed for Perth's urban residential developments that reflects an existing culturally embedded indigenous concept of sustainability and ethics, which draws on Perth's Water Sensitive Urban Design work and emphasises the protection of the integrity of receiving waters of wetlands, creeks and the estuary. It refers to and celebrates the Nyungar name for Perth's land and waters, which is Derbal Yarragan or the Estuary of the Fresh Water Turtle. Considering respect for country (life and culture); water balance; water quality; and efficient water use; at the regional and house lot scale; a new five-step rating model for sustainable water use is now proposed. The Nyungar cultural associations with land and water remain as powerful wisdoms and sources of direction for more sustainable management of this land. Big issues include the importance of protecting water regimes of wetlands.

2. Water Sensitive Urban Design

The objectives of a water sensitive design project are to:

- Maintain water regimes and manage the water balance;
- Maintain and where possible enhance water quality;
- Encourage water efficiency;
- Maintain and enhance water-related environmental, recreational and cultural values;
- Address water management in an integrated and adaptive way initially at house lot, then at estate and regional levels.

The actions required to achieve ecologically sustainable development with respect to water management issues are facilitated and encouraged by water sensitive urban design. The techniques of water sensitive urban design are now well documented in the literature (e.g. Water Sensitive Design Research Group 1989, Hill & Nicholson 1989, Whelans *et al*. 1993, Evangelisti & Mouritz 1994, LandVision 1997, Evangelisti, McAlister & Mouritz in the 2003 Draft Australian Runoff Quality Manual). Water Sensitive Urban Design involves best practice water resource management across the following criteria:

- Water efficiency;
- Water balance;
- Water quality;
- Water-related environmental, recreational and cultural values;
- House lot, local area and regional strategies.

Water efficiency involves the minimal use of scheme water, encouraging water harvesting, reuse of stormwater, recycling of effluent, minimal irrigation and utilising appropriate self supply.

Maintaining and managing water balance involves maintenance and management of natural water regimes, appropriate aquifer levels, recharge and stream flow characteristics, preventing flood damage and erosion.

Water quality management aims to minimise pollutant export, minimise sediment load, protecting vegetation and aquatic fauna.

In general, the adequate recognition and protection, sustainable use and enhancement of the *beneficial uses* or *values* of water resources, often already recognised as important and protected by water allocation and planning processes (eg WAWRC, 1991) in subsequent land and water planning is essential. These specialist regional assessments of ecological value, indigenous value, scientific value, historic value need to be continually referred to maintain these special beneficial uses and values, often enormously important to regional and local communities.

A series of detailed water sensitive design checklists have been prepared to assist water auditing. Water auditing can contribute significantly towards the achievement of more integrated and aesthetically and culturally appropriate ecologically sustainable development.

There have been some recent documents produced which on the surface appear to continue the momentum of implementing water sensitive design and better integrated water management in WA.

- The Water Corporations Water Wise Developer Endorsement;
- The Water and Rivers Commission's Urban Stormwater Management Policy Statement;
- Recent Drainage & Nutrient Management Plans similar to Harvest Lakes.

However, they do not have a completely holistic view of water management, or adequate recognition of the need to protect natural and cultural values, and hence do not reflect all the good foundations of the Planning and Management Guidelines for Water Sensitive Design and the Development Control policies prepared over a decade ago.

Good recent work has been done in WA describing environmental, cultural, historical values. The proposed new Integrated Urban Water Management model will build on the water sensitive design work done over the last twenty years and incorporate new understandings of the natural, cultural and historical values of the sites. It will pay particular attention to sources of water available to the particular sites proposed for development or redevelopment.

3. Integrated Urban Water Management

The main aims of an Integrated Urban Water Management (IUWM) strategy will be to design a good place to live that is also a sound example of better water management (Odendaal, 2002). It will demonstrate optimum water efficiency for the site, pollution control and cost effective capital and recurrent costs for the developer and householders.

Figure 1 shows the concept of "closing the loop" to achieve a "zero-emissions" urban development. This model of Integrated Urban Water Management integrates urban design, landscape architecture and stormwater and wastewater management infrastructure into a new water sensitive form. By applying the Water Sensitive Urban Design principles to an urban development, and managing stormwater and wastewater as a resource, water efficiency and environmental and cultural values will be optimised whilst at the same time providing aesthetic and recreational benefits to the community.

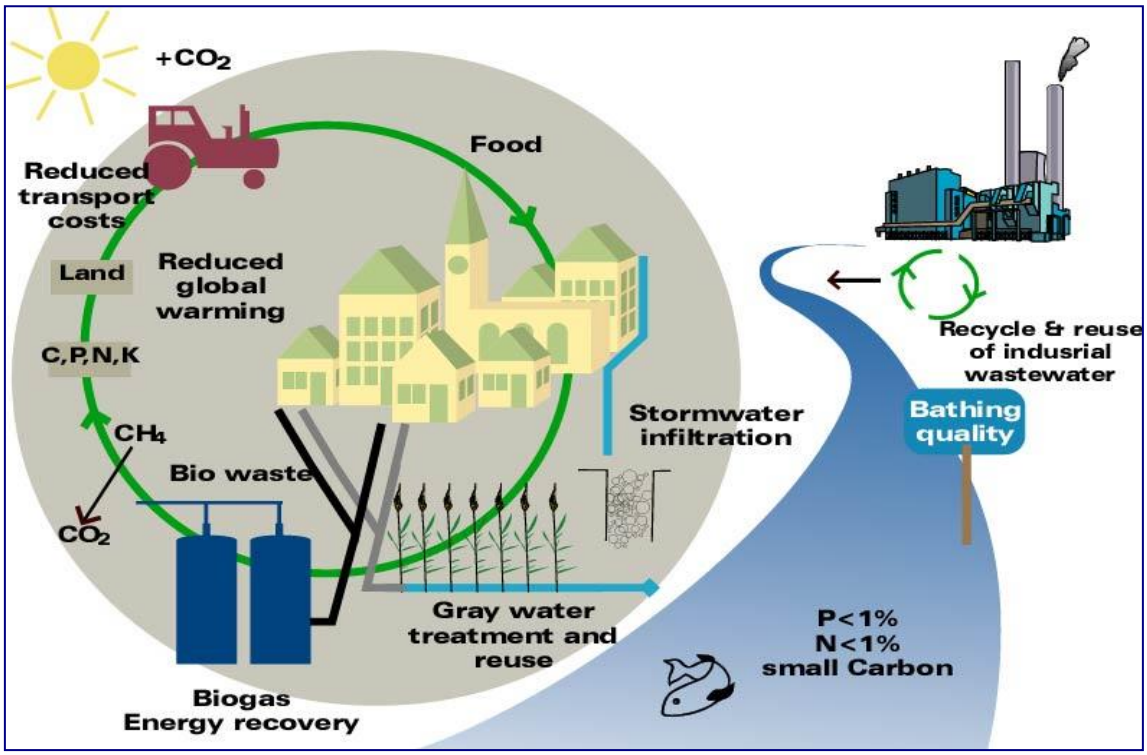

Figure 1: Integrated Urban Water Management: Closing the Loop for Sustainability (Source: UNEP, 2002)

The Integrated Urban Water Management model will deliver best practice water resource management across the following criteria known from Water Sensitive Urban Design:

- Water efficiency;
- Water balance;
- Water quality;
- Water-related environmental, recreational and cultural values;

- House lot, local area and regional strategies.

The following steps would be undertaken:

a. Identify regional and local natural, cultural and historical values
b. Identify regional and local water balance and water quality issues
c. Define strategies to address these issues at house lot, estate and regional levels
d. Estimate typical household (internal and external) and community facilities water requirements by means of existing data and independent modelling;
e. Identify opportunities for scheme water substitution;
f. Identify options for storage as may be necessary for rainwater, stormwater, reclaimed water;
g. Identify appropriate technologies;
h. Preliminary cost-benefit analysis.

The subsequent tasks as part of a detailed design phase would be to:

i. Detail the preferred option at estate and household levels;
ii. Detailed cost analysis;
iii. Identify environmental and public health hazards and define risk management strategies;
iv. Run hydraulic simulations and prepare concept drawings for civil works consultant to include in final documentation.

The model considers scheme water, rainwater harvesting, groundwater, stormwater runoff, greywater and blackwater as sources. The model reviews the opportunities and constraints that exist for treating and utilising each of these sources.

The modelling software called *Aquacycle* by the CRC Catchment Hydrology (Mitchell 2000) can be used to develop scenarios for different water balances in proposed urban developments (eg see McLean, 2002).

4. A New IUWM Model

Previous rating schemes are as follows:

- the water droplet is used by Water Corporation in its Waterwise campaign,
- the A is used by the Water Services Association of Australia in its water appliance efficiency rating scheme,
- the star is used for energy efficiency rating of electrical appliances, and
- NABERS uses a colour coding.

The Y is used by the ETC Murdoch University village rating model to differentiate itself from these schemes. The Y also has Nyungar associations and therefore helps to assess some of the water-related cultural and environmental criteria.

An important Nyungar dreaming story relates water and environmental management to human relationships and brings together care for earth and each other as an underlying principle which can provide a value base for a new approach to water management.

The Nyungar cultural and environmental associations are currently the subject of discussions between the traditional owners of the Swan Coastal Plain and Murdoch University. This forms the basis of an entirely new scientifically, environmentally and culturally sound model.

This model includes a new urban development water management rating scheme. A rating of 1Y (Y) to 5 Y (YYYYY) against each of the 5 criteria above is applied. The rating is applied as follows in Table 1 with some strategies listed as a minimum:

Table 1: A summary of proposed minimum strategies for each rating of the IUWM model

Rating	Water efficiency	Water balance	Water quality	Water-related environmental, recreational and cultural values	House lot, local area and regional strategies
None					All scheme
Y	internal AAA-min	1:5 ARI stormwater infiltrated onsite			POS irrigation by groundwater
YY	internal AAA-min + rainwater tanks plumbed in	1:10 ARI stormwater infiltrated onsite			POS + external residential by groundwater + onsite greywater
YYY	internal AAAA-min	1:50 ARI stormwater infiltrated onsite			POS + external residential/ business by central greywater
YYYY	internal AAAA-min + rainwater tanks plumbed in	1:100 stormwater infiltrated onsite			POS + external residential/ business by central blackwater
YYYYY	internal AAAAA-min + rainwater tanks plumbed in	1:100 stormwater infiltrated onsite	Full protection of groundwater and wetlands	Full range of values implemented	Maximum strategies implemented at all 3 levels

5. Case Study

An Integrated Urban Water Management Plan has been developed for the “South Beach Village” residential development currently under construction. The site is situated on South Beach and includes land in both City of Fremantle and City of Cockburn. The site is being developed by South Beach Joint Venture (SBJV).

The Integrated Urban Water Management (IUWM) Plan when implemented will far exceed other examples of water-related best practice land development in Perth such as that achieved at Harvest Lakes and Minim Cove.

The IUWM Plan can achieve all the necessary requirements for South Beach Village to be endorsed as a “Waterwise Village” by the Water Corporation.

Information from current and previous studies appears to indicate that groundwater may become too polluted from the adjacent landfill leachate and saltwater intrusion for long-term high rates of abstraction necessary for landscape irrigation.

The study has generated 9 feasible scenarios for South Beach Village. The base Scenario #1 assumes that water efficient appliances and systems will be used throughout the development. It is assumed the building guidelines will ensure water efficient appliances are adopted inside homes. In the base scenario it is assumed all landscape irrigation is by surface or subsurface drip-line and public open space is irrigated by groundwater. This alone ensures that South Beach Village is using in the order of up to 50% less water than a conventional development.

The other 8 scenarios variously substitute scheme and groundwater for recycled greywater or blackwater. Centralised greywater reuse commences at Scenario 4 while prior to this it can be onsite at the household scale.

Infiltration of stormwater occurs increasingly while moving from Scenario 1 to 9. Internal supply of rainwater commences with Scenario 2. Local and regional strategies to improve groundwater quality increase also while moving from Scenario 1 to 9.

Scenario 6a is recommended to achieve maximum water efficiency, cost-effectiveness and greatest control over wastewater recycling during subsequent management and maintenance operations. It comprises:

- **scheme** water use only inside homes with AAA minimum rated appliances;
- **rainwater** is collected at households and plumbed to toilet cisterns and washing machines;
- **greywater** is collected at one central treatment plant and distributed to POS, group dwellings, businesses and then house gardens for landscape irrigation, all irrigation is by means of surface or subsurface drip-line irrigation;
- **stormwater** is infiltrated in house yards, roadsides and the POS with peak events to the railway reserve and ultimately to sea on rare occasions;
- **groundwater** is reserved only for establishment of POS when no homes exist to supply greywater. Groundwater is available initially and for back up in the event of insufficient production from homes. Groundwater is topped up by the local infiltration.

Blackwater is not used in this Scenario #6.

There is more than enough greywater generated by the village when it is fully developed to irrigate both the POS and house yards. It is for this reason that centralised greywater collection is recommended against onsite household systems and also to avoid dependency on the high risk groundwater.

Plant species have been recommended to promote water efficiency and local biodiversity.

The cost-benefit analysis and rating of the scenarios is summarised in Table 2 below:

Table 2: Summary of Scenarios for SBV Case Study

Scenario #	**Waterwise Village rating**	**Water source** (Internal/external single res/external multi res + business/POS + lake)	**Scheme water savings above base (kL/day)**	**Water Corp Waterwise Village?**	**Cost above base price ($)**	**Cost to house-holder ($)**
1	Y	Scheme/scheme/scheme/bore	0	No	0	0
2	YY	Scheme+rain/scheme/bore/bore	14	No	40,000	3,000
3	YYY	Scheme+rain/bore/bore/bore	100	Yes	270,000	1,000
4	YY	Scheme+rain/scheme/ scheme /grey	0	No	300,000	3,500
5	YYY	Scheme+rain/scheme/grey/grey	14	No	340,000	4,500
6a (single g/w plant)	**YYYYY**	**Scheme+rain/grey/grey/grey**	**100**	**Yes**	**610,000**	**1,500**
6b (5 staged g/w plants)	YYYYY	Scheme+rain/grey /grey/grey	100	Yes	1,200,000	1,500
7	YYY	Scheme+rain/scheme/scheme/black	14	Yes	550,000	1,000
8	YYYYY	Scheme+rain/scheme/black/black	100	Yes	590,000	1,000
9	YYYYYY	Scheme+rain/black/black/black	200	Yes	820,000	1,000

6. Conclusions

The challenges for the model are as follows:

- the design will need to be of a high standard to secure regulatory approvals;
- economic viability - to the householder and developer, and
- the Local Government Authority that will be accepting the Public Open Space upon completion of the development will have a more complex system in terms of management and maintenance.

Other challenges include marketability, knowledge of designers, skills of LGA staff. It is proposed that scoring highly on a rating for regional sustainability will help this process.

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