EXECUTIVE SUMMARY

Background

Recent droughts in South-East Queensland and other Australian urban centres have driven investigations into alternative sources of supply to assist with water security. The capture and use of stormwater is one such source, which can be used to replace, and thereby take pressure off, central supplies.

At the same time the significant environmental impact of urban run-off has become better understood. These two drivers are leading to new practices and design approaches for stormwater management.

The Queensland Water Commission has released the SEQ Water Strategy, which sets out the means to ensure a secure water supply over the next 50 years, to support our lifestyles and provide for our water use needs as well as those of the environment. The Strategy includes a water supply guarantee which is to be met by a range of supply infrastructure, such as dams, desalination, purified recycled water and a grid linking them up, as well as an ongoing demand management program.

One key mechanism to ensure a secure water supply is the mandating of local supplies to be provided as part of new developments. The Water Savings Target under the Queensland Development Code requires the substitution of town water supplies by alternative sources which provide 70,000 litres per year per house and 42,000 litres per year per townhouse. Alternative sources include rainwater, stormwater, and recycled wastewater.

Source substitution has generally been achieved through rainwater tanks due to the lack of basic information on stormwater harvesting such as:

- What infrastructure is needed to meet the water savings target?
- Is integrating stormwater supply infrastructure into greenfield developments cost effective compared to other options?
- Can other requirements for stormwater, such as water quality and flow, be cost-effectively be built into harvesting infrastructure?

To facilitate the uptake of stormwater harvesting the Commission commissioned the *Stormwater Infrastructure Options to Achieve Multiple Water Cycle* Outcomes consultancy. The purpose of the consultancy is to address these questions and in particular, to provide:

- Cost and performance details of stormwater infrastructure for key types of greenfield developments to meet supply, quality and flow outcomes;
- Analysis of the influence of key variables on cost and performance of infrastructure such as: slope, rainfall, development type/intensity, demand, and storage;
- Identification of development scenarios where supply volumes beyond the water savings target could be achieved; and
- The key factors that make stormwater harvesting a viable option.

Methodology

Selection of development sites

The consultancy has identified and assessed stormwater infrastructure options for new broad scale developments, based on case studies for real sites:

- **North Lakes** - Large greenfield development site north of Brisbane situated on moderate topography (rolling hills). Most of the development has been designed and constructed.

Within the development site the following development parcels were selected for case study assessment:

- 20ha low density residential, 11-12 dwellings per ha;
- 100ha low density residential, 11-12 dwellings per ha;
- 500ha low density residential, 11-12 dwellings per ha; and
- 20ha industrial.

- **Sippy Downs** – Medium density development proposed for the Sunshine Coast. The layout and infrastructure associated with the development has been designed, and implementation is progressing at the time of this assessment. The following case study options were assessed:
  - 40ha residential, 100 dwellings per ha; and
  - 40ha residential, 40 dwellings per ha.

These developments were selected for assessment for the following reasons:

- they provide a representative mix of land use, scale, density and topography;
- they provide a mix of alternative stormwater infrastructure;
- the developments are considered to be representative of the large portion of development that will occur in SEQ; and
- they address greenfield and infill development.

Stormwater infrastructure scenarios

Each of the case studies was investigated across a range of stormwater scenarios. These can be generally described as follows:

Table 1 Stormwater Scenarios

Scenario	Name	Stormwater Management Measures
1	Traditional	• Normal Conveyance • Flood Flow Rate Mitigation
2	Current	• Traditional, PLUS • Queensland Development Code: Water Savings Target • Stormwater Quality Management Measures
3	WSUD	• Current, PLUS • SEQ Draft Implementation Guideline No 7
4	Stormwater Harvesting at Allotment Scale	• WSUD, PLUS • Stormwater Harvesting at an Allotment Scale • Only investigated for Sippy Downs and reuse was for irrigation only
5	Stormwater Harvesting at Catchment Scale	• Same as no 4, but catchment scale stormwater harvesting • Sippy Downs the scenario included rain tanks and reuse was for irrigation only • North Lakes considered 3 sub-scenarios: o No rainwater tanks, dual reticulation to allotments only o No rainwater tanks, dual reticulation to allotments and public open space o Rainwater tanks and public open space irrigation

Scenario	Name	Stormwater Management Measures
6	Stormwater Harvesting to an External Demand	• Catchment scale stormwater harvesting with a connection to an external demand equivalent to collection and reuse of the runoff from rainfall events up to 15mm • Similar to the above the Sippy Downs scenario included rain tanks and North Lakes did not.

Storage

Storage is required to buffer the episodic nature of stormwater runoff and ensure end use demands are met. The size of storage is dependant on re-use demand and the desired water supply reliability. In the past, the storage size required to attain a high reliability has been viewed as a major constraint to the wide spread application of stormwater harvesting. However, in the urban context, stormwater harvesting may be adopted to supply non-potable end uses using modest storage sizes to achieve moderate water supply reliability, with mains supply as a back-up if necessary.

A large constant demand delivers the most cost efficient stormwater harvesting scheme with the highest yield. This is because the higher the demand for stormwater, the more rapidly the storage is drained, thereby creating space to capture the next rainfall event. The volume of the storage for each case study and scenario was established based on the economic limit of performance of the storage (i.e. the diminishing rate of return on the storage versus demand met curve).

Treatment for reuse

The existing draft Australian Guidelines for Water Recycling: Stormwater Harvesting and Reuse (Phase 2) (EPHC, NHMRC, & NRMMC 2008b) do not define specific water quality classes for various uses. Instead, the guidelines provide Log Reduction targets for various uses for virus, parasite and bacteria concentrations. Therefore, to assist in defining treated water quality requirements, the following quality levels have been defined (Draft Stormwater Harvesting Guidelines, Healthy Waterways Partnership 2009):

1. Primary Contact (PC) – for uses such as community swimming pools;
2. Non-Potable High Contact (NPHC) – for uses where there is a high probability that people will come into contact with the water during use, e.g. toilet flushing, private garden watering, high use public facilities;
3. Non-Potable Medium Contact (NPMC) - for uses where there is a moderate probability of contact during use, e.g. low use public facilities or dust suppression;
4. Non-Potable Low Contact (NPLC) - for uses where there is a low probability of contact, e.g. industrial uses or where public access is effectively restricted during irrigation.

In general, with appropriate levels of treatment, harvested stormwater is considered to be suitable for all uses which could be supplied by treated recycled water, including toilet flushing, garden / landscape watering, general maintenance and car washing.

Results

Select results are presented in the below charts. The charts have been formulated as follows:

- WSUD/Current represents Scenarios 2 and 3;
- SWH to Site represents Scenarios 4 and 5;
- SWH to Ext represents a yield generated by collecting and reusing the whole of the Frequent Flow objective to capture and reuse the runoff from impervious areas and all rainfall events up to 15mm;
- The Bars represent the Highest and Lowest values estimated, and;
- The Dots represent the Median of the values estimated.

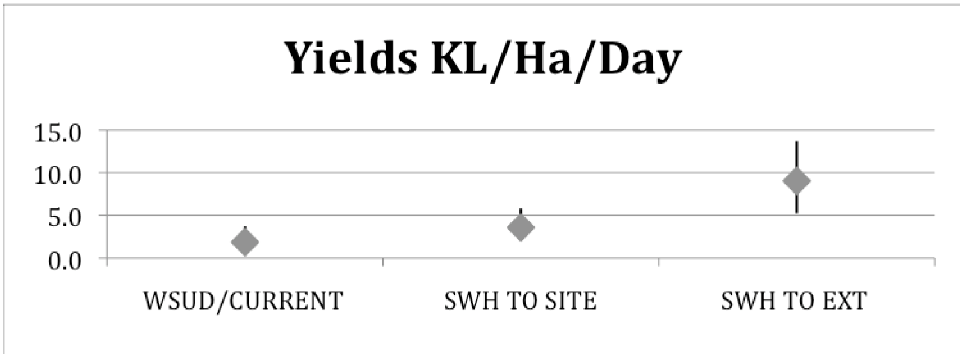

Figure 1: Stormwater Harvesting Yield

The following observations are made:

1. The progression from WSUD/Current to SWH to Ext shows a steady rise in the median yield.
2. The median yield is 3.6 kL/Ha/Day for all stormwater to site options, and 9 kL/Ha/Day for the stormwater to an external source option.

Costs have been determined on a stand-alone basis for all the stormwater and rainwater harvesting options (Marginal Costs), as well as including all stormwater costs (Gross Costs). The stand-alone basis is presented first, as this represents the marginal costs of stormwater and rainwater harvesting.

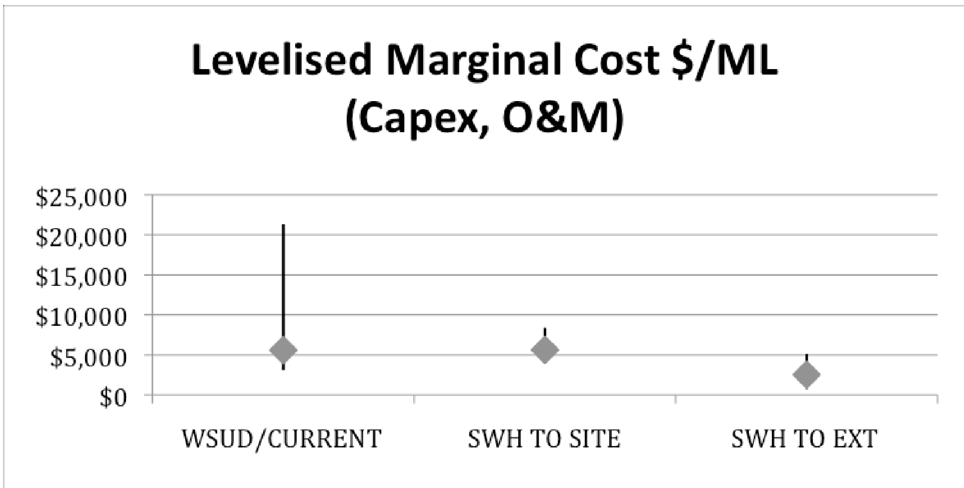

Figure 2: Levelised Marginal Cost of Stormwater

Table 2: Marginal Cost (capital and ongoing) of Stormwater Harvesting per Dwelling

Scenario	Description	Capital and Ongoing Cost (incl Land) $NPV/dw					
		Sippy Downs 100 dw/Ha	Sippy Downs 40 dw/Ha	North Lakes 20Ha Res	North Lakes 20Ha Ind	North Lakes 100Ha Res	North Lakes 500 Ha Res
1	Traditional						
2	Current	$500	$800	$4,400		$4,500	$3,500
3	WSUD	$500	$800	$4,400		$4,500	$3,500
4	WSUD + SWH (Allotment Scale)	$1,200	$2,400				
5a**	WSUD + SWH (Catchment Scale, Dual Retic to Lots)	$1,200	$2,300	$8,800		$6,300	$5,900
5b**	WSUD + SWH (Catchment Scale, POS irrigation, Dual Retic to Lots)			$9,100		$6,800	$6,100
5c*	WSUD + SWH (Catchment Scale, POS irrigation only)			$8,600		$6,500	$5,100
6**	WSUD + SWH to External	$1,300	$2,700	$9,600		$5,200	$2,600

*RWT all cases, ** Sippy Downs RWT were allowed, at North Lakes RWT were not allowed

The following observations are made:

- The costs of any of the stormwater harvesting options on a per dwelling basis are significantly lower for the medium density cases i.e. at Sippy Downs (circled in red) than for the low density development at North Lakes.
- the medium density cases only represents a relatively small cost increase over and above the Current/WSUD options.

To provide context for the above, the total costs of all stormwater conveyance, peak flow mitigation, water quality management rainwater and stormwater harvesting have also been estimated.

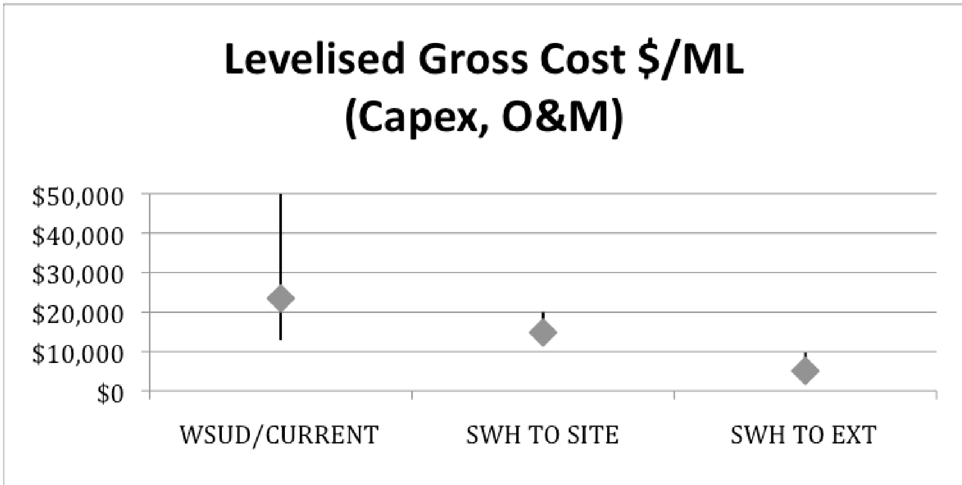

Figure 3: Levelised Gross Cost Stormwater Infrastructure

The following observations are made:

1. The WSUD/Current scenario shows a wide spread, due to the low demands and yields for the industrial estate case study.
2. The median value of the cost decreases consistently for the three groupings from $23,000 per ML, to $15,000 per ML, to $5,000 per ML.

Conclusions

Factors for successful stormwater harvesting

- Large scale development;
- High water demands
- Moderate slopes which drain to single/few points;
- Low cost storage.

Supply/Yield conclusions

- The yields from the schemes investigated provide a range for stormwater harvesting to site uses of 4 to 5 KL/Ha/Day;
- Yield is maximised (8 to 10 KL/Ha/Day) when there is a large demand (or large storage such as aquifers) which allows for storages to be drawn down and readily fill at the next rainfall event;
- High demand/yield reduces the levelised cost of the water, and reduces the environmental impact of stormwater flows;
- To achieve high demands in practice it will be necessary to have high density development, or a large external water user;
- A supply reliability of 70-75% has been designed for through storage size.
- An improved reliability can be achieved through larger storage size but this is leads to a worsening cost to supply ratio;

Cost conclusions

- The levelised cost of harvested stormwater is around $1,000 to $5,000 per ML, which is at the lower end of costings for rain tanks;
- The ‘add on’ costs for stormwater harvesting are not large compared to overall infrastructure costs;
- Stormwater harvesting has potential for greater water supply yields at lower costs than rainwater tanks, particularly for large developments, or where high water demands can be supplied;
- A key cost issues is the value of land used for stormwater infrastructure (and in particular storage), where infrastructure leads to loss of lots the cost increases significantly;
- Therefore storage in an existing drainage reserve or a suitable aquifer greatly reduces the cost of stormwater harvesting;
- Draining catchments to a single/few locations results in lower costs of storage, treatment and distribution of stormwater. This can readily occur in moderate to steep catchments (2 - 10% slopes) rather than flat sites where catchments are typically split to avoid large pipe drainage infrastructure;
- Larger scale development appears to reduce the costs on a levelised and per Ha basis. The minimum scale that should be considered is around 20Ha, but 100 Ha or more is desirable;
- Low density development provides a lower levelised cost for water, but higher density development provides a lower cost per dwelling for water;
- At a small scale, treatment (filtration and disinfection) costs tend to dictate cost whereas at a large scale the distribution network dictates costs.

Environmental and multiple water cycle outcome conclusions

- A stormwater harvesting scheme with a high yield has the potential to significantly contribute to improvement in downstream aquatic ecology by capture and re-use of small frequent flows;

- Infrastructure can achieve a number of stormwater outcomes (e.g. water quality, supply and environmental flow) and therefore cost efficiencies do occur.

General conclusion

- In a number of development scenarios stormwater harvesting can deliver water supply to meet and exceed the water savings target at a cost comparable to rainwater tanks, and in some cases cheaper;
- Stormwater harvesting could be the means of cost-effectively meeting the Water Savings Target under the Queensland Development Code for certain developments;
- There are likely to be many areas identified for development in the SEQ Regional Plan 2009-2031, which meet the factors for stormwater harvesting above the Water Savings Target;
- If wide uptake of stormwater harvesting to exceed the water savings target occurs, further reductions in demand on central supplies may be achieved.

However, it is stressed that this study has found a significant spread in the results, albeit with some clear trends. This indicates that there is wide variability in the way a stormwater harvesting scheme should be conceived and implemented, so every harvesting system should be considered on its merits and optimised to suit the situation in hand.

Future work

There are a range of other factors for consideration in the implementation of stormwater harvesting systems. These are not the subject of this study, but nevertheless, a list of these issues and actions have been compiled to provide some context to this work. The further issues for consideration are:

- Developing the information from this consultancy and other documents (such as the Healthy Waterways Partnership Draft Stormwater Harvesting Guidelines) into information products and workshops for local government and developers;
- The findings of this study could be applied to future development areas identified under the SEQ Regional Plan to map where significant stormwater supplies can be harvested;
- This analysis could be compiled to allow for an estimation of stormwater supply volumes across the region;
- How the costs of stormwater harvesting are assigned is a key question – for example charging on a volumetric basis would lessen the cost burden on house price (currently the cost of rainwater tanks are incorporated into the house price);
- Who owns and manages a scheme needs to be clarified to ensure efficient and effective operation and to inform pricing frameworks;
- Incentives for stormwater harvesting could be considered (such as reduced developer contribution to supply infrastructure due to the local supply provided) to account for the beneficial externalities;
- Ensuring that local and State government legislative approvals are sufficient to ensure schemes are effective but are not overly burdensome;
- Clarify the impact of land costs on stormwater harvesting systems;
- Review the impact of rain water tanks on the effectiveness of stormwater harvesting systems;
- What are the all encompassing advantages and disadvantages of a stormwater harvesting scheme, for example, including community benefits, environmental benefits, water security and so on.

Recommendations

This study provides a strong basis over a range of scenarios and development types for the consideration of stormwater harvesting as a source of water for SEQ. The modelling and analysis herein have been undertaken with rigour, providing a set of results that can be used with confidence. The results demonstrate that stormwater harvesting is a feasible alternative to a range of other alternative water sources. It is recommended that the results of this study be used to underpin a study into the broader application of stormwater harvesting in SEQ.