STAKEHOLDER ENGAGEMENT

For Implementation of Direct Potable Reuse

Abstract

Australia, as one of the driest continents, is highly susceptible to water scarcity as a result of climate change, population & economic growth and ongoing droughts. For many decades, Singapore and Namibia have demonstrated that direct potable reuse can be widely accepted in community and it is a technologically and economically viable option to ensure water security compared to other options such as indirect potable reuse and desalination.

Similar to Iran, other cities in the Middle East and the United States, direct potable reuse hasn't been successfully implemented due to strong public perception against reclaimed wastewater. Health concerns and psychological problem with the 'yuck' factors are some of the key drivers in the community for unwillingness to accept reclaimed water for cooking and drinking.

This report is aimed to explore new and innovative approaches to community engagement as part of the planning process for a complex and uncertain water future.

Minh Tran

April 2019

Table of Contents

1. BACKGROUND

2.1. Water Scarcity in Australia

Population growth, urbanisation, climate change and increasing community expectations on efficiency of services and use of resources are posing major challenges for authorities and water utilities.

The 2011 population projections in all major cities by state government departments around Australia suggest a steady growth over the next decade with steep, high rate of growth is expected to occur in Sydney, Melbourne, South East Queensland and Western Australia, Figure 1. These projections demonstrate an urgent need for immediate actions by authorities, service providers, regulators, industries and community at large.

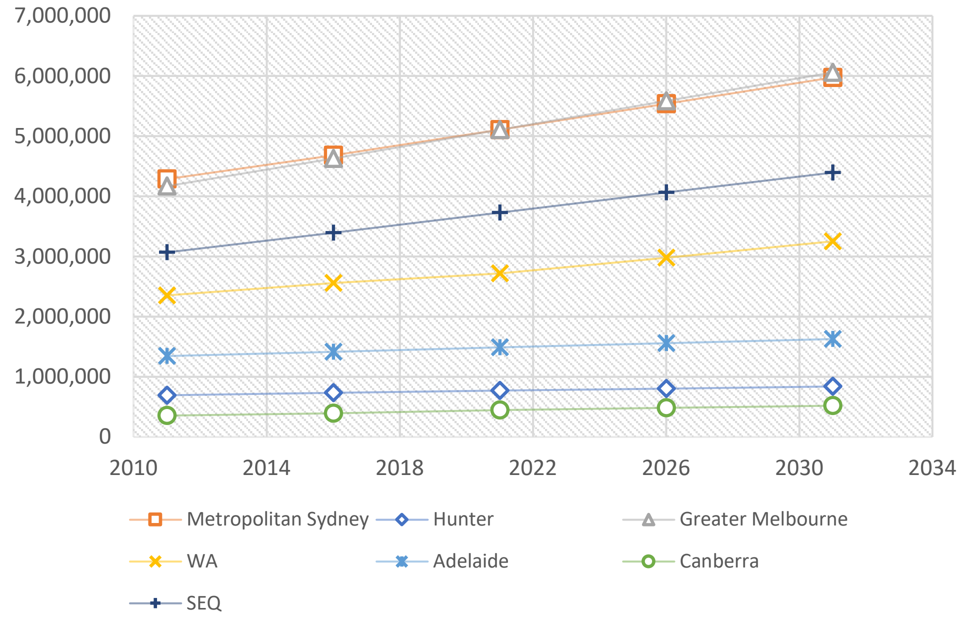

Figure 1: Population Projections for Major Australian Cities

Apart from Antarctica, Australia is known to be the driest continent in the world. Droughts are well understood and they are integral part of everyday Australian life. They can be intense, unpredictable and often have long lasting effects to communities across the country. The Millennium drought was the worst drought recorded in Australia since the European settlement. The event placed extreme pressure on urban water supply and completely changed the way water resources being treated at every community in the country.

Recent rainfall data from the Bureau of Meteorology (BOM) indicates that severe drought has returned with similar characteristics of Millennium drought patterns. Rainfalls in Sydney and other major cities were heading towards record low, especially in Brisbane, Melbourne and Adelaide, Figure 2.

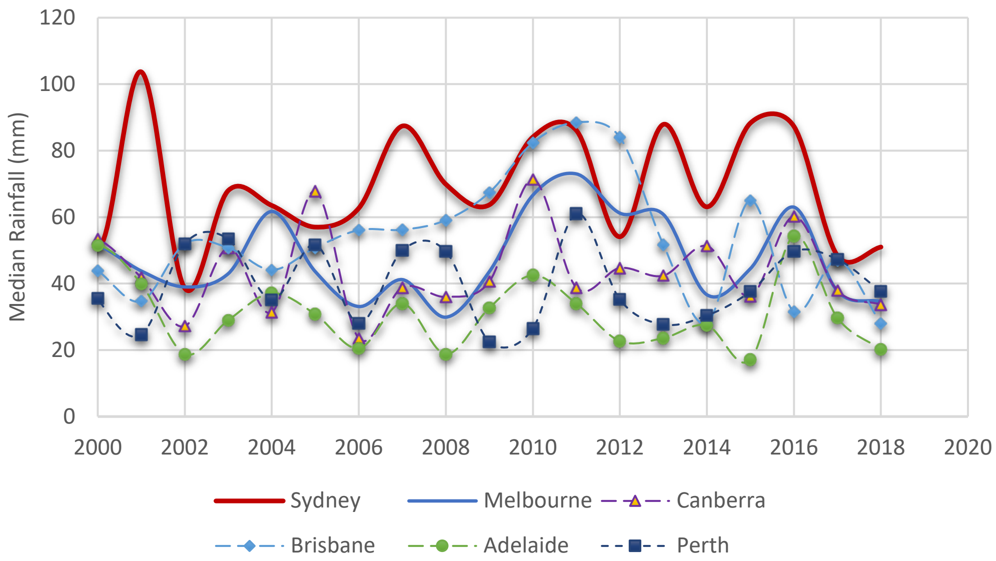

Figure 2: Median Rainfalls in Australia (Source: BOM)

Steady population growth and recurrence droughts place significant pressures on authorities and water utilities to find long-term solutions to water security and ensure reliable supply to increased demands.

Sydney Water is the largest water utility in Australia with extensive water and wastewater networks capable of servicing a population of more than 5 million people. Recent water storage and demand report indicates the total available water within the networks is fast approaching the 50% threshold. As drought continues to affect New South Wales and other the eastern states, Sydney's dam water levels are falling at a rapid rate since late 2017 compared to the previous declining rate notably between 2000 and 2004 during Millennium Drought, Figure 3. Despite a number of existing water saving initiatives such as recycled water, water harvesting and water efficiency through BASIX, long-term drought is placing significant stress on Sydney's freshwater resources. Recent catastrophic problems in Murray-Darling system led to millions of native fishes killed and farmers are struggling to their feed livestock.

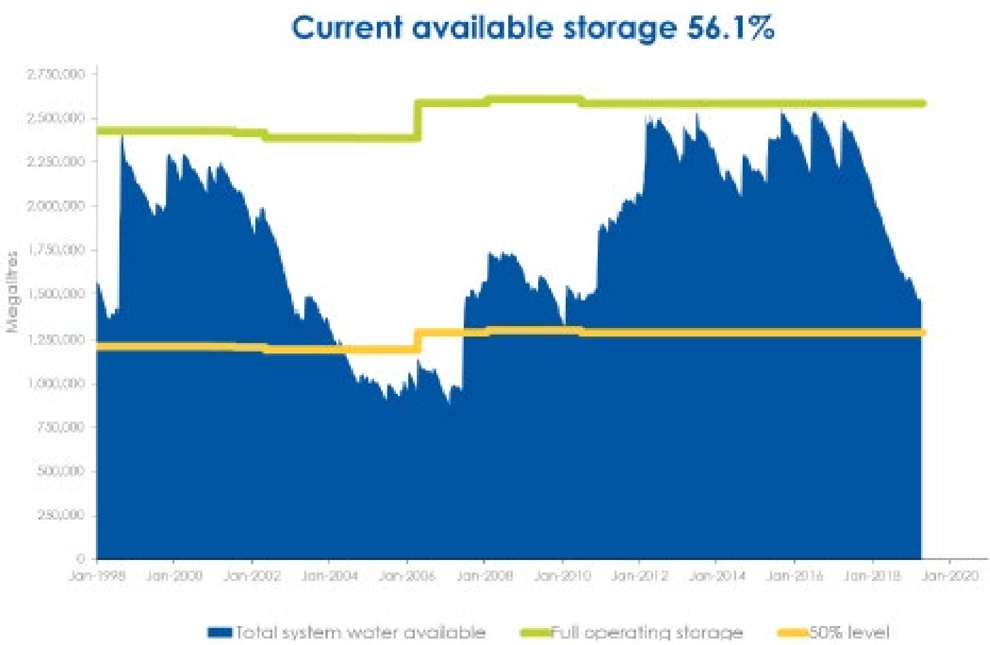

Figure 3: Greater-Sydney-water-storage-and-supply-report (WaterNSW, 2019)

Other developed and developing countries around the world are also facing similar water scarcity problem in Australia, especially countries in the Middle East and North Africa. The common drivers for declining of water resources are population & economic growth, unprecedented climate variability and urbanisation. When it comes to implementing direct potable reuse, most countries including the United States face the biggest hurdle which is public perception. Although, United States and countries such Singapore have developed more resilience regulations for indirect and direct potable reuse.

2.2. Public Perception on Reclaimed Wastewater in Iran

Like many other countries in the Middle East and North Africa, Iran faces severe water crisis due to irresponsible irrigation practices, depletion of groundwater supplies, population growth and climate change. The situation has increased the need for better water resource management and the use alternative water sources such as reclaimed wastewater. In 2004, the World Bank approved a USD$279M loan to Iran aiming to improve access to water supply and increase coverage of sanitation services in Ahvaz and Shiraz (The WBG, 2004). The project completed in 2009. In addition to the Ahvaz and Shiraz water supply and sanitation project, Iran also commenced construction of 117 dams in 2008. In 2012, there were also several large desalination projects in the Caspian Sea and Persian Gulf areas aiming to transfer about 200 million cubic meters of water a year to the central regions of Iran (Wikipedia, 2017). However, by 2014, it was apparent that all six major cities in Iran face severe water shortage due to long-term mismanagement and lack of planning (FDI, 2014).

Despite imminent water scarcity, future of direct potable reuse in Iran is still uncertain. A 2017 study by Baghapour, M. A. et al. (2017) shows 74.9% of respondents in Shiraz opposed the use of reclaimed wastewater for drinking and cooking sighting health as a main reason for the opposition. However, Baghapour, M. A. et al. (2017) has also indicated that lack of education and ideological could also be the main reasons for the unwillingness and acceptance of direct potable reuse, (Baghapour, M. A. et al., 2017).

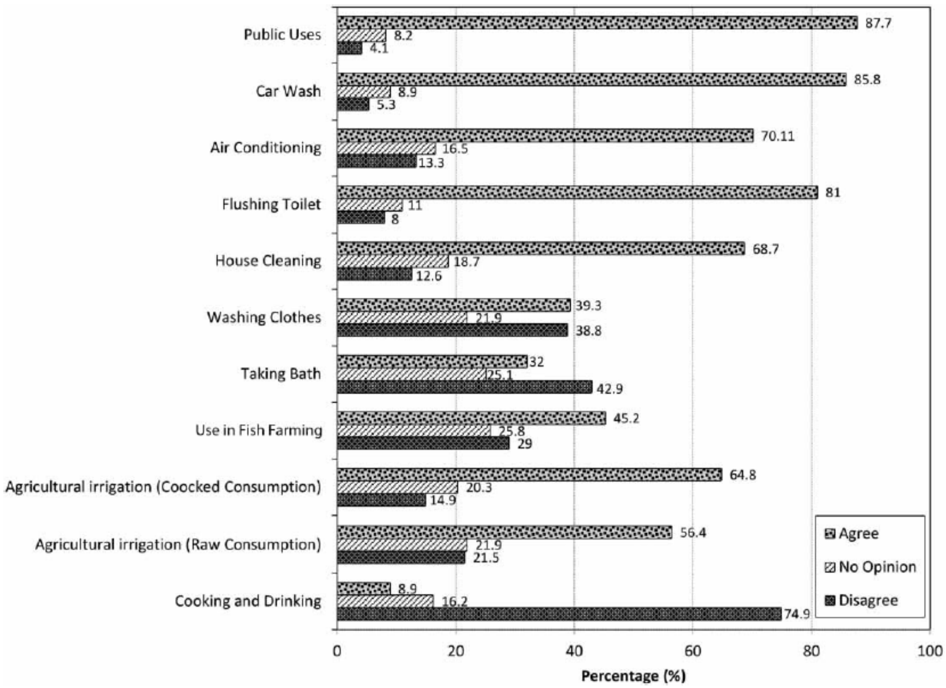

Figure 4: Shiraz citizens' willingness to reuse reclaimed wastewater (Baghapour, M. A. et al., 2017)

2.3. Successful Water Reuse in Singapore

Highly urbanised and lack of resources are some of the major challenge for a tiny island-nation of Singapore. With a population of more than 5.6 million people and total renewable freshwater resources of less than 110 m^3 per capita, Singapore is the most water scarce country in South East Asia and the water problem is comparable to that of other water scarce countries in the Middle East such as Jordan, Sudan and Libya (Lefebvre, 2017).

Recognising the problem, Singapore started investing in water reuse technologies since early 1970s. It wasn't until the 2000s, Singapore implemented an island-wide NEWater scheme providing an average 30% of Singapore's water demand and expected to increase to 55% by 2060 (Lefebvre, 2017).

Treatment for water reuse in Singapore consists of:

- Primary sedimentation
- Activated sludge
- Microfiltration (MF)
- Ultrafiltration (UF)
- Reverse osmosis (RO), and
- Ultraviolet (UV) disinfection

Pressure-driven RO is known to be the main technology in the production of NEWater. It is the technology that allows particle separation by excluding particle sizes ranging between 0.2 and 0.4nm preventing technically all permeable particles, including emerging contaminants and vi-ruses. The technology requires substantial energy demands which are mitigated through pre-treatment process where biological treatment and low-pressure MF or UF are being implemented. The multiple-barrier water treatment approach in NEWater plants leads to higher the quality, exceeding the WHO drinking water quality guidelines, gaining wider public trust and acceptance (Lefebvre, 2017).

NEWater was developed with a strategic goal to free space for more valuable land usage, ensuring self-sufficient water supply and energy efficiency in water treatment. It was an initiative that has much larger public acceptance than developed countries such as Australia. The NEWater success journey was generally attributed to the effective branding of NEWater and the media as a communication tool. It was a strategy that that help to build different layers of trust in communities, increase public awareness of water security and acceptance of the technology, experts and authorities overcoming the 'yuck' factor (Lefebvre, 2017).

2.4. Direct Potable Reuse in Windhoek, Namibia

Lies in the central highlands, Windhoek is the capital city of Namibia, the driest and barren country in sub Saharan Africa. With lack of perennial rivers, population growth and increased agricultural activities, the ground-water reserves were under severe stress (Pisani, P. and Menge, J., 2013). In early 1960s, authorities in Windhoek were forced to seek alternative water sources to meet increasing demands. Some of the key drivers that triggered the need for change were (Wood, 2014):

- The 1957 water crisis
- Increased demands as a result of population growth
- Significant decline in annual rainfall, and

- Increased evapotranspiration

By November 1968, Goreangab Water Reclamation Plant (GWRP) became the longest running direct potable reuse in the world with a capacity to supply up to 12% of Windhoek's daily water demands. The GWRP was converted to a two-train operation in which secondary treated sewage effluent was combined with dam water and introduced directly into the city's drinking water supply (Pisani, P. and Menge, J., 2013).

The process train employed at the GWRP had been the object of rigorous pilot studies and testing between 1960 and 1968. The phrase was based on the multiple barrier principle. After multiple upgrades over the years, a New Goreangab Water Reclamation Plant (NGWRP) was commissioned providing high quality drinking water to about 350,000 Windhoek residents (Wood, 2014).

The treatment process at the NGWRP was built upon the principle of multiple barrier approach at the old GWRP. The multi-layered approach was designed to protect public health by employing redundancies throughout the system in the event one or multiple barriers failures. The multi-layered system is unique to NGWRP consists of a comprehensive treatment train that has been adapted over time to optimise the process and handle the seasonal changes.

To control source water pollution, industrial wastewater is treated separately for releasing into the Klein Windhoek River or for irrigation purposes whilst tertiary-treated domestic and commercial wastewater is being used for direct potable reuse, Figure (Wood, 2014).

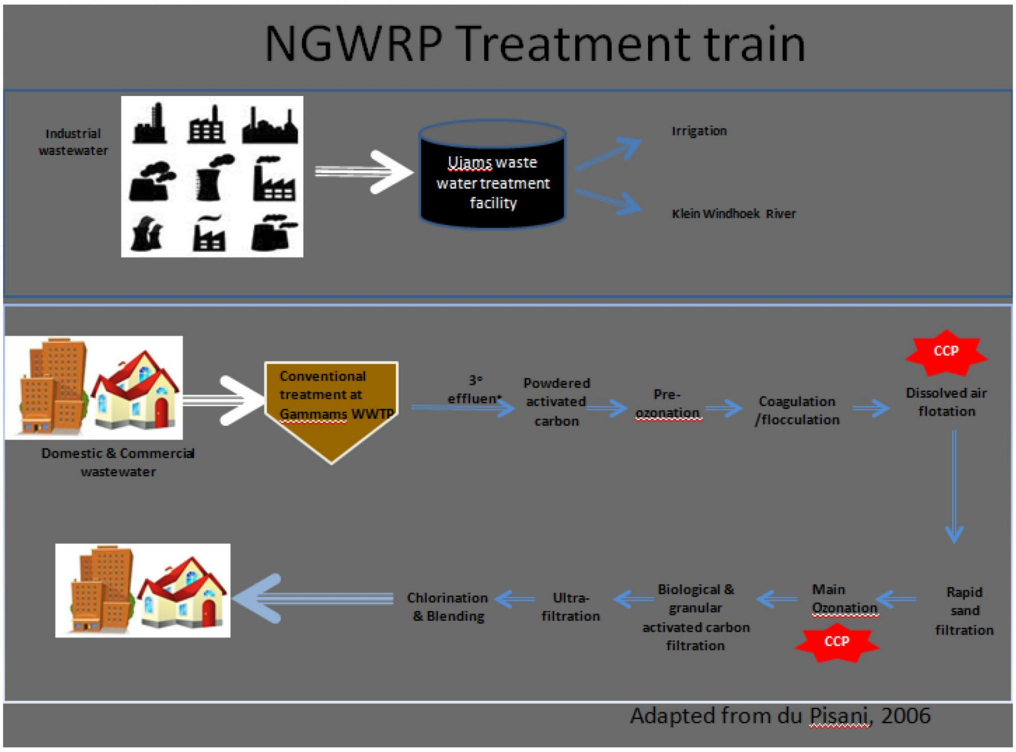

Figure 5: Windhoek's NGWRP treatment train (Wood, 2014)

2. SITUATIONAL ANALYSIS

In recent decades, in light of imminent water crisis around the world, numerous direct and indirect potable reuse projects were instigated but there were only a small number of successful projects in Singapore, Israel and Namibia whilst in the United State (US) and Australia, there were a mix of successful and unsuccessful projects (Mainali, B. et al., 2010).

In many applications, Strength, Weakness, Opportunity and Threat (SWOT) analysis is a useful analytical tool for identifying the critical factors in the implementation of a concept or model, in this instance, a direct potable reuse scheme. The SWOT analysis in this report utilises previous study by Mainali, B. et al. (2010) and other studies on direct and indirect potable reuse where the strengths and weaknesses of various successful and unsuccessful water reuse schemes were analysed and assessed.

SWOT Analysis	
Strength	▪ Increase public awareness of the water scarcity ▪ Advanced water treatment and purification system ▪ Technically and socio-economically viable ▪ Long-term social, environmental and economic benefits ▪ Strong support from water industry, professionals, academics and researchers ▪ Drought proofing and reduce stress on freshwater supply
Opportunity	▪ Provide alternative source of freshwater supply ▪ Provide better communication and educational tools on advanced water treatment technologies ▪ Strengthen the trust and confidence of communities and end users ▪ Enhance economy and reduce environmental impacts
Weakness	▪ Lack of understanding on public perceptions and attitudes toward direct potable reuse ▪ Lack of education and outreach programs ▪ Significant communication gaps between authorities, stakeholders and communities ▪ Ideological and psychological barriers
Threat	▪ Health concerns and lack of trust in communities ▪ Increased costs to end users ▪ Additional levels of treatment, testing and contaminant monitoring needed to ensure public safety

Table 1: SWOT Analysis on DPR

3. STAKEHOLDER ANALYSIS

A successful project requires rigorous stakeholder analysis which is an important technique for identify and analyse relevant parties with different level of interest and influence. Figure 6 outlines the conceptual model in which each stakeholder will be grouped in correspondence to their level of interest and influence. The identifications and ratings for each stakeholder are shown in the below Table 2.

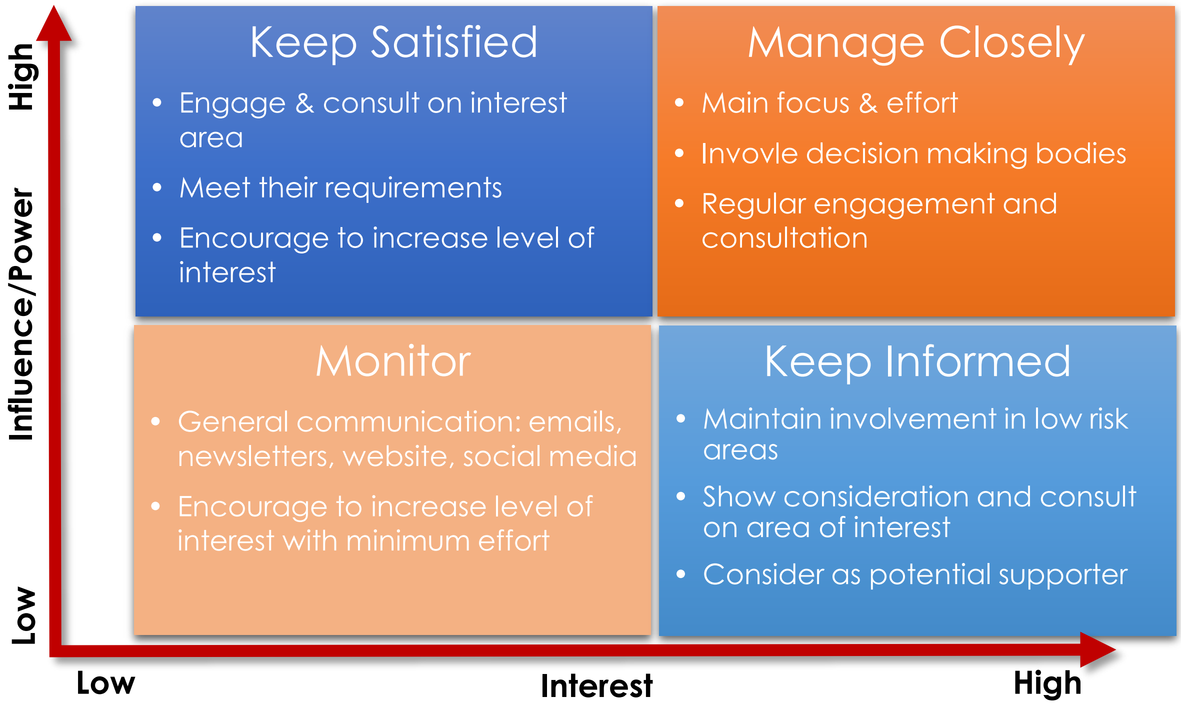

Figure 6: Stakeholder Matrix Model

Stakeholder	Representatives	Interest	Influence
End Users	Communities, families, households	9	6
Regulators	Department of Industry, Natural Resources Access Regulator, independent agencies (e.g. IPART)	9	9
Business Partners	Consultants & contractors with fixed commercial agreements	8	6
Investors	Bank, financiers & private investors	6	9
Suppliers	Product providers	6	7
Contractors	Service delivery providers	8	3
Consultants	Professional service providers	7	4
Industry Associations	Water Service Association Australia, Australian Water Association, Public Interest Advocacy Centre, Social Services and Ethnic Communities Council	9	7
Media	Major media outlets including social media	4	8
Other Utilities	Electricity, gas, telecommunication	4	4
Educational Institutions	Schools, TAFE, universities, training organisations	9	8

Table 2: Stakeholder identification and rating

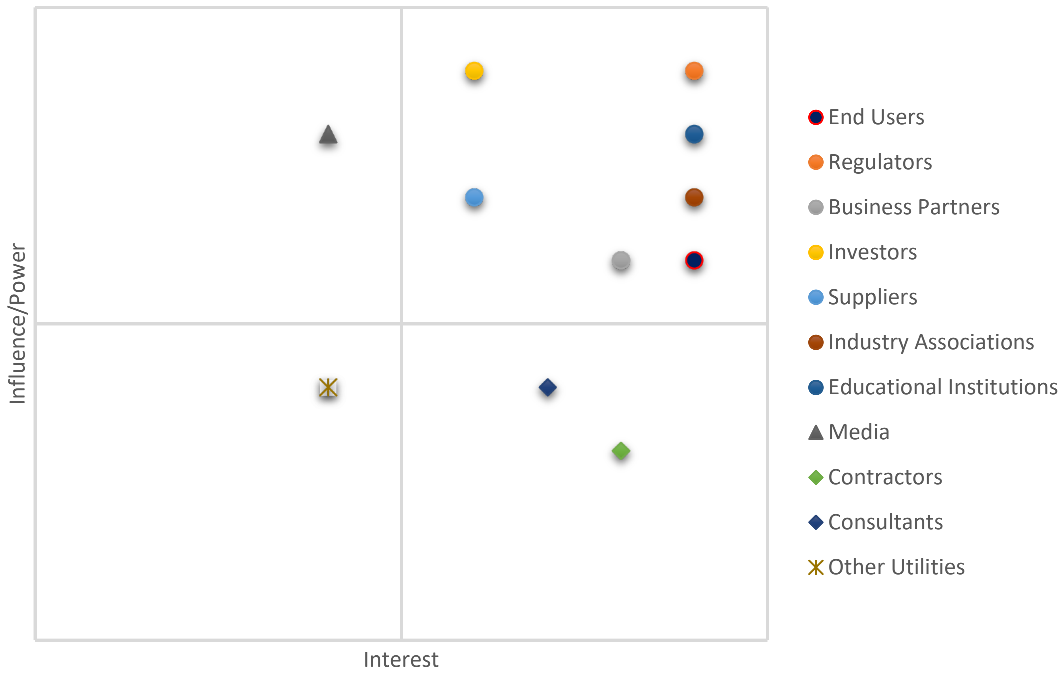

Figure 7: Stakeholder matrix

A visual representation of the stakeholder rating in Table 2 is shown in above Figure 7. The stakeholders were grouped in accordance with the matrix model illustrated in Figure 6 which is based on their interest and influence.

Table 3 provides a summary of the role of each key stakeholder identified in the above process.

Key Stakeholder	Role
End Users	Overall acceptance and exercise their role as the tax payers
Regulators	Enforcing water legislations such as NSW Water Management Act 2000 and NSW Water Act 1912
Business Partners	A panel of experts to provide strategic advice and deliver key infrastructure
Investors	Provide financial support to ensure viability of the project
Suppliers	Main suppliers providing critical inputs in technological development & manufacturing components & parts as well as operation and maintenance
Industry Associations	Peak bodies providing technical support, promoting the technology and lobbying changes to professionals and wider community
Educational Institutions	Provide essential knowledge-based foundation and enabling technology advancement through teaching, researches and collaboration with scientific communities

Table 3: Role of Stakeholders

4. STAKEHOLDER ENGAGEMENT AND EVALUATION STRATEGY

Planning for a sustainable and resilience water future is both complex and uncertain. In a complex and uncertain future, planners are not only required to develop forecasts and projections using facts but also adopt the scenario planning for the future (Dawson, M. et al., 2018).

In many businesses, scenario planning is a well-accepted method used to develop aggressive strategies to address emerging problems and improve preparedness for unforeseeable failures (Dawson, M. et al., 2018). The same approach can be aplied in the strategic planning of DPR and other related water infrastructure. Dawson, M. et al. (2018) describes a three-step scenario planning approach that is currently being integrated into Sydney Water's business and planning processes. Summaries of these steps are as below.

5.1. Step 1: Interviews, Surveys and Horizontal Scanning

This initial step is essential for identifying appropriate input dimensions for the scenarios through a series of background interviews and online surveys. Horizontal scanning is necessary to identify potential market drivers, emerging technologies, social & economic trends and potential disruptions that could have substantial impacts to the project outcome (Dawson, M. et al., 2018).

5.2. Step 2: Scenario Development

Workshopping is an effective way to develop scenarios. Attendees should be those who are able to promote diversity of thought. People from different disciplines, a mix of ages and cultures enable traditional thinking to be challenged.

The scenario development workshop is based on the strategic conversation approach which allows participants of different backgrounds, disciplines, ages and cultures to explore different visions and develop a shared appreciation of challenges and opportunities for the project. Figure 8 illustrates a two-by-two matrix in which four scenarios can be presented.

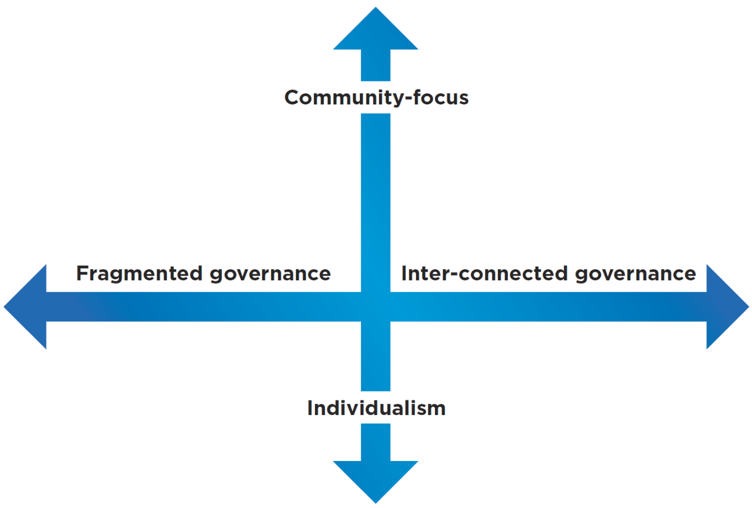

Figure 8: Critical uncertainties in future planning (Dawson, M. et al., 2018)

5.3. Step 3: Key Dataset Identifications and Signposts Monitoring Trajectory

Key datasets and signposts are required to ensure the scenarios are usable and integrated into infrastructure planning. As we are progressing towards the future, signposting and monitoring changes is critical in understanding the trajectory. The key datasets will enable the scenarios to be modelled and a wide range of potential future outcomes to be quantified. The process allows the proposed plans and strategies to be tested under a range of scenarios to identify the strengths and weaknesses of each strategy (Dawson, M. et al., 2018).

5.4. Alternative Scenario Development Process

Recent paper published on the Water e-Journal by Chong, J. et al. (2018) describes a new and innovative community engagement process that was developed in collaboration between the Institute for Sustainable Futures at the University of Technology Sydney (UTS) and the New South Wales Government's Metropolitan Water Directorate (MWD).

In many ways, the process is similar to the above process described by Dawson, M. et al. (2018) which include appreciateive enquiry and scenario analysis & planning. However, the notable differences are the future triangle concept (Figure 9) and the use of artworks (Figure 10) as a visual scenarios.

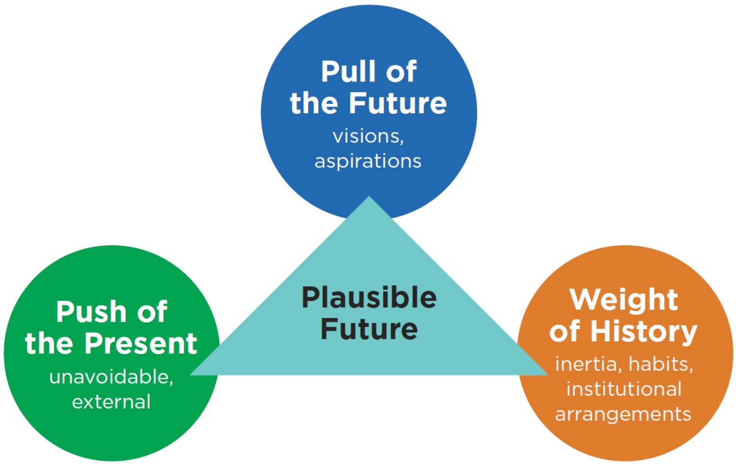

Figure 9: Future triangle concept (Chong, J. et al., 2018)

In a workshop, participants are encouraged to recognise multiple alternative futures using the future triangle concept which is based on mapping the past, present and future drivers of change in accordance with baseline scenario elements such as climate change and population growth (Chong, J. et al., 2018).

It is a technique used to inform the development of plausible futures reflecting the participants' visions and dreams for the future within a context of reality (Chong, J. et al., 2018).

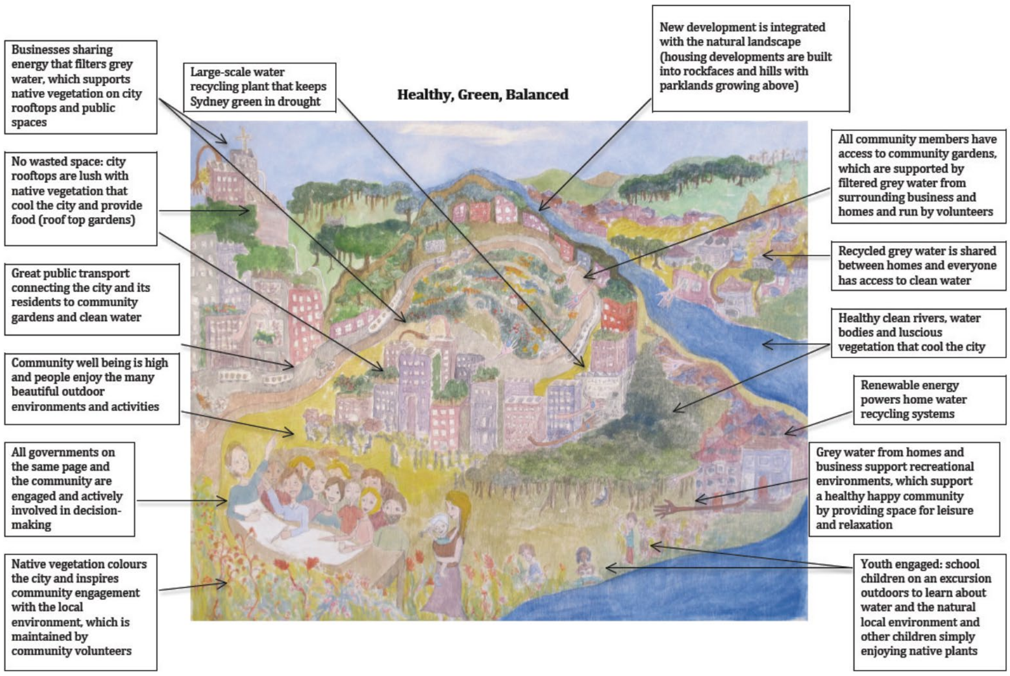

Figure 10: Example of Future Scenario (Chong, J. et al., 2018)

Reflecting the above two approaches, the creative visioning and concept of future triangle could be an effective tool to be used for engaging the stakeholders in workshops, public debates, social media, traditional media outlets and online surveys.

In addition to these scientific approaches, there should be a much more aggressive campaign on water scarcity using the media to reach a wider range of audients. During the Millennium Drought, there was an effective community engagement strategy in which water scarcity was well understood in every community. The constant water shortage messages, live report of dam water levels, information about water saving devices, water restrictions and many other initiatives have played a significant role in increasing stakeholders' interest and support. A similar approach with modern and advanced technologies can be introduced to promote awareness and understanding of direct potable reuse.

5. CONCLUSION

Climate change, population & economic growth and ongoing droughts place tremendous pressures on the already stressed freshwater supply. As a dry continent, Australia is vulnerable to water scarcity. Singapore, Namibia, Israel and some part of the US have demonstrated that direct potable reuse can be a technologically and economically viable option to ensure water security compared to other options such as indirect potable reuse and desalination.

The biggest hurdle for a successful implementation of direct potable reuse is public perception of reclaimed wastewater. Health concerns and psychological problem with the 'yuck' factors are some of the key drivers in the community for unwillingness to accept reclaimed water for cooking and drinking.

A new and innovative approach to community engagement using future triangle and creative visioning techniques can be adopted to plan for a complex and uncertain water future. An aggressive awareness campaign is also required to increase public awareness of the water shortage problem, the advanced technologies in water treatment and, more importantly, to build trust and confidence from all key stakeholders.

6. REFERENCES

Baghapour, M. A. et al., 2017. *A survey of attitudes and acceptance of wastewater reuse in Iran: Shiraz City as a case study,* s.l.: Journal of Water Reuse and Desalination.

Chong, J. et al., 2018. Community Engagement on Water Futures: Using creative processes, appreciative inquiry and art to bring communities' views to life. *Water e-Journal,* Volume 3(Issue 3).

Dawson, M. et al., 2018. Planning for uncertain water futures. *Water e-Journal,* Volume 3(Issue 4).

FDI, 2014. *The Iranian Water Crisis.* [Online]
Available at: http://www.futuredirections.org.au/publication/the-iranian-water-crisis/
[Accessed 20 April 2019].

Fox News, 2015. *Iran's severe water shortage may lead to rationing.* [Online]
Available at: https://www.foxnews.com/world/irans-severe-water-shortage-may-lead-to-rationing
[Accessed 20 Arpil 2019].

Lefebvre, O., 2017. *Beyond NEWater: An insight into Singapore's water reuse prospects,* s.l.: ScienceDirect.

Mainali, B. et al., 2010. *SWOT analysis to assist identification of the critical factors for the successful implementation of water reuse schemes,* s.l.: Desalination Publications.

Martin, L., 2013. *Direct Potable Reuse Vs. Indirect: Weighing The Pros And Cons.* [Online]
Available at: https://www.wateronline.com/doc/direct-potable-reuse-vs-indirect-weighing-the-pros-and-cons-0001
[Accessed 20 April 2019].

Pisani, P. and Menge, J., 2013. *Direct potable reclamation in Windhoek: a critical review of the design philosophy of new Goreangab drinking water reclamation plant,* s.l.: IWA Publishing.

The WBG, 2004. *Iran: Ahwaz and Shiraz Water Supply and Sanitation Project - Project Appraisal Document,* s.l.: The World Bank.

WaterNSW, 2019. *Greater-Sydney-water-storage-and-supply-report-weekly-edition-Thursday-18-April-2019,* s.l.: WaterNSW.

Wikipedia, 2017. *Water supply and sanitation in Iran.* [Online]
Available at: https://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_Iran#cite_note-FOXNEWS-11
[Accessed 20 April 2019].

Wood, J., 2014. *Global Potable Reuse Case Study 4: Windhoek, Namibia,* s.l.: University of New South Wales.