Drivers for Decentralised Systems in South East Queensland

Grace Tjandraatmadja, Stephen Cook, Angel Ho,
Ashok Sharma and Ted Gardner

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The Urban Water Security Research Alliance (UWSRA) is a $50 million partnership over five years between the Queensland Government, CSIRO's Water for a Healthy Country Flagship, Griffith University and The University of Queensland. The Alliance has been formed to address South-East Queensland's emerging urban water issues with a focus on water security and recycling. The program will bring new research capacity to South-East Queensland tailored to tackling existing and anticipated future issues to inform the implementation of the Water Strategy.

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Enquiries should be addressed to:

The Urban Water Security Research Alliance
PO Box 15087
CITY EAST QLD 4002
Ph: 07-3247 3005; Fax: 07-3405 3556
Email: Sharon.Wakem@qwc.qld.gov.au

Ashok Sharma - Project Leader Decentralised Systems
CSIRO Land and Water
37 Graham Road
HIGHETT VIC 3190
Ph: 03-9252 6151
Email: Ashok.Sharma@csiro.au

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FOREWORD

Water is fundamental to our quality of life, to economic growth and to the environment. With its booming economy and growing population, Australia's South-East Queensland (SEQ) region faces increasing pressure on its water resources. These pressures are compounded by the impact of climate variability and accelerating climate change.

The Urban Water Security Research Alliance, through targeted, multidisciplinary research initiatives, has been formed to address the region's emerging urban water issues.

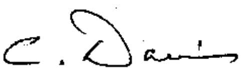
As the largest regionally focused urban water research program in Australia, the Alliance is focused on water security and recycling, but will align research where appropriate with other water research programs such as those of other SEQ water agencies, CSIRO's Water for a Healthy Country National Research Flagship, Water Quality Research Australia, eWater CRC and the Water Services Association of Australia (WSAA).

The Alliance is a partnership between the Queensland Government, CSIRO's Water for a Healthy Country National Research Flagship, The University of Queensland and Griffith University. It brings new research capacity to SEQ, tailored to tackling existing and anticipated future risks, assumptions and uncertainties facing water supply strategy. It is a $50 million partnership over five years.

Alliance research is examining fundamental issues necessary to deliver the region's water needs, including:

- ensuring the reliability and safety of recycled water systems
- advising on infrastructure and technology for the recycling of wastewater and stormwater
- building scientific knowledge into the management of health and safety risks in the water supply system
- increasing community confidence in the future of water supply.

This report is part of a series summarising the output from the Urban Water Security Research Alliance. All reports and additional information about the Alliance can be found at http://www.urbanwateralliance.org.au/about.html.



Chris Davis
Chair, Urban Water Security Research Alliance

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EXECUTIVE SUMMARY

Centralised water and wastewater systems, characterised by the sourcing of water and treatment of wastewater outside of the urban area, have traditionally delivered important benefits to society, particularly in the improvement of public health. However, in South-East Queensland (SEQ) and in other regions of the developed world, this traditional paradigm for water services is challenged by rapid urban growth, capacity constrained infrastructure, limited available water resources and uncertainty associated with the impact of climate change. These challenges have prompted the consideration of alternative approaches to managing urban water services that integrate water planning, wastewater and stormwater services. They will also encourage the utilisation of alternative localised water sources such as rainwater, recycled water and stormwater.

This report will assist in understanding the potential role of decentralised systems for SEQ. Decentralised systems *in situ* or in combination with centralised systems are increasingly regarded as important components for the transition to a more sustainable provision of urban water services. This report aims to understand the major drivers for implementing decentralised water and wastewater systems in SEQ by: (i) summarising drivers applicable to Australian developments, as defined in previous work; (ii) identifying the major challenges to water security experienced in SEQ and (iii) identifying the key drivers of change toward the use of decentralised systems in SEQ. The report also explores site-specific factors that influence the suitability of decentralised systems and examines the benefits of decentralised systems for SEQ. The report is informed by a review of the SEQ regulatory and biophysical context, particularly through investigation of initiatives from the different levels of government; examination of case study developments that incorporate decentralised systems; and the establishment of a focus group, comprised of SEQ water professionals with expertise in conventional and integrated water and wastewater service, which was conducted in September 2008.

In SEQ, rapid population growth, an extended period of below average rainfall and the need to preserve sensitive ecosystems have created a sense of urgency that is causing a rethink of the provision of urban water services. This urgency is reflected in the rapidly evolving legislative and planning framework that is enabling and providing the impetus to implement alternative approaches, such as the increased adoption of decentralised systems.

The major drivers influencing the uptake of decentralised systems in SEQ are the increased uncertainty of traditional water supplies, rapid population growth and associated population impacts in the region. Against this background, the report identifies the adoption of decentralised systems in SEQ as being driven by:

(a) the need to overcome limitations of existing water and wastewater services;

(b) the need to defer expensive infrastructure upgrades;

(c) environmental protection;

(d) opportunity to showcase the potential for sustainable approaches and innovative technologies;

(e) water conservation; and

(f) enhancement of landscape amenity.

Eight out of the nine focus group respondents believed decentralised systems have a potential role in the development of SEQ as decentralised systems can be adopted in a variety of situations i.e. greenfield, brownfield, urban infill, and rural developments, and either connected or not to the SEQ water grid.

In assessing the suitability of decentralised systems for the servicing of a specific development site, a number of site-specific characteristics needed to be considered, such as the system configuration and viability. The principal characteristics which determine suitability have been identified and are explored in the report including (i) regional climate, (ii) geographical and topographical features, (iii) soil and hydrogeological characteristics, (iv) existing water and wastewater infrastructure and capacity; and (v) development plans for the area.

Focus group participants identified the following benefits for SEQ that are likely to accrue through increased adoption of decentralised systems: (i) reduced environmental impact of urban water services; (ii) staged investment of capital through the life of a development (offering economic benefits); (iii) promotion of community ownership and awareness of water use/impact; (iv) creation of opportunities for technological innovation; (v) encouragement of institutional reform; and (vi) movement towards more sustainable development and use of water resources.

The integration of decentralised systems into urban areas is not without challenges. It represents a significant departure from the typical centralised water and wastewater service provision model adopted in urban areas; for instance, it requires a larger degree of cooperation between stakeholders, such as service provider and users. Integration will require a paradigm shift in the water and urban planning sector, such as the development of new frameworks for governance/service provision, regulation and its enforcement. Whilst this brings forward new challenges, there are existing service models in other industries that can provide a basis for such transition.

1. INTRODUCTION

Decentralised systems are increasingly adopted in urban areas of Australia and across the world in response to a diverse range of factors. Gikas and Tchobanoglous (2009) point out that alternative approaches are required to cope with population growth, provide competition for urban water from other sectors (particularly agriculture) and develop more environmentally sustainable approaches to the management of urban water resources. Van Roon (2007) identified escalating infrastructure costs, ecological impacts and water shortages as the primary drivers for shifting to decentralised systems. The definition of decentralised systems adopted by Cook *et al.* (2009, p.19) is adopted in this report:

> *"Systems for water, wastewater and stormwater services at the allotment, cluster and development scale that utilise alternative water resources; including rainwater, wastewater and stormwater; based on a 'fit for purpose' concept. Systems can be standalone, or integrated with centralised systems. In those systems wastewater streams are partially or completely utilized at or close to the point of generation. Stormwater is also managed as part of an integrated approach that aims to control the quality and quantity of runoff at or near the source to minimise the impact of development on natural environment."*

As defined, decentralised systems are not limited to water or wastewater alone; they are able to operate across the traditional functional boundaries of the urban water cycle—from the provision of water supply, to management of wastewater, and control and treatment of stormwater. They can also be applied in a range of sizes: lot, cluster and development scale.

In Australia, a primary driver for decentralised systems in urban settings is water scarcity, prompting the need to utilise alternative water sources in order to minimise potable water use. In Europe (Sweden, Finland, Norway, Iceland, Germany, Switzerland), the detrimental impact of effluent on lakes and rivers has made pollution prevention the major driver for decentralised wastewater treatment, with a large number of projects focusing on nutrient recovery and reuse in agriculture (Tjandraatmadja and Burn 2006). Decentralised wastewater systems in the USA have been primarily driven by the sprawl of urban development beyond the core area serviced by centralised infrastructure (Fielding, 2007).

The type of decentralised system adopted is influenced by the local context. In Japan, adoption of on–site water reuse and recycling for both individual and clusters of multi-storey buildings has been practised in major urban centres for over 20 years, with a range of schemes integrating a mix of sources including greywater, rainwater, piped treated effluent, on–site treated wastewater and mains water (Yamagata *et al*. 2002, Asano *et al*. 2007). In the Japanese context, such recycled water schemes have been economically cheaper than conventional centralised infrastructure for the provision of water at scales of over 100 m^3/d, when assessed by life cycle cost analysis (operation and maintenance costs and capital expenditure) (Yamagata *et al.* 2002).

In the USA, one in four households relies on individual on-site or small clusters systems to treat wastewater. The majority of these systems are located in rural areas; however, over 25 million people in suburban areas are serviced by decentralised systems, and up to 33% of new development is served by on–site or cluster wastewater systems. Outcomes from a United States Environmental Protection Agency (USEPA) (1997) report to the US congress on decentralised wastewater systems established that:

> *"Decentralised systems can protect public health and environment, typically have lower capital and maintenance costs for rural communities, suburban developments, remote school and institutional facilities and are appropriate for varying site conditions, and are suitable for ecologically sensitive areas when adequately managed" (USEPA 1997).*

In Australia, decentralised systems in urban areas using an integrated approach to the provision of water services have emerged in the last 15 years. Examples of developments that are adopting decentralised and integrated water managements practices can be found across the majority of States, with a number of prominent examples in SEQ (Tables 2 and 3) including Capo di Monte (Qld), Sunrise at 1770 (Qld), the Ecovillage at Currumbin (Qld), Mawson Lakes (SA), Aurora (Vic), and Rouse Hill and Newington (NSW).

While implementation of decentralised systems occurs at local level and ideally such systems are designed to target local needs and site conditions, the uptake is strongly linked to overarching legislation, policies and institutional arrangements (Tjandraatmadja *et al*. 2008).

This report aims to: (i) provide a summary of the major drivers for implementing decentralised water and wastewater systems across Australia, defined in previous work; (ii) identify the major challenges to water security in SEQ; and (iii) identify the specific drivers that influence the adoption of decentralised systems in SEQ. This exploration will assist in improving the understanding of the forces that are shaping the future provision of water and wastewater services in SEQ. Furthermore, elucidation of the drivers provides a foundation for understanding the role that decentralised systems may have in addressing the critical sustainability challenges threatening the security of water services in SEQ.

2. METHODOLOGY

In order to explore drivers for decentralised systems in the SEQ context the following tasks were undertaken:

(a) a review of the SEQ context and government initiatives was performed;

(b) case studies of developments incorporating decentralised systems in SEQ were conducted; and

(c) a focus group consisting of SEQ water industry professionals with expertise in the implementation of decentralised systems was convened.

Although a larger number of potential participants (16) were initially approached to participate in the focus group, the final sample size was determined by the number of professionals that were able to participate in the study. Consequently, nine SEQ water industry professionals with expertise in decentralised systems in the region were consulted using an online questionnaire. Five worked in the government and/or water sector, three for major consultancy companies and one in academia.

3. THE SOUTH-EAST QUEENSLAND CONTEXT

SEQ is faced with significant challenges in securing sustainable water and wastewater services. The fundamental challenge facing SEQ is a rapidly increasing population, resulting in an increase in water demand. This is coupled with a decreased confidence in traditional sources due to an extended period (2001–2007) of below average rainfall and projected negative impacts of climate change. To address this challenge, a number of initiatives have emerged at various levels of governments. This section summarises the SEQ context in terms of issues faced for water and wastewater services, and existing government initiatives and guidelines.

3.1. Population

SEQ has been recognised as Australia's fastest growing region (Queensland Government 2005a). Based on population projections, the average rate of growth of 60,000 people per year will result in an additional population of anywhere between 3.6 to 4.3 million people by 2026 in SEQ (Queensland Government, 2005b).

The expanding population will require the construction of an additional 575,000 new dwellings by 2026. Although 40% of the housing needs is anticipated to be covered by infill or redevelopment in existing urban areas, the remaining 60% will need to be met through greenfield development and rural living on the peri-urban fringe (Queensland Government 2005b). This will result in expansion of the urban area and conversion of rural land or bushland, and will require the provision of associated urban infrastructure.

As the population increases, further pressure will be placed on sensitive ecological habitats and receiving environments in SEQ, such as the ecologically significant Moreton Bay, Noosa River, Maroochy River, Pimpama River and Hotham Creek and Glass House Mountains (Queensland Government 2005b).

3.2. Water Supply Security

In the period between 2001and 2007, SEQ experienced a severe drought, with rainfall over dam catchments to the west of Brisbane the lowest on record (Queensland Government 2007). The only comparable drought occurred during the period between 1898 and 1903 (the Federation drought) and recorded similar duration and severity. It is not clear if recent periods of very low rainfall resulted from climate change due to global warming and the increased greenhouse effect. Historical rainfall records and surrogate records derived from coral suggest that SEQ has experienced extended dry periods interspersed with wet periods (Queensland Government 2007). This suggests that the SEQ water supply needs to be resilient to extended periods of low rainfall regardless of climate change impacts.

Climate change projections for the SEQ region for 2030 anticipate an increase in annual temperature of 0.2 °C to 1.6 °C, with an associated increase in potential evaporation of between 1% and 8% and rainfall variation by ±7% from long-term averages (Natural Resources and Water 2007). These conditions would impact significantly on water security in SEQ. Projections of water demand and availability, based on the current water supply in the region and a 10% reduction in water storage capacity in dams due to climate change, estimate a shortage between 97,000 and 308,000 ML/y of water by 2056 (Queensland Government 2005b). The traditional water supply model, which is based on 95% of water being supplied by existing dams, will not be able to cater for the needs of a growing population; therefore, supply will need to be augmented by alternative sources. In the search for alternative sources the Queensland government is currently exploring a range of initiatives such as potable recycled water, dual reticulation, desalination and demand management.

3.3. Government Initiatives

Since 2003, planning policies and guidelines have emerged from federal, state and local governments to facilitate demand management and the adoption of systems utilising alternative water sources. These initiatives are available on respective government websites. Notable initiatives relevant to SEQ are summarised below.

3.3.1. Federal and State Government Initiatives

At the federal level, the *National Water Initiative* (NWI) is a shared commitment between the Commonwealth of Australia and all states and territories to achieve better water management across Australia. The NWI identifies key areas to improve management of water in urban environments including: providing healthy, safe and reliable water supplies; encouraging reuse and recycling of wastewater in cost-effective ways; and promoting innovation in water services (i.e., sourcing, treatment, storage and discharge).

In October 2001, the Queensland Environmental Protection Agency (EPA) released the *Queensland Water Recycling Strategy* (QWRS), a state level initiative to encourage water recycling in government, industry and the community. The QWRS stated the Queensland Government policy positions on the use and sources of recycled water, and emphasised the important role of water recycling in an integrated water cycle management approach. The QWRS also addressed the need for financial incentives for water recycling and identified action plans, providing guidance for public and private sectors in developing water recycling initiatives.

In 2005, the Queensland Department of Nature Resources and Water (Qld NRW), revised the *Queensland State Government Planning Guidelines for Water Supply and Sewerage*; this was the first major revision in over ten years. The guideline reinforced the implementation by local governments of a wide range of infrastructure, source substitution and non-asset solutions to potentially meet current and future water demands.

Perceived health risks have been identified as a major barrier to the adoption of alternative water sources (Dimitriadis 2005). In November 2006, the National Resource Management and the Environment Protection & Heritage Ministerial Councils released the *Australian Guidelines for Water Recycling Phase 1: Managing Health and Environmental Risks*. This was followed by Phase *2: Augmentation of Drinking Water* in April 2008.

In September 2008, the Qld NRW updated the *Queensland Guidelines for Water Recycling*, with a major change in the Water Quality Section, to ensure alignment with the emerging national standards for water recycling. Concomitantly, the *Water Supply (Safety and Reliability) Act 2008* was introduced to ensure the protection of public health and reliability of water sources, including recycled water. The act was administered through the Office of the Water Regulator in July 2008 (Queensland Government 2008a).

Additional guidelines in areas such as auditing and annual reporting, planning of a recycled water scheme and use of recycled water have also been released. These include, for example, the *Recycled Water Management Plan and Validation Guidelines* (Queensland Government 2008b) and the *Water Quality Guidelines for Recycled Water Schemes* (Queensland Government 2008c). These guidelines aim to provide a framework for managing public health risks of recycled water systems and to promote public confidence in its safety and reliability.

The *South-East Queensland Regional Plan 2005-2026* provided a blueprint for the creation of sustainable, affordable, prosperous and liveable communities with provisions for quality infrastructure and services. The strategic plan promotes sustainable development, recognises the unique subtropical character of the region and seeks to value and protect significant ecological and cultural landscapes (Queensland Government 2005b).

The *Smart Queensland: Smart State Strategy 2005-2015* advocates, in the search for sustainability, the need to find the right balance in managing its resources (land, water and energy) and promotes among its principles: (i) integrated and long term decision making; (ii) intergenerational equity; (iii) intragenerational equity; (iv) precautionary principle; (v) conservation of biological diversity and ecological integrity; and (vi) internalisation of environmental costs (Queensland Government 2005a).

In particular, on water management, the *SEQ Regional Plan 2005-2026* identified the following strategic priorities (Queensland Government 2005b):

(a) creating more efficient water management and use;

(b) increasing water supply to accommodate growth in the region;

(c) diversifing supply to address climate variability, change and other supply risks; and

(d) ensuring policy frameworks and subsidies that support total water cycle management and review institutional arrangements to ensure efficient, sustainable and equitable coordinated regional water planning and delivery of bulk water supply and treatment activities.

A significant initiative for water management is the draft *South-East Queensland Water Strategy*, a long-term (50 years) planning document aimed at delivering a new standard of water security in the SEQ region (Queensland Water Commission 2008). The main features of this strategy are highlighted in Table 1. Focusing on the entire cycle of water production and use, the strategy identifies the need to consider local supply sources, such as rainwater harvesting and water recycling, in order to achieve a demand-supply balance. The strategy also proposes regulations that mandate the installation of rainwater tanks on new residential, industrial and commercial buildings (such as the Queensland Development Code mandatory provision 4.1), the use of greywater and requirements for businesses to prepare and implement water efficiency management plans as part of demand management program to achieve structural water efficiency (such as the Queensland Development Code mandatory provision 4.2) (Queensland Government 2009).Through these measures, rainwater tanks and other alternative water sources are expected to contribute 24% of supply by 2056.

At the same time, the Queensland government has been investing in large-scale initiatives, such as the construction of the desalination plant at Tugun on the Gold Coast, as part of the *SEQ Water Grid, Gold Coast City Council's Waterfutures Strategy* and the *State Government's South-East Queensland Regional Drought Strategy Contingency Supply Plan* (Queensland Government 2005b).

Table 1: Key features of the draft South-East Queensland Water Strategy

Strategy Goal	Feature
Target 230	Reduction in residential water use by 24% to 230L/d per capita.
New water supplies	Decrease reliance on water dams and investigation of sources such as desalination plants, purified recycled water, increased uptake of rainwater tanks for homes and business and consideration of local supply sources such as stormwater harvesting and wastewater recycling.
Drought planning	Sufficient investment and management of the water supply system and a drought response plan.
Rural production and power stations	Sale of surplus water to rural producers and power stations.

Source: Queensland Water Commission 2008

3.3.2. Local Government Initiatives

In line with the objective of the Queensland State Government to provide sustainable water services, local governments in SEQ have developed policies to encourage diversification of water sources. The most widely adopted initiative is the rainwater tank rebate scheme for ratepayers. All local governments in SEQ have implemented this initiative, offering rebates of up to $1500 for internally plumbed water tanks of 3000 litres or greater, in pursuit of Queensland Development Code Part 25 (MP4.2) Water Saving Target (Queensland Government 2009). Other significant initiatives associated with decentralised systems at local government level in SEQ are described below.

The Brisbane City Council developed an integrated water strategy, named "*Water for Today and Tomorrow*" in 2005, and in 2008, it was re-released as "*An integrated water cycle management strategy for Brisbane*", to meet Brisbane's short-term (2010) as well as long- term (2026) water demand. One of the eight sub-strategies is to "provide sustainable water services for the city and local areas" through "promoting alternative water sources and supplies" (Brisbane City Council 2008). A target was set to achieve a 7% substitution of urban potable water supply by alternative water resources. To achieve this, the Brisbane City Council is developing plans for developments across Brisbane to use water more efficiently and for its intended purpose, explore opportunities for dual reticulation and sewer mining and conduct feasibility studies into alternative sources of water to augment existing storage systems.

The Rochedale Urban Community (RUC) development, located 15 kilometres south-east of Brisbane, is Brisbane City Council's showcase for sustainable water services for urban residential development. The development encompasses about 500 hectares of land for 600 houses. The Master Plan for RUC incorporates world's best-practice standards for urban design and integrated water management, and adopts innovative technologies to achieve a reduction in drinking water consumption levels by up to 75%. The RUC incorporates water sensitive design features such as (i) rainwater tanks for toilet flushing, bathroom and laundry; (ii) sewer mining to supply treated wastewater to outdoor uses; (iii) "smart" sewers to eliminate stormwater infiltration; (iv) bioretention basins and permeable pavement to reduce stormwater runoff; and (v) aquifer storage and recovery of stormwater and treated wastewater.

The Gold Coast City Council developed the Waterfuture Strategy in December 2005 by investigating every possible water supply source. Serving as a blueprint for sustainable water supply over the next 50 years in Gold Coast region, the strategy focuses on establishing a better "water balance", with supply augmentation and demand management as equally important parts of the solution. The Waterfuture Strategy recognises the importance of diversifying water supply sources and matching them to suitable purposes to improve the security of water supply. Actions have been identified to ensure that, of the targeted 466 ML/day of the city's water demand in 2056, approximately 10.5% is made up of localised sources of supply, including rainwater tanks, recycled greywater and stormwater harvesting. The Pimpama-Coomera Waterfuture Project is the Gold Coast City Council's showcase for sustainable urban development. Details of the project are presented in section 4.1.

The water and sewerage structure in SEQ is also experiencing significant changes in its water grid (new dams, pipelines, desalination plant) as infrastructure is developed across the state through partnerships with local and state governments and private sector to increase the security, distribution and management of water resources. Examples of such initiatives, such as the Eastern pipeline connector, the Southern Regional pipeline connector and the Gold Coast Desalination project, can be found in the website <http://watergrid.infrastructure.qld.gov.au/asp/index.asp>.

4. DRIVERS FOR DECENTRALISED SYSTEMS

To gain an understanding of the key drivers for decentralised systems, a review of urban developments as early adopters of decentralised systems in Australia was conducted based on guidelines from Naiad ™ (2004–2007) and Tjandraatmadja *et al.* (2008). A case study review identified the drivers leading to adoption of decentralised services in each development.

Furthermore, a selection of leading professionals in the water and wastewater sector based in Queensland were interviewed about their perceptions on the drivers for uptake of decentralised systems in SEQ. Professionals from water authorities, state government and consultancy firms participated in the focus group.

Water professionals who participated were not necessarily representative of the whole industry, but were instead approached based on their perceived knowledge and involvement in decentralised systems in the SEQ context. Privacy concerns have been addressed by providing anonymity for individuals participating and not attributing answers to a specific organisation. A thematic analysis of questionnaire and interview results was undertaken to identify common themes and descriptors used for decentralised systems.

Nine professionals participated in the focus group during the period of September to October 2008. Responses did not refer to a specific case study; instead responses were general to the SEQ milieu and reflected the professional's perception of the main drivers.

4.1. Drivers for Specific Developments

Analysis of case studies revealed a diversity of drivers that influenced the uptake of decentralised systems. Tables 2 and 3 describe drivers for the adoption of decentralised systems in existing developments in SEQ and in other parts of Australia. The drivers identified in this section are related to these specific case studies and are referred to in this document as "development drivers". The number of times a driver is mentioned is designated as "n" in the following sections.

As seen in Tables 2 and 3, the range of drivers for the adoption of decentralised systems across the country includes: sustainability exemplar (n=16); environmental protection (n=9); limited access to reticulated water supply or to centralised infrastructure (n=7); government support and/or funding opportunities (n=3); and demonstration of innovation (n=3). Among the case studies in the tables and also in other examples found in the literature (Radcliffe 2004, Diaper *et al* 2007, Barton and Argue 2007), improving the sustainability of a development is often mentioned as a primary driver across Australia (n=16), followed closely by protection of the environment (n=9).

Comparison of drivers (Tables 2 and 3) reveals that, in most cases, there are often multiple drivers for adoption of a decentralised approach. For example, in the case of Beachmere Sands Resort and O'Reily Rainforest Resort, the remoteness of the development limited access to existing wastewater infrastructure and the need to protect the receiving environment led to the adoption of on-site treatment systems.

Urban water governance structures vary significantly between different state and local governments. Therefore, there can be a disparity in the level of institutional support for decentralised systems in different jurisdictions. In SEQ case studies (Table 2), institutional reform for enabling the increased uptake of decentralised systems occurred in response to primary drivers such as limited access to water and wastewater infrastructure (n=9) and improved sustainability of urban water systems (n=8).

For a number of projects in other states, such as Brighton Townhouses in Victoria and Sydney Olympic Park in NSW, the availability of funding and political will were major factors that enabled the developments. Further discussion of state specific drivers can be found in Tjandraatmadja *et al.* (2008), whilst the remainder of this paper will focus on SEQ.

The major drivers identified in the SEQ case studies can be grouped by these characteristics:

(a) overcoming limitations of local water and wastewater services;

(b) deferring the need to upgrade infrastructure;

(c) promoting environmental protection;

(d) showcasing sustainability;

(e) promoting water conservation;

(f) improving landscape amenity; and

(g) promoting innovation and technology.

These drivers are described in detail in the following sections.

4.1.1. Overcoming the Limitation of Local Water and Wastewater Services

No access or limited access to existing water, wastewater and stormwater service infrastructure can be a dominant driver for the incorporation of decentralised systems into developments. This was expressed by all respondents. For example, in the development of Capo di Monte in Mt. Tamborine (30 km hinterland of Gold Coast), no access to reticulated water supply and wastewater services resulted in communal rainwater tanks with bore water back-up being installed for all in-house uses, and wastewater treated on-site for toilet flushing and external uses. The development achieves self-sufficiency in water supply with zero discharge of wastewater into the local waterway. Another example is Beachmere Sands, located on Bribie Island. Due to a long distance from existing sewer trunk mains and no plan from Council to expand the sewer mains network in the near future, the developer adopted dual pipe systems in order to enable the developments to proceed, which otherwise would have stalled incurring high land-holding costs.

4.1.2. Deferring the Need to Upgrade Existing Infrastructure

In areas where the existing water and wastewater systems have reached full capacity, or are expected to be close to its design capacity, developers and planners would often choose decentralised systems to meet additional service demands from new developments, thus reducing loads for existing water and wastewater service infrastructure and deferring the need to upgrade or build additional systems.

An example of this is the Pimpama-Coomera development, a greenfield area with a mix of residential, commercial and industrial development. In view of rapid population growth in the Pimpama-Coomera growth corridor, Gold Coast City Council is undertaking planning to transform the region to a major urban area of SEQ. However, Council also realises that this large scale development requires an 84% increase in potable water supply and associated wastewater services. Currently, the Pimpama-Coomera area has a potable water main along the Pacific Highway and along Foxwell Road to the Coomera Waters development. If future water supply to the Pimpama-Coomera region solely adopts the conventional water supply approach, Council needs a significant investment in upgrading the existing water service infrastructure, including pipelines, treatment plants, dams or desalination plants. There are other factors also, such as proximity to environmentally sensitive areas and regional water scarcity (Table 2), making the conventional approach unviable. In this context, decentralised systems, including rainwater tanks, a new regional wastewater treatment plant, a recycled water treatment plant and dual pipe reticulation are identified in Council's Pimpama-Coomera Waterfuture Masterplan as a key component to delivering sustainable water, wastewater and stormwater services.

Deferring the need to upgrade existing infrastructure can also be realised by discharging wastewater to Council's sewer network during off-peak periods, as in the example of the Silva Park development (Payne Road Project, Brisbane). While greywater generated in the development is treated at household scale and used for subsurface irrigation in order to minimise the amount of wastewater transport to Councils' sewerage systems, blackwater is stored in an on-site holding tank and only discharged to Council's sewer networks during daily low-flow periods.

4.1.3. Protecting Sensitive Environments

The proximity of the development to environmentally sensitive areas can be a significant driver to protect ecosystems and mitigate flood risks. An example is the Silva Park development (Payne Road Project), located in the western foothills of Mount Coot-tha and the D'Aguilar Range, adjacent to Brisbane Forest Park and Enoggera Reservoir and to the north-west is Enoggera Creek which has dedicated parkland along both banks. In order to reduce the environmental impacts of intensive runoff and peak stormwater flows, bioretention basins are used in the Silva Park development to reduce sediment and contaminant export. The development is designed to be largely self-sufficient in water provision by using large household-scale rainwater tanks (18 kL to 25 kL) and two 75 kL communal water tanks which are used primarily for firefighting.

The Sunrise at 1770 greenfield development near Gladstone is another good example of adoption of decentralised systems to protect local vulnerable waterways. The development, located in an environmental sensitive area, has no access to the sewerage network, instead reclaiming and treating all wastewater to class A+ or better for use in toilet flushing, exterior domestic uses including car washing and firefighting.

4.1.4. Showcasing Sustainable Developments

Showcase developments by governments, universities, developers, consultants and even individuals to demonstrate sustainable developments can often drive significant applications of decentralised systems. An example is the Pimpama-Coomera development which is a sustainability showcase for Gold Coast City Council and is the largest sustainable urban development in SEQ covering an area of 5945 hectares. The development utilises rainwater tanks, water recycling, smart sewers and water sensitive urban design features for stormwater to provide sustainable water, wastewater and stormwater services. By initiating this large-scale project, Gold Coast City Council aims to gain experience in its new institutional scene and strive for improvement in its institutional support for future sustainable developments. In contrast to such a large-scale demonstration, there are showcases for individuals to display a perspective of sustainable housing. For example, in the Healthy Home (Gold Coast), the house owner designed and built his home with a range of decentralised system features to achieve self-sufficiency in water supply and greywater recycling.

There are also a number of showcases launched by developers to promote a new type of residential or commercial development. An example is the Ecovillage at Currumbin development (QLD), which was the winner for the World's Best Environmental Development in the 2008 FIABCI Prix D'Excellence Awards in Amsterdam. Based on principles of ecological sustainability, the development applies rainwater tanks for all in-house uses, dual pipe systems for toilet and external use, and bioretention basins for stormwater treatment. In addition to residential developments, commercial developments, for example, Council House 2 (VIC), 60L Building (VIC), Investa Property Group (VIC), Parfitt Square (SA) and Green Square North Tower (QLD), also adopt decentralised systems to demonstrate the application of sustainability in non-residential settings and, in particular, their viability as a commercial enterprise. Developers often consider decentralised systems as a key marketing advantage in a development because a localised water source can enhance landscape amenity through water features and greening of open space.

4.1.5. Water Conservation

The need to conserve water to provide for long-term urban water demands is, as reflected in the new water target for the State, an important driver for the application of decentralised systems. An example is the Carindale Pines development located in the eastern suburbs of Brisbane. The development, a 14 hectare low density residential project, features rainwater tanks for all household uses including drinking water and demand management via adoption of low flow and water saving fittings and appliances. The development has been designed with vegetated swales as a key landscape feature in order to maximise stormwater infiltration and reduce irrigation requirements for public open space. By providing rainwater tanks of 25 kL capacity for all household uses and adopting stormwater for irrigation, freshwater is conserved, achieving a 75% reduction in use of imported water (Table 2).

4.1.6. Landscape Amenity

Alternative water sources, such as stormwater harvesting and recycled water, enables improved landscape amenity through greening of open space and water features. The enhanced aesthetic landscape values associated with decentralised systems is a significant driver for wider uptake of the systems.

One of the examples is Bribie Island, located 50 km north of Brisbane (Naiad 2004). The wastewater generated in the township is treated at the Bribie Island water reclamation plant to class A quality and subsequently used for irrigation of parks, sport ovals and gardens and dust suppression, hence preserving facilities for community interaction and social well-being. In Coomera Waters and Jacob Creek's Estate, which are located in the Pimpama-Coomera region, preservation of remnant natural vegetation and the adoption of water sensitive urban design features (e.g. swales and infiltration ponds) allowed the creation of green features in the estate. A major driver for developers to adopt these features is that buyers are willing to pay a premium for areas with high levels of landscape amenity. For instance, the properties in the Jacob Ridge Estate sold for $400k to $425k, compared to equivalent size properties which sold for $325k to $350k in estates with a perceived lower level of landscape amenity (Diaper *et al* 2007).

4.1.7. Promotion of Innovation and Technology

Developments that demonstrate innovative designs and leading-edge technologies in water services can provide exemplars of sustainable development to the development industry and encourage adoption of decentralised systems. Some applications of decentralised systems had the express purpose of providing exemplars for the industry. The Ecovillage at Currumbin (QLD), Healthy Home (QLD) and Docklands (VIC) are showcases of sustainable urban development in a commercial context, where the developers aimed to demonstrate that such systems are economically viable and commercially competitive.

The Ecovillage at Currumbin is a 110 hectare greenfield development planned for 114 dwellings, community shops and a school in Stage 1. As mentioned in Section 4.1.4, it was designed to be self-sufficient and includes: (i) rainwater tanks for all potable water supply and fire fighting provision; (ii) wastewater treated to class A at a local wastewater treatment plant and used for non-potable applications; (iii) rehabilitated green corridors, (iv) preserved open space; and (v) adopted water sensitive urban design for stormwater management. Wastewater treatment uses a system comprised of septic tank, textile filter, membrane filtration and UV disinfection, characterised by a low energy footprint.

The Healthy Home, one of the first demonstration projects in the Gold Coast, was a pioneer in the demonstration of the application of alternative water sources at a residential level. It incorporated treated rainwater for the provision of potable water and pioneered adoption of treated greywater for toilet flushing and garden irrigation. Research into its operation and performance has led to learnings into the application and practicalities of rainwater and greywater implementation in residential developments.

Docklands is a major urban renewal development on the edge of Melbourne CBD. In addition to adopting decentralised system features for stormwater detention, treatment, storage and reuse, VicUrban developed the Melbourne Docklands Ecologically Sustainable Development Scheme. The scheme is a sustainability rating scheme that evaluates the environmental and energy impacts of developments. All commercial developments in Docklands need to meet the requirements of the scheme to ensure the developments are socially, economically and environmentally responsible. The development of Docklands provides an example of water sensitive urban design in a major urban renewal project.

Table 2: Decentralised Systems in Queensland

Development	Location	Council	Water Authority	Physical Features	Drivers
Beachmere Sands Retirement Resort	Bribie Island, 45 km north of Brisbane CBD, Sunshine Coast Region	Moreton Bay Regional Council	Moreton Bay Regional Council	Wastewater from 1440 units treated by a recirculating evapotranspiration channel system named Kele Effluent and Wastewater Treatment (KEWT) to class C for subsurface irrigation and following UV disinfection to class A for local surface irrigation.	Remote development with limited access to existing wastewater systems
Capo di Monte	Mt Tamborine, in Scenic Rim Regional Council, 30 km north-west of the Gold Coast	Scenic Rim Council	Scenic Rim Council	Reticulated rainwater with bore water top up used for all in house usage except toilet; this system includes filtration, UV and chlorination. On-site treatment of wastewater by immersed membrane bioreactor, UV and chlorination; used for toilet flushing, garden irrigation and dedicated disposal areas.	Remote development with no access to reticulated water and wastewater systems
Carindale Pines	east of Brisbane	Brisbane Council	Brisbane Water	Individual 25 kL rainwater tanks topped up with reticulated water for all uses including drinking.	Water conservation
Ecovillage at Currumbin	7 km west of Currumbin Beach	Gold Coast Council	Gold Coast Water	Rainwater tanks for all in-house usage except toilet. Reticulated dual pipe system with recirculating textile filter, microfiltration, UV and chlorine to provide A+ water for toilet, external use and fire fighting.	Provide exemplar of sustainable development
Healthy Home	Francis Avenue, Mermaid Beach, Gold Coast	Gold Coast Council	Gold Coast Water	Rainwater tanks topped up from Council mains, filtration and disinfection before use. Grey water system for toilet flushing and garden irrigation.	Vision of Chris and Kym Prosser and UQ A/ Professors Richard Hyde and Ted Gardner for developing sustainable housing
Manly Eco village	Manly, Brisbane, 15 km south east of the CBD	Brisbane Council	Brisbane Water	Stormwater treatment via swales and bioretention basin. Greywater treatment and reuse. Rainwater tanks.	Demonstration project
Noosa North Shore Resort	20 minutes from Noosa's Hastings Street Shopping precinct	Noosa Regional Council	Noosa Regional Council	Wastewater treated by immersed membrane bioreactor to produce A+ water for toilet flushing, laundry, garden watering and car washing.	Remote development with limited access to existing wastewater systems and also for water conservation
O'Reily Rainforest Resort	Gold Coast Hinterland	Gold Coast Council	Gold Coast Water	Spring water treated with UV for main water supply, several houses supplemented with lot-scale rainwater tanks. On-site centralised immersed membrane bioreactor to produce A+ recycled water.	Remote development with limited access to existing wastewater systems
Pacific Harbour Golf Estate	Bribie Island, 45 km north of Brisbane CBD	Moreton Bay Regional Council	Moreton Bay Regional Council	Rainwater tank at each lot. Dual pipe for future recycled water supply of toilets and external use such as lots and public open space irrigation. 25 lakes for stormwater detention, peak flow reduction, nutrient and sediment containment	Security of supply and environmental protection
Payne Road	Payne Road, the Gap, Brisbane	Brisbane Council	Brisbane Water	Rainwater tank at each lot for all in-house usage plus two centralised rainwater tanks which are topped up from Council supply. Greywater reuse from Biolytix system for subsurface irrigation. Low infiltration gravity sewer for blackwater to council sewer. Stormwater treatment via swales and bioretention basin	Development has limited access to reticulated water and wastewater systems and is located in an environmentally sensitive area.
Pimpama-Coomera Residential Estate	40km south of Brisbane	Gold Coast Council	Gold Coast Water	Rainwater topped up from Council mains, used for external uses and laundry. Dual reticulation, with recycled water for toilet flushing, external household and public open space irrigation. Storm water treated by swales, bioretention, wetland and basins for nutrient reduction. Wastewater collected using low infiltration gravity sewer treated for reuse using membrane filtration and disinfection at regional wastewater treatment and recycled water (class A+) treatment plants.	Vision of Gold Coast Water and Gold Coast City Council for sustainable development. Area has limited access to reticulated water and wastewater systems and in proximity to environmentally sensitive areas.
Sunrise at 1770	10 km from the Town of 1770, one and 1.5hour north of Bundaberg	Gladstone Council	Gladstone Council	Rainwater tanks are topped up with potable water from the Reedy Creek Aquifer. All waste water is reclaimed and treated to provide a class A+ recycled water supply for toilet flushing, exterior domestic uses, car washing and fire fighting via dual reticulation.	Development has no access to wastewater systems and is located in environmentally sensitive area.

Source: Naiad ™ (2004-07) and Tjandraatmadja, et al, (2008)

Table 3: Decentralised Systems outside Queensland

Development	Location	Physical Features	Drivers
Forde development	ACT	Targeting 40% reduction in water usage by suggesting rainwater or greywater reuse. Stormwater used to irrigate parks.	Sustainability
Brindabella Business Park	ACT	Water conservation	Improved built environment.
Rouse Hill	Sydney's north-western suburbs	Dual pipe system with recycled wastewater for toilet, garden and car wash. Stormwater wetland and ponds.	Limiting discharge of treated sewage and stormwater to vulnerable Hawkesbury River.
Sydney Olympic Park	west of Sydney CBD	Sewer mining incorporating proven and emerging technologies such as biological treatment, MF and RO. Stormwater harvesting for local irrigation.	Government commitment to put on a "green" Olympics.
Mawson Lakes	12 km North of Adelaide	Recycled water dual pipe system for toilet, car washing and garden watering. Stormwater treated by natural wetlands and stored in underground aquifers for reuse.	Private initiative to showcase high tech development supported by State Government.
Parfitt Square	City of Charles Sturt, Adelaide	Stormwater retention for aquifer recharge and irrigation. Stormwater treated using gross pollutant and sediment traps, infiltration swale, gravel based sub-surface wetland.	Showcase for University of SA water centre.
New Haven Estate	north-west of Adelaide CDB	Dual pipe recycling for toilet and irrigation. Tertiary wastewater treatment with activated sludge, sand filtration and UV.	Opportunity to explore cutting edge solutions in WSUD.
St Elizabeth Church	Oaklands Park, Adelaide	Stormwater quality source control, grass-pave for hard standing area and soak ways. Aquifer recharge and reuse in Church landscaped area and adjacent public reserve.	Championed by Professor John Argue, University of South Australia.
New Brompton Estate	Brompton, 5km North West of Adelaide	Roof runoff management – collection of roof runoff from 15 cluster houses and diverted to infiltration trench for aquifer recharge.	Academic project to demonstrate on-site stormwater retention technologies and approaches.
Municipality of Brighton	TAS	Stormwater and treated wastewater for agricultural reuse.	Sustainable wastewater reuse and protection of environment.
Aurora	Epping, VIC	Rainwater tanks and rain gardens in allotments. Effluent reuse through dual pipe for toilet and gardens. Stormwater treatment using bio-retention trenches and swales.	The development is remote from existing trunk sewers, with branch sewer extension not scheduled in near future. It is an alternative approach to avoiding high land-holding costs for the developer. The developer, VicUrban, has a charter to provide a leading role in sustainable development.
Brighton Eco Townhouses	Brighton, VIC	Rainwater use for toilet and garden. Rainwater collected from entire roofs, decks and paved pathways.	Smart Water Funding.
Docklands Business Precinct	Melbourne, VIC	Stormwater harvesting, treatment and reuse for irrigation. Stormwater quality control, such as bioretention swales and wetlands. Development guidelines encourage initiatives such as on-site greywater recycling.	The developer (VicUrban) has charter to demonstrate innovation in area of sustainability to lead the development industry.
60L Building	60 Leicester Street, Carlton, VIC	Use of water efficient fixtures, waterless urinals, low flush volume toilets. Rainwater use to replace mains water (90% less usage). Reclaimed water for toilet and roof garden irrigation. Wastewater treatment system of biofiltration and clarification.	Demonstration of sustainability principles applied to a commercial development.
Sharland Oasis – Geelong	VIC	Rainwater for toilet, water efficient fittings and appliances, grey water reuse.	To put a showcase development to display ecological sustainability.
Investa Property Group	Melbourne, VIC	Waterless urinals, water flow restrictions to taps, hand basins and showers. 25% reduction in water consumption.	Integrating long-term sustainability practices as part of business platform.
Council House 2	218/240 Little Collins St, Melbourne, VIC	Rainwater collected and used to supplement water mains. Sewer mining - treated effluent from the building supplies irrigation, cooling, toilet flushing and other Council water needs, e.g. equipment for street washing and open spaces.	Showcase of sustainability by the Melbourne city council.
Bridgewater South Estate	WA	The development is mainly stormwater focussed. Structural controls for stormwater infiltration, retention and detention at source through infiltration swales and vegetated buffers are provided. The stormwater system also includes soakwells. No direct stormwater use.	Protection of sensitive water receiving environment and flooding.
Lakelands Private Estate	WA	The development is devoted to sustain the natural wetlands and thus is stormwater focussed. The on-site infiltration of stormwater through basins, drains and swales are integrated with landscape of public open spaces. Bore water for POS irrigation.	To protect natural environment, in particular sensitive lakes proximal to development.

Source: Naiad ™ (2004-07) and Tjandraatmadja, et al (2008)

4.2. General Drivers

Through consultation of the nine SEQ water professionals in the focus group, common drivers for the provision of decentralised systems in SEQ were identified.

Table 4 displays a summary of the major drivers for the 12 case studies across SEQ and 31 case studies around Australia, as well as the drivers mentioned by the focus group specific to SEQ. The number of times a driver was mentioned by participants is marked in the text. Participants often mentioned more than one driver.

A number of drivers identified from the case studies were similar to those mentioned by the focus group; however, as focus group responses were based on the broader SEQ region, a wider range of drivers was then identified from individual case studies.

According to the focus group, the region's climatic conditions, rapid growth in population and its associated consequences, such as urban sprawl, are challenging the traditional approaches to water and wastewater service provisions and creating opportunities for decentralised service provision. The prolonged drought is contributing to a sense of urgency and has shaped many of the initiatives and changes in institutional, legislative and policy arrangements taking place in the State.

Based on the number of responses, the major drivers conducive to the uptake of decentralised systems for SEQ are:

(a) *Population growth* (n=4). As a result of SEQ's rapid population growth, water demand exceeds the capacity that dams, the major source of water, can currently supply using traditional methods.

(b) *Existing infrastructure reaching design capacity in certain areas* (n=3). Densification of cities is placing greater demand on existing collection infrastructure and there is limited capacity for infrastructure upgrade in major urban centres such as Brisbane. The growth in population will also be linked to further development in the area creating opportunities for further commercial and industrial development and requiring appropriate infrastructure. On the other hand, integration of decentralised systems, with centralised infrastructure as a complement to infrastructure operation, was mentioned as a positive by one of the respondents; for example, the "use of rainwater tank run-off for flushing of sewers".

(c) *Urban sprawl and large number of greenfield areas* (n=3). With the rapid growth, SEQ offers the uniqueness of rapid and large expansion of low density greenfield residential developments into previously rural areas, where no water servicing infrastructure exists. This provides a challenge for the provision of services, but also provides opportunities for the implementation of new integrated services.

(d) *Diverse range of water sources available in the region, but shortage of water in dams, and reduction of run-off into them* (n=11). In particular, rainfall distribution has been considered a major driver for decentralisation of water supply (n=7), as in SEQ, "high rainfall is concentrated near the coast and in populated areas, whilst water supply catchments, located mainly inland, have received decreasing rainfall runoff in the past few years" as outlined by one of the respondents. Despite the drought in the State, "rainfall has been close to the yearly average in many coastal towns, and could provide a suitable source of water if captured" either as rainfall or stormwater as mentioned by respondents.

(e) *Diversified locations of treatment facilities* (n=1). Wastewater treatment plants are distributed across the region, which could create opportunities for more sustainable infrastructure development for wastewater treatment and reuse.

(f) *Political impetus* (n=2). The government's restructure of the water industry and recent modifications to legislation and planning codes in Queensland, e.g. Queensland Development Code, allow adoption of decentralised options such as rainwater tanks, greywater systems and piped effluent. Yet, the political impetus and the degree of support are perceived to vary, with some councils, sectors of state government and institutions seen to be more progressive than others.

(g) *General public acceptance of recycled water for non-potable applications* (n=1). Drought/climate change experience, including water shortages in SEQ, has resulted in a greater acceptance by government and residents of the need for alternative water sourcing and management strategies (n=1).

(h) *Emergence of a green culture* (n=2). Particularly in some of the new developments, there is an understanding of the need for preservation of the environment, including green belts and waterways, with increased expectation for sustainability.

(i) *High quality waterways*, *greenbelts and ecosystems that need to be protected* (n=4). As mentioned in section 4.1.3, SEQ has a number of habitats that need to be preserved due to their ecological significance and/or their significance to the lifestyle expected by the local population, for example the beach lifestyle at the Sunshine and Gold Coasts.

(j) *Availability of technical and institutional capacity in the region* that can make decentralised systems work, and significant research activity on decentralised systems taking place in SEQ, e.g. the Urban Water Security Research Alliance (n=2).

(k) *Architecture of Queenslander homes*, with a raised first floor, are more easily amenable to retrofitting and adoption of alternative technologies compared to concrete slab homes (n =1).

Table 4: Comparison of major drivers for decentralised systems in SEQ and across Australia

Case study outcomes

Based on 31 Australian developments, including 12 SEQ developments

Category	**Major drivers in general**	**Number of mentions: Australian cases**	**Number of mentions: SEQ cases**
Water availability and infrastructure	Limited access to wastewater infrastructure	7	6
	Limited or no access to reticulated water	2	2
	No access to other water sources	1	1
	Water conservation	4	2
Sustainability and environment protection	Protection of environment	9	4
	Promotion of sustainable development	16	4
Government support	Support from government	2	1
Research	Technology innovation	3	

Focus group outcomes

Based on opinions of focus group of 9 SEQ professionals

Category	**Major drivers for SEQ**	**Number of mentions**
Population growth	Population growth	4
	Urban development (sprawl, densification,	3
	Need for more industrial sites	1
Water supply availability	Rainfall distribution (reduced input into dams, potential for storm water harvest –appreciable runoff)	7
	Water shortage	3
	Drought/Climate change	1
Infrastructure	Infrastructure at capacity	1
	Potential to complement functions between rainwater tanks and centralised infrastructure	1
	Queenslander house architecture suitable for retrofit	1
	Location of existing wastewater treatment facilities	1
Sustainability and environment protection	Protection of environment (green belts, waterways)	2
	Emerging green culture	1
	Need for sustainable water solutions	1
Government support	Government support	1
	Legislation, codes, industry restructure	3
Public support	Public acceptance of recycled water	1
Capacity	Availability of technical and institutional capacity	2

5. SITE-SPECIFIC FEASIBILITY FACTORS FOR DECENTRALISED SYSTEMS

One of the major benefits of decentralised systems is the potential to adapt the design of a system to the specific needs of a site or development area. Hence, in assessing the suitability of decentralised systems for the servicing of a specific development site, their configuration and viability, a number of site characteristics need to be considered.

These characteristics are grouped into the following categories:

(a) regional climate

(b) geographical and topographical features

(c) soil and hydrogeological characteristics

(d) energy demand

(e) existing water and wastewater infrastructure and capacity

(f) development plans for the area.

The following sections discuss these characteristics in detail.

5.1. Regional Climate

Local climate, particularly precipitation and evaporation, is a major influence on the suitability of a site for adoption of decentralised systems. Historical rainfall (monthly distribution and intensity) and evaporation records are important elements in determining available rainwater and the potential demand for water reuse. Arid or semi-arid areas tend to favour water reuse as a viable option to supplement non-potable use due to lack of rainfall or irregular rainfall distribution throughout the year.

Figure 1 shows the average annual rainfall distribution in major population centres in SEQ. Rainfall data refers to the period of 1920 to 1969. In some areas historical rainfall records are shorter as many weather stations became operational subsequent to the selected period. Figure 1 shows that rainfall totals are generally of a similar order of magnitude in most of SEQ areas. However, whilst the rainfall average across SEQ is 1073 mm/y, coastal areas such as Noosa and Gold Coast generally receive more rain than inland areas like Gatton, Toowoomba and Ipswich.

Temporal variations in rainfall at the daily, monthly and seasonal scale need to be considered as these influence required storage capacity as well as the water demand for landscape irrigation. Figure 2 shows the average monthly rainfall (over the period between 1869 and 2008) in the major cities of SEQ (Bureau of Meteorology – Climate Data). The rainfall in the SEQ region varies seasonally with the highest average rainfall in the months of December to February (100 to 230 mm) and the lowest in July to September (average of 50 mm).

Urban landscape irrigation demands are highest in summer and lowest in winter due to higher evapotranspiration rates in summer. The high summer rainfall in SEQ indicates that rainwater harvesting can meet peak demand during the warmer months and can provide water mainly for in-house use throughout the year, thus making a significant contribution to meeting total water demand.

The temporal rainfall variation is more marked in coastal areas, particularly in Noosa, and becomes less evident in inland areas such as Toowoomba and Ipswich. A significant seasonal variation impacts the size selection, and therefore the economic viability of rainwater tanks, as an extended dry period necessitates a larger storage tank to meet demand during the low rainfall period.

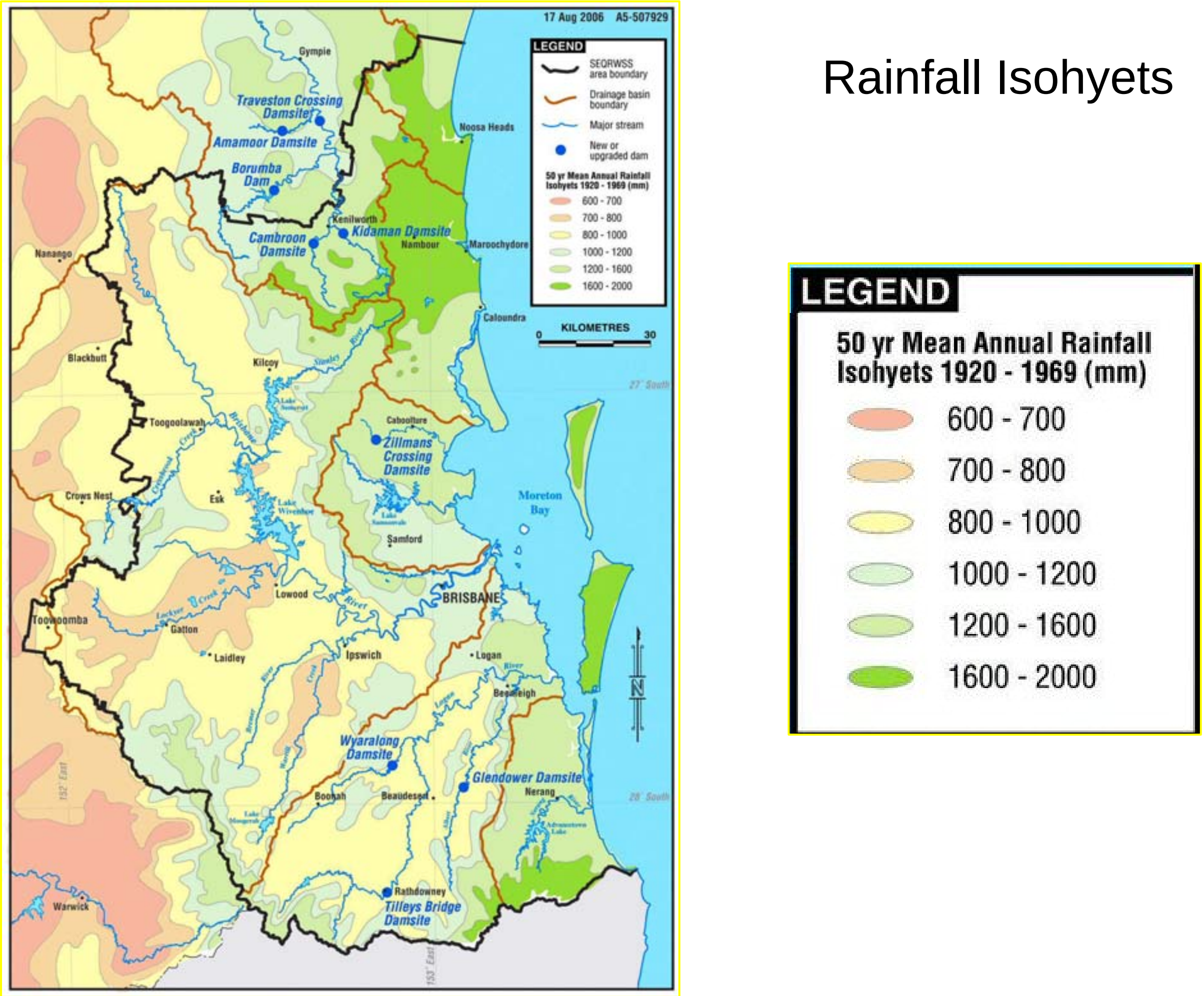

Figure 1: **Average annual rainfall (1920–1969) distribution in SEQ (DERM 2006)**

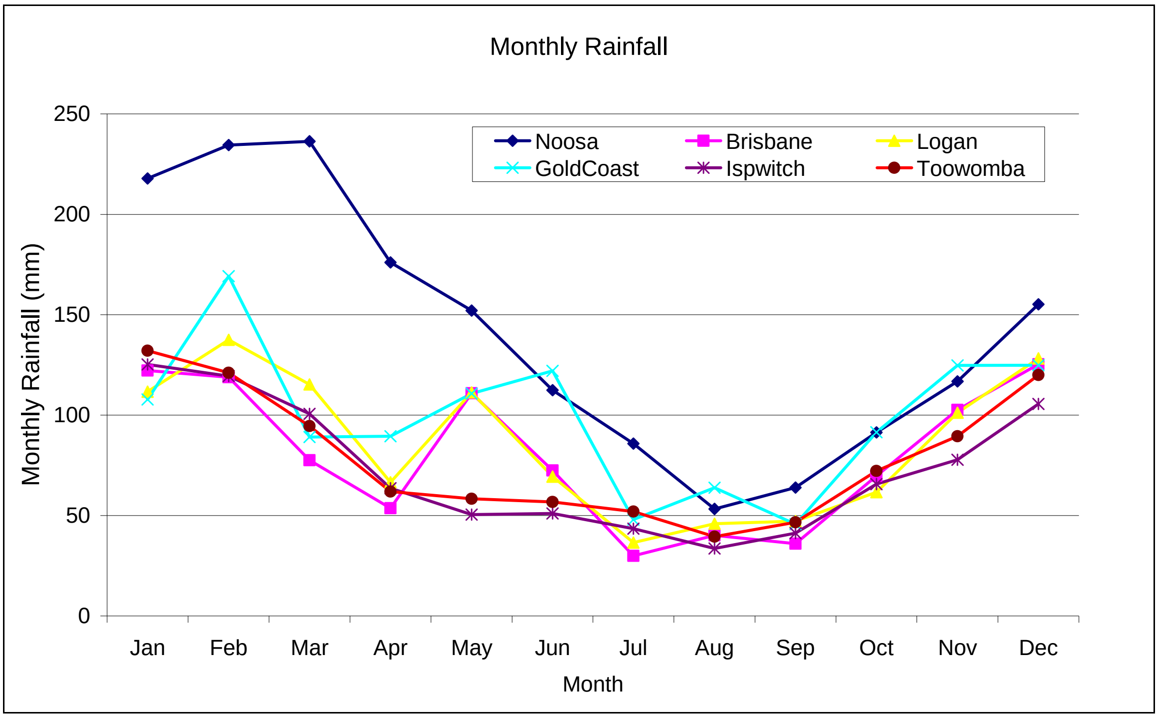

Figure 2: **Monthly rainfall in some major cities of SEQ (1869–2008)**

5.2. Geographical and Topographical Features

Knowledge of the geographical features of a development site is important to select appropriate water and wastewater service strategies as well as system options and layout.

A number of the major growth centres in the SEQ region (Figure 3) are located in proximity to or discharge into environmentally sensitive habitats, shown in Figure 4.

At such locations, decentralised systems that offer water reclamation with zero discharge can be considered an option to reduce wastewater discharge, mitigating possible local environmental and ecological impacts. This approach could be adopted for the protection of sensitive areas in SEQ such as Moreton Bay, the Bay of Islands, Maroochy River coastal communities, Pimpama River and Hotham Creek as well as other receiving environments.

The landscape topography is also influential. Decentralised systems can exploit a range of topographies, e.g. elevation differentials can be used to provide gravity feed in collection of wastewater or stormwater for downstream applications. In some cases, topography may demand pumping of wastewater over short distance through pressure sewers.

Most importantly, landscape topography, in conjunction with the distance to existing water supplies and wastewater treatment plants, influences the amount of energy required for transfer of bulk water and wastewater across the landscape, which impacts energy consumption and greenhouse gas emissions.

5.3. Soil and Hydrogeological Characteristics

In 2005, up to 127,000 on-site wastewater treatment systems were in operation in the SEQ region, with approximately 80% comprised of septic systems (Beal et al 2005b). Whilst there was insufficient data to confirm groundwater or surface water contamination from on-site systems, under-reporting of failures was believed to be common. Among reported failures, the most common causes were surcharge of the absorption trench for septic systems (59% of failures) and inappropriate discharge of greywater for split greywater/blackwater septic systems (56% of failures) (Beal et al 2005b).

Thus, soil characteristics of a site are important in evaluating suitability of different decentralised systems, particularly for schemes that adopt land application or disposal, such as on-site wastewater disposal to household gardens and public landscape irrigation after appropriate treatment (Beal et al 2005a).

For these applications, hydraulic properties, such as soil infiltration rate and permeability, and chemical characteristics, such as salinity and sodicity, need to be evaluated.

Fine-textured soils retain water for long periods of time and therefore can limit the loading rate for water that can be assimilated and transported away from the site. Coarse textured soils, on the other hand, drain water rapidly and may not provide sufficient retention time for effective filtration and biological treatment mechanisms of the disposed water before it reaches aquifers. The implication is that coarse textured soils may require a pre-treatment system to produce suitable quality water to minimise contamination to surface water bodies and/or groundwater.

Sodic soils are often impermeable to water and, in flat areas, a sodic soil layer may lead to waterlogging.

Hydrogeological characteristics such as the depth to groundwater and the presence or absence of a confining layer can be influential in determining the suitability of options such as on-site greywater or wastewater disposal. Due to the potential risk of groundwater contamination, a permanent shallow groundwater table with unconfined aquifers might limit the options of wastewater land disposal or reclaimed water irrigation, both of which are dependent on the quality of the effluent. On the other hand, the presence of accessible aquifers can also create opportunities for aquifer storage and recovery.

Figure 3: Potential areas available for growth areas in SEQ region (adapted from DIP, Queensland Government 2009a, SPOT 5 © CNES 2005 SPOT Image - Australia)

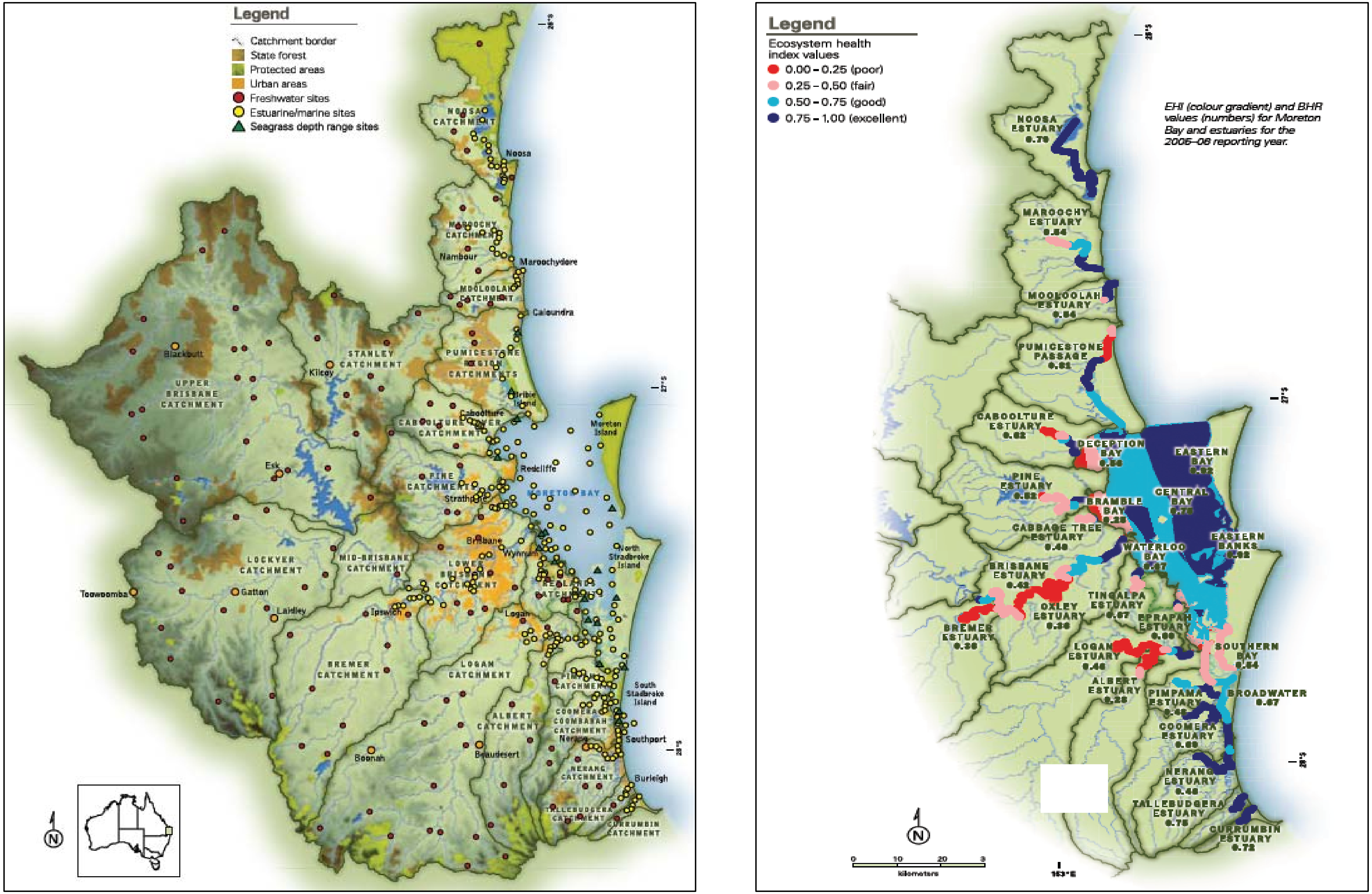

Figure 4: Major ecosystems and assessment of riverine and marine health in the SEQ region (EHMP 2007)

5.4. Energy Demand

In centralised schemes, where large volumes of water need to be transferred across large distances or elevations, the associated energy requirements can be substantial. It is estimated that the future 2056 energy requirements for SEQ water and wastewater services will increase to more than three times the 2008 energy levels as both centralised and decentralised systems are adopted (Hall *et al*. 2008). Projected energy requirements for centralised supply of water and wastewater are estimated to be approximately five times the energy required for supply from localised rainwater tanks and six times the energy for on-site wastewater services shown respectively in Figure 5 and Figure 6 (Hall *et al*. 2008).

Studies of actual decentralised systems conducted at Payne Rd established that the specific energy for decentralised systems for the supply of rainwater was typically higher than conventional water supply by centralised systems on a kWh/kL basis - particularly for rainwater tanks that adopt small, inefficient pumps (Gardner *et al* 2006, Beal *et al* 2008). Recent monitoring of rainwater tanks estimated a typical energy intensity of 1.5 kWh/kL water for the most common pump and rain switch system and a range of 0.9 to 1.7 kWh/kL for sites using rainwater for toilet flushing, laundry and outdoor uses (Retamal *et al* 2009). Energy intensity is, however, largely determined by the specific characteristics of each site as factors such as system configuration, equipment selection, water use and topography impact the total energy consumption (Retamal *et al* 2009, Beal *et al* 2008).

The uncertainty of energy intensity requirements of decentralised systems is further compounded by the diversity of technologies and the limited number of empirical studies on the subject (Retamal *et al* 2009, Hall *et al* 2009). As a result, energy estimates for decentralised water supply typically have an uncertainty of ±50%, whilst for centralised systems a lower value ±15 % can be assumed (Hall *et al* 2009).

Decentralised water supply based on small pumps compared to traditional centralised gravity supply tends to be more energy intensive. For example, the energy intensity for the centralised water supply by gravity to Brisbane and the Gold Coast was estimated to be 0.68 and 0.21 KWh/L in 2006–07 (Kenway *et al* 2008), which is significantly lower than 1.5 kWh/kL for rainwater tanks (Hall *et al* 2009).

However, a different perspective emerges when new centralised water sources are considered. As traditional gravity catchment sources are mostly already at capacity, new demand is increasingly being met by more energy intensive sources such as desalination, centralised treatment and recycling for non-potable uses and pumping for longer distances. This is illustrated in Table 5, which compares energy intensities for water supply for major capitals before and after centralised augmentation was implemented.

In this context, comparison of energy intensity for rainwater tanks versus new centralised water sources starts to look more favourable. For instance, in Adelaide, the additional pumping from the Murray River increased the energy intensity to around 1.8 KWh/kL, on a par with the 1.5 KWh/kL for rainwater tanks.

Hence, the general principle is that if water can be sourced locally and long distance pumping minimised (particularly where there is significant lift), then the energy of water supply will be reduced. However, this depends on what is being compared and where the analysis boundaries are drawn.

Overall, there is a strong need to further document energy consumption and increase the energy efficiency of decentralised systems (Beal *et al* 2008, Hall et al 2009, Retamal *et al* 2009).

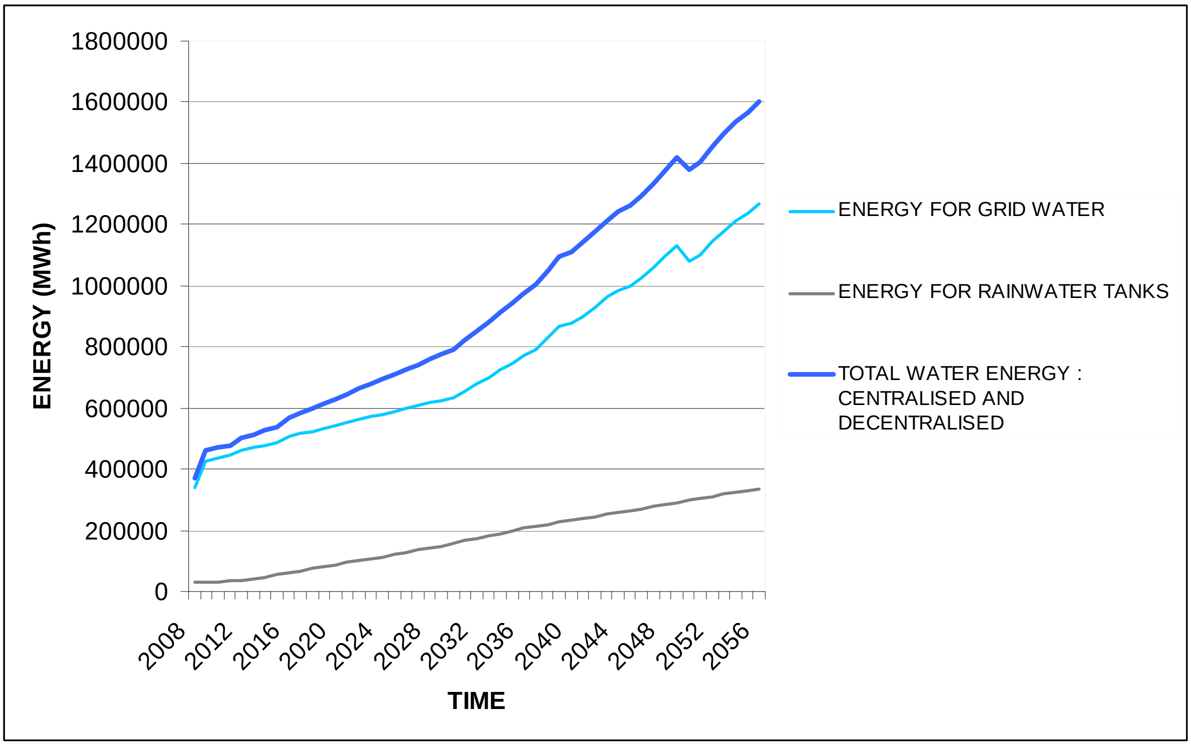

Figure 5: Draft predicted trend in total energy demand by centralised and decentralised water supply options (Hall *et al*. 2008)

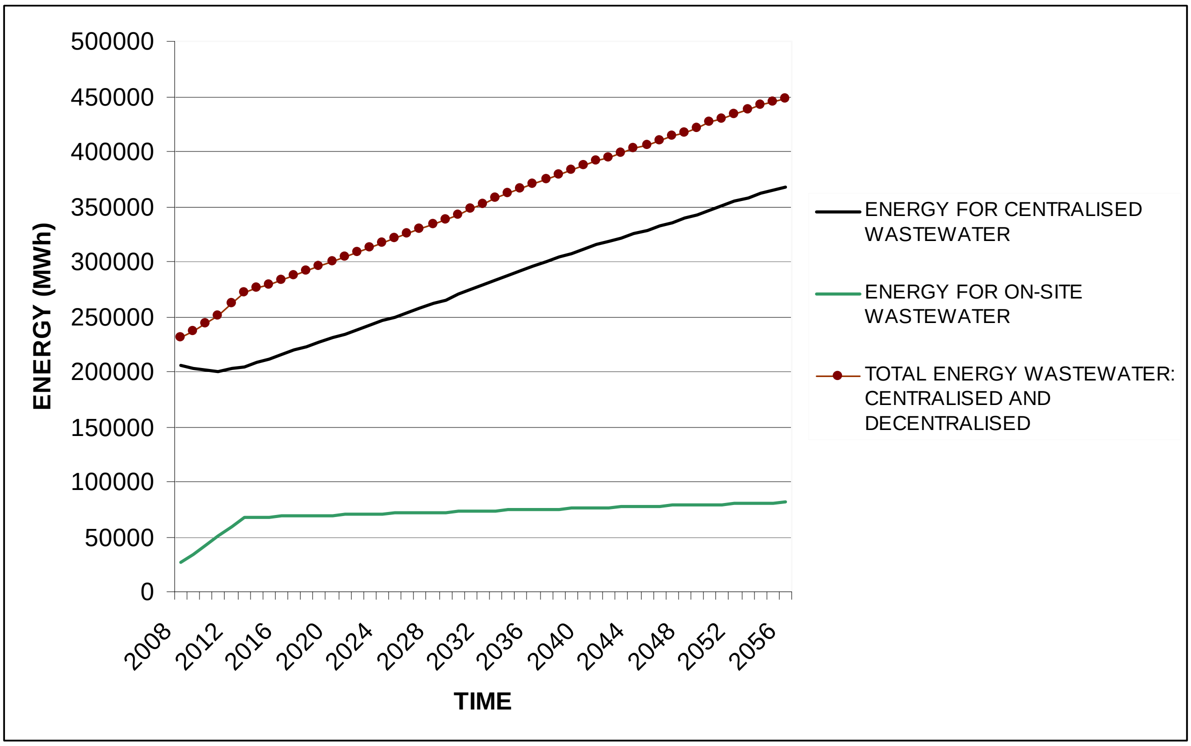

Figure 6: Draft predicted trend in total energy demand by centralised and decentralised wastewater management options (Hall *et al*. 2008)

Table 5: Energy intensity of decentralised water supply and centralised water supply before and after large scale augmentation (adapted from Retamal et al 2009)

Water service	City	Energy intensity (kWh/kL)		Comment	Reference
		2001/02	2006/07		
Centralised water supply	Sydney	0.25	1.03	Pumping from Shoalhaven river in 2006-07	Kenway *et al* 2008
	Perth	0.56	0.98	Desalination in 2006/07	
	Adelaide	0.85	1.84	Pumping from the Murray river in 2006/07	
Decentralised	Typical range for rainwater tank pumps	0.9 to 1.7			Retamal *et al* 2009

5.5. Existing Water and Wastewater Infrastructure and Capacity

The presence of centralised water and wastewater infrastructure very often influences the adoption of decentralised systems. When centralised water and wastewater services are proximal and with adequate capacity, developers generally favour using the existing systems, mainly because they often are required to pay for the service fees to local council - regardless of whether the services are being used. There are, however, examples where rainwater tanks and water reuse are incorporated into developments with access to existing water service infrastructure as efforts to conserve drinking water and to enhance greener living amenity (Tjandraatmadja *et al* 2008). Adoption of rainwater tanks is encouraged in SEQ through the Queensland Development Code (Section 25), which provides guidelines on installation and maintenance of rainwater tanks (Queensland Government 2007a). However, more needs to be made of this rule to drive decentralised systems.

Where existing water and wastewater service infrastructure are close to their design capacity and could not meet the demands of a new development, decentralised systems are often a viable option to reduce the pressure on the existing services, thus deferring the immediate needs to upgrade the infrastructure.

When a decision is made to adopt decentralised systems, an important consideration in selecting system features and layout is the compatibility with existing infrastructure.

5.6. Current and Future Development

The suitability of decentralised systems needs to be assessed in development plans for the region to ensure that the systems implemented are appropriate to meet both the short-term and long-term water service needs of the population. Major factors to be considered include population size and density, housing types, community facilities, and the mix of land uses such as residential, commercial and industrial. Populations that fluctuate seasonally, such as those in holiday resorts, can also impact on suitability of decentralised wastewater systems.

Development layout helps identify available space, which is critical to determine water storage and effluent disposal options, as a large area may be required to store and absorb treated wastewater for many on-site wastewater treatments. A suitable catchment size (roof area) is also required for rainwater tanks to provide sufficient water for reliable supply.

Developments characterised by small lot size and high density can particularly limit the options for wastewater collection and disposal, recycled water storage and rainwater tank size. In such cases, adoption of cluster or even community scale decentralised systems may be more feasible for this type of development.

A compact development layout may constrain the use of individual household scale wastewater treatment systems and are often characterised by more impervious areas, thus increasing stormwater runoff. Developments that have significant industrial activity may require separate wastewater treatment to handle highly contaminated wastewater streams suitable for reuse.

Ultimate population size and the pattern of population growth are important factors that need to be considered. For example, a large development with slow growing occupancy or high population turnover will have different impacts on the viability and appropriate scale of decentralised service options.

Overall, decentralised systems are suitable to be incorporated into a whole range of developments. A wide range of decentralised technologies and configurations are available and with appropriate design, system configurations can cater for a range of spatial scales (e.g. from a single allotment, to clusters and larger areas). Decentralised systems are also adaptable to various population densities and functions (water supply and treatment of different wastewater streams). Even where a development has ready and adequate access to centralised water and wastewater systems, rainwater tanks and water reuse can still be considered for non-potable uses in order to conserve potable water and defer the upgrade of infrastructure.

Evaluation of the interrelationships between all suitability factors is needed. For example, if the development is located in a very arid area with low groundwater tables, which means that neither rainwater tanks, bore water nor spring water would be a reliable supply for drinking water, then conventional water service systems may be the appropriate option.

6. BENEFITS OF DECENTRALISED SYSTEMS

Focus group participants were also asked to describe the benefits they associated with decentralised systems. Their responses, which are shown in full in Table A1 (Appendix 1), have focused on benefits that stem directly from the uptake of decentralised systems and the problems that they help address. Furthermore, they also recognise the potential of developing a whole new industry sector around decentralised systems.

Such benefits, identified by survey participants, are grouped under seven major areas which will be explained further:

(a) reduced environmental impact (n=9);

(b) better use of capital investment (n=8);

(c) increase in sustainability (n=7);

(d) technology development (n=9);

(e) increase in community ownership and awareness (n=5); and

(f) institutional reform (n=6), it requires continuous review of science and technology and the adoption of best practices at institutional level.

6.1.1. Reduced Environmental Impact

As decentralised systems are designed based on local conditions, they increase the flexibility of the overall system to be sensitive to the local environment and respond to changes at the local level. For example, they: (i) allow the opportunity to adopt alternative water sources at a range of scales; (ii) create more diffuse waste streams which can be tailored to specific receiving environments, increasing its capability to deal with discharged nutrients and contaminants; (iii) avoid excessive extraction and transfer of bulk water and wastewater; (iv) minimise energy and large infrastructure (pipelines) for pumping and transport over long distances, reducing GHG emissions and pollution; and (v) preserve potable water resources.

Environmental benefit is one of the major positive outcomes associated with decentralised systems. By focusing on water and wastewater management closer to the point of use, the overall amount of water extracted from an environment is reduced, less storage is required (compared to dams servicing whole cities) and environmental impact is reduced.

6.1.2. Better Use of Capital

When costs are considered over the asset's life cycle, decentralised systems are perceived by respondents to have a lower overall footprint as less infrastructure is required for transport of water and wastewater.

Furthermore, decentralised systems can often be designed for incremental growth. This allows better planning in capital investment through staged investment of capital throughout the life of the asset, and a greater range of options and flexibility for upgrade of treatment technology - depending on the local constraints. Its implementation can also be conducted alongside centralised systems, e.g. water reuse in high density urban areas, where it can be used to supplement or complement existing infrastructure that is reaching capacity, and hence delay the need for an upgrade of centralised infrastructure.

Large centralised infrastructure usually needs to be publicly funded, due to its high capital investment needs. Decentralised systems have greater potential for funding from private and/or private-public partnerships, due to lower costs and scale. This results in greater sharing of costs among different segments of society (e.g. rainwater tanks for individual households or scaled upgrade as developments grow).

6.1.3. Increased Sustainability

Improving sustainability of water servicing was identified by seven respondents as a benefit arising from the adoption of decentralised systems, while the remaining two respondents were unable to identify a specific benefit derived from such systems. The benefits described relate to the better utilisation of water through reuse, the lower energy consumption and associated green house emissions expected from such systems, and increased resilience of communities to drought.

Increased water reuse is perceived as more sustainable than a once-only use. It is also recognised that achieving sustainability also hinges on energy efficiency and whole life-cycle costs associated with the system (n=3). Therefore, this carries the proviso that sustainability will depend on the appropriateness of the technology and system selected. Whole of life cycle considerations can play a significant role in sustainability and on the associated costs of the project. For example, the cost of system upgrade in decentralised systems, compared to the larger investment required in centralised systems, is a critical factor for consideration.

6.1.4. Increased Community Ownership and Awareness

Four of the respondents indicated that decentralised systems can serve as a tool for increasing community awareness of sustainability, promoting the understanding of the link between individual behaviour and the impact on the water cycle and the environment at a local level.

When solutions are tailored to the needs of local community or catchment, the community can see a clear link between their actions and the benefits associated with the scheme. For example, demand management and rainwater tanks allow householders to understand the limitations of water supply, whilst water reuse after localised treatment for preservation of a local habitat allows residents to see direct benefits for their local environment. This can lead to greater sense of empowerment and ownership by the local community.

6.1.5. Technology Development

All nine respondents were able to name benefits in the technology field. Overall, it is perceived that technology will improve and mature with the greater uptake of decentralised systems. As more decentralised systems are implemented, more opportunities will be created for further reuse and the limits of existing technologies will be pushed, leading to further development and encouraging innovation. Consequently, robustness and cost-effectiveness (as scale of market and production grows) are likely to increase for decentralised systems.

Uptake of more advanced decentralised technology could lead to the up-skilling of local operators and technicians, the upgrade of practices and hardware and the creation of a new industry segment.

Furthermore, one respondent highlighted that the smaller scale and lower capital investment required for operation of decentralised technologies could allow for transfer of such technologies to less developed countries.

6.1.6. Institutional Reform

As decentralised systems become more widely adopted, there is the need for incorporating relevant practices at an institutional level to address the management of such systems.

Decentralised systems require a re-examination of the current institutional arrangements, as more control and responsibility is distributed to system owners.

Institutional arrangements were perceived by respondents to be essential for the operation of decentralised systems, with the need for the identification and enforcement of clear guidelines and responsibilities on the operation and ownership of the systems. Yet, at the same time, current arrangements were perceived to be complex and excessively challenging by respondents. For example, this area was referred to as “one of the main bottlenecks to the widespread use of decentralised systems”, whilst another respondent equated approvals to an “obstacle course” which could eventually be simplified as systems become more widespread. These comments highlight that this is an area that requires further research and development.

7. DISCUSSION

Overall, the major drivers for the uptake of decentralised systems in SEQ are the increased uncertainties in traditional water supplies combined with rapid population growth and its associated impacts in the region. The growth in population and the associated development of the region require the provision of new water sources and expansion of the built environment (residential, commercial and industrial). This places additional demands on existing infrastructure and the need to expand infrastructure services into growth areas. To achieve sustainable growth, the region needs to be able to wisely exploit resources, minimise impacts on the environment and preserve the lifestyle opportunities expected by the population.

In Section 4.1, the development drivers relevant at the time of the implementation of specific case studies in SEQ were identified. In section 1.1, the views of SEQ professionals on perceived current drivers for decentralised systems were presented. The outcomes from these two information sources have been amalgamated to produce a list of drivers for decentralised systems in SEQ, which are:

(a) Overcoming current limitations of local water and wastewater services. Decentralised services can exploit multiple water sources, such as rainwater, stormwater and recycled wastewater. In addition, features such as rainwater tanks provide additional water storage capacity.

(b) Deferring infrastructure upgrades by allowing a staged investment in decentralised infrastructure in areas that are at capacity, or remote from existing centralised services. The provision of infrastructure according to the local environment allows for gradual upgrade and flexibility in uptake/upgrade of technology/systems in the future. The unique characteristics of existing housing stock in SEQ may offer opportunities for retrofitting of existing urban areas, e.g. raised first floors in traditional ”Queenslander” homes are easier to retrofit compared to houses built on concrete slabs.

(c) Environmental protection by minimising the impact of discharges and large volume transfer that may harm ecologically significant areas.

(d) Showcasing sustainability by demonstrating the application of sustainable principles in water service provision through decentralised systems and addressing issues cited above.

(e) Water conservation. Decentralised systems facilitate the adoption of alternative water supply and maximum benefit through reuse of water streams preserving potable supplies.

(f) Enhancement of local amenity. Local landscape amenity can be preserved through water made available by local harvesting and reuse of different sources for garden and public open space irrigation.

(g) Technology showcase. The potential to adopt innovative technologies and also develop proof-of-concept in decentralised developments has traditionally been an important driver in many systems.

Furthermore, factors closely associated with the drivers and essential to the increase in uptake of decentralised systems are:

(h) Increase in public acceptance contributes to the wider uptake of decentralised systems by developers, particularly due to the reality of the drought.

(i) Availability of intellectual capacity and know-how on decentralised systems in SEQ. Initiatives in SEQ such as case studies and investment in research and reform by Government in many areas have contributed to the build-up of intellectual know-how on many aspects of decentralised systems in Queensland, which is essential for proper implementation.

(j) The importance of Government support has been shown to be an essential enabling factor for the adoption of decentralised systems. In SEQ, reform in the water industry, legislation, changes to planning and building codes and implementation of projects at all levels (e.g. Pimpama-Coomera Waterfuture Masterplan) have become essential in facilitating the adoption of decentralised systems at a wider scale.

The combined effect of these multiple factors and the process they initiate in SEQ is a powerful force for the uptake of decentralised systems. Figure 7 shows the drivers, enabling factors and response options that are required to achieve sustainable growth and development.

The adoption of such systems will generate benefits which can be reaped at particular developments and also at the regional scale. These important steps in moving towards sustainable development include reduced environmental impact, better use of capital, increased community ownership and awareness towards resource use, creation of new opportunities for technology development and institutional change.

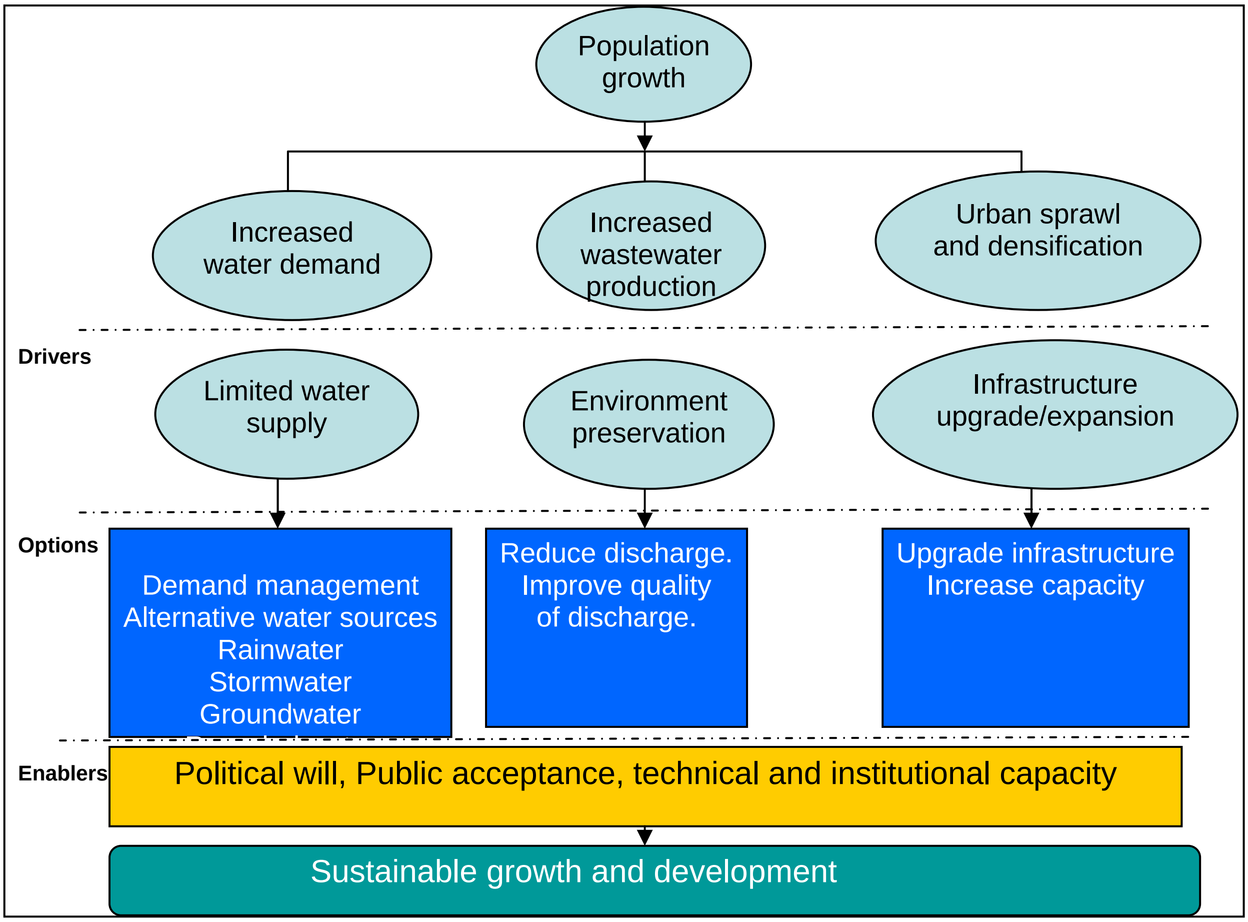

Figure 7: Factors impacting sustainable growth for decentralised systems in SEQ

8. UNDERSTANDING THE POTENTIAL ROLE OF DECENTRALISED SYSTEMS IN SEQ

Survey participants were also asked to comment and provide their opinion on the role of decentralised systems in SEQ. Among the nine participants, eight identified a role for decentralised systems in SEQ and one person did not believe it warranted a role. Those who replied “yes” were asked to elaborate on the role. The responses from survey participants can be found in Table A2 in the appendix.

The major themes emerging from the analysis are presented in this section.

Generally, the role defined by respondents for decentralised systems in SEQ varied between individuals. There was strong agreement that each role must be determined by the specific context and needs of each development, as customisation is an important factor in maximising the effectiveness of the systems and the sustainability of each development.

The responses also highlighted a number of important discussion points.

Difficulty in Defining a Role for Decentralised Systems

Developing a generalised definition for the role of decentralised systems is a challenging task. Decentralised systems have the flexibility to fulfil a range of functions and roles. Systems are designed to suit a wide range of functions, from water supply to wastewater treatment, recycling and reuse. They can also adopt a range of technologies and configurations depending on the specific needs and functions of the target area and the water and wastewater needs of each development. As a result, the technology costs and characteristics of such systems will vary widely depending on each individual case.

For instance, one response stated “in rural areas, adoption of natural treatment systems which can offer good water quality at low cost would be preferred. Whilst in urban areas, investment in more expensive and lower footprint technologies would be warranted due to population density and affordability”.

Integration or Complementarity between Decentralised Systems

Some respondents saw decentralised systems as better suited for areas not connected to the SEQ water grid. Others saw advantages in integrating decentralised systems with the centralised system. Whether such systems are better suited as an alternative to centralised systems, allowing development in areas previously constrained due to availability of water services, or whether opportunities should be explored in areas already connected to services, is a point for further investigation.

Whilst benefits, such as increased water storage capacity, from the adoption of rainwater tanks in built-up areas are often widely recognised, wastewater treatment and reuse tends to generate greater debate. Part of the debate stems from the need to ensure that adequate operation and maintenance, and safeguard of public health take place. For example, currently public water authorities manage large scale decentralised technologies, whilst many of the communal systems are managed by bodies corporate.

In addition, uncertainty as to how the integration of decentralised systems could affect volume and quality in existing and future centralised systems or Indirect Potable Reuse schemes could also play a role in the debate.

More discussion is also needed on: (i) the requirement of new commercial buildings in SEQ that must supply mains water for toilet flushing; and (ii) how to best address storage of treated effluent from decentralised systems.

Suggestions for Further Development

Respondents agreed that the role decentralised systems can have is associated with the development of systems for their governance/service provision and also the cooperation between multiple stakeholders. Such systems represent a radical departure from the centralised water and wastewater service provision model, where minimal interaction with stakeholders is required and all operations are under centralised control. In decentralised systems, local stakeholder behaviour has a much greater impact on the performance of the system. In addition, as decentralised systems are often based on the principle of integration of the water cycle, the system design can incorporate different streams, such as rainwater, stormwater and wastewater, which traditionally fall under the jurisdiction of different government authorities. Hence, to define a role for decentralised systems it is also necessary to re-define the support and service framework and models under which such systems operate.

Suggestions from respondents to progress in these fields include learning from existing industries that effectively operate decentralised assets, such as the solid waste and cooling tower industries, and the development of tools that can facilitate the communication between different players. For example, a respondent suggested the development of common frameworks for planning activities across the region for water service providers, planning authorities and developers to facilitate cooperation and integration between these groups.

Additional challenges/opportunities that will also need to be considered in SEQ include:

(a) integration of stormwater reuse into water sensitive urban design (WSUD) for greenfield suburbs;

(b) the need to upgrade centralised sewage treatment plants. If extra EPs are added – the driver is a cap on nutrient load licensed by the EPA. In such cases, treatment and reuse of load at the local scale may become attractive; and

(c) the need to further discuss the restriction of new dual reticulation developments to protect sewage for potential future PRW.

9. CONCLUSIONS

In order to understand the potential impact that decentralised systems could have in SEQ, it was necessary to understand the key drivers for their uptake. This was achieved through the analysis of a set of SEQ specific case studies to determine the drivers in existing developments, and by consultation with leading professionals based in Queensland who were familiar with decentralised systems to determine perceptions of current major drivers applicable to the SEQ region. A total of nine leading professionals took part in the study.

At present, SEQ faces significant challenges and a sense of urgency to develop sustainable water services. This is due to the pressure on existing water sources to meet the demand of the rapidly growing population in the region and to cope with the associated pressures brought on by rapid urban growth, which includes contamination of environmentally sensitive receiving waters.

Against this background, the adoption of decentralised systems in SEQ is being driven by:

(a) the need to overcome limitations of existing water and wastewater services;

(b) the need to defer expensive infrastructure upgrades;

(c) environmental protection;

(d) opportunity to showcase the potential for sustainable approaches and innovative technologies;

(e) water conservation; and

(f) enhancement of landscape amenity.

However, to transition decentralised systems from a niche to a more mainstream approach requires enabling through:

(g) government reform of legislative and strategic planning frameworks (e.g. MP 4.2, Pimpama-Coomera Masterplan);

(h) increased public acceptance for alternative water sources and water reuse; and

(i) building of professional skills and capacity for implementation of decentralised systems in SEQ.

Overall, it is recognised that the region could benefit from decentralised systems in SEQ by: reducing environmental impact; allowing gradual investment of capital through the life of a development (offering economic benefits); and creating opportunities for technological innovation. However, adoption of decentralised systems requires enabling through promoting community ownership and awareness of water use/impact, encouraging institutional change, and moving towards more sustainable development and use of water resources.

Eight of the nine respondents also believed that decentralised systems had a potential role in the development of SEQ. The role of decentralised systems will be defined, in each case, by the local context. Site specific factors that influence the design and suitability of decentralised systems include regional climate, geography and topography, soil and hydrological characteristics, existing infrastructure, and current and future plans for the region.

Decentralised systems can be adopted in a myriad of situations such as greenfield and brownfield developments and both urban and rural areas. They can be adopted either as a complement to the centralised water grid or for communities isolated from the water grid.

As an emerging industry, the segment is also prone to risks and challenges, and its development will need to be allied to the development of suitable planning and governance structures.

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APPENDIX 1

Table A1: Benefits from DCS to SEQ identified by survey participants

No.	Benefit from Decentralised Systems	Participant comments
1	Environmental benefits:	Reduces amount of water extracted from environment (e.g. dams). Better use of stormwater and recycled water. Increases availability of water for 60% of uses. Reduces stormwater flow and associated erosion. Reduces amount of waste/nutrients discharged into environment (more diffuse waste streams). Less contamination from inferior treatment. Less energy consumption. Avoids large scale disruptions. Offers opportunities for reuse at all scales. Offers ability to adapt outcomes to the required needs/sensitivity of the receiving environment (waste, stormwater, flow, etc) - i.e. allow tailoring of discharge and treatment to suit conditions of local receiving environment. Decreased need for construction of long pipelines though sensitive areas and provides clean and green solutions.
2	Economic	Lower Life Cycle Cost because long distance pumping and associated infrastructure costs are avoided. Allows incremental growth - compared to the need for high capital investment in early stages of project and for upgrade in urban areas (especially with densification). Decreases need for new dams, desalination plants. Small stand alone is more effective in isolated areas, but needs to consider the realistic maintenance costs. Less cost for public as systems are privately funded. Rain tanks are cheaper than water grid construction. Potential reduction in costs of water supply and wastewater compared to centralised systems.
3	Social	Stakeholders take more responsibility for water use and waste management - including the community as they can see local impact. Increased community awareness, ownership/empowerment. Specific solutions for specific locations in line with local needs. Better lifestyle associated with water provision.
4	Technological	Technology exists. Robustness and cost effectiveness will improve as more projects are implemented on the ground. Small systems produced by small operators could have potential for export to less developed countries. Opportunities to match technologies with greater number of reuse options. Innovation of practices and hardware. Control systems allow checking performance over the web. Help breakthroughs away from conventional systems.
5	Sustainability	Should be the driving force for adoption of decentralised schemes. Can reduce power demand and increase opportunities for recycling. With right planning/technology can be GHG and whole of life positive. Varied but water systems need to be energy efficient to be sustainable. Easier to upgrade compared to large systems - better use of capital.
6	Institutional	Need good institutional arrangements with clear guidelines as to who has responsibility for ownership and operation of these assets. Better fit with needs of communities, reduces risk that comes from large infrastructure projects. Acceptance/approval of fool proof no opex systems will be matter of course not an obstacle course. Research opportunities. Some of the regulation associated with wastewater systems is made more complicated with decentralised wastewater systems. Give control back to the people.
7	Other	Can provide cheap sewer and deliver high Quality water. Spreads the risk of running out of water. Independence from old mentality and slow centralised public service administration attitude. Very political though. DCS more effective in remote areas of SEQ. Integration of DCS in decentralised in brownfield should be considered. Increases resilience of towns.

Table A2: Comments on the role of decentralised systems in SEQ

• Develop a complete sustainable suite of technologies: water reuse in garden, high tech composting toilets, low impact environmental safe soaps/detergents, raintanks, recycled water in garden, single point enhanced filtration with activated carbon for drinking, bypass rainwater tank to sewer to flush out centralised systems.
• The role would be highly varied and should be suited to local situation. • Have capable providers provide best service to customer at best cost;
• Adoption of a service model for decentralised systems similar to solid waste management with several private operators who provide a full service supply, installation and operation of decentralised systems. Householders pay an annual service fee for the provision of water supply, treatment and recycling provided by the systems.
• In rural areas: replace or develop new natural systems as sewage treatment that have small operating expenditure and provide high quality water. In Urban areas as the population increase drives the need for services, there is potential to use more expensive technologies and as sewage systems overload for wet weather, treatment will be more favourable than upgrade of the network.
• To assist the water industry to develop sustainable solutions a template for all planning activities could be developed.
• DCS has a place in greenfield, brownfield and communities not connected to SEQ water grid.
• Promoting the need for true integrated water supply planning in SEQ and demonstrating that decentralised systems can coexist with the western corridor recycled water schemes.

Urban Water Security Research Alliance

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