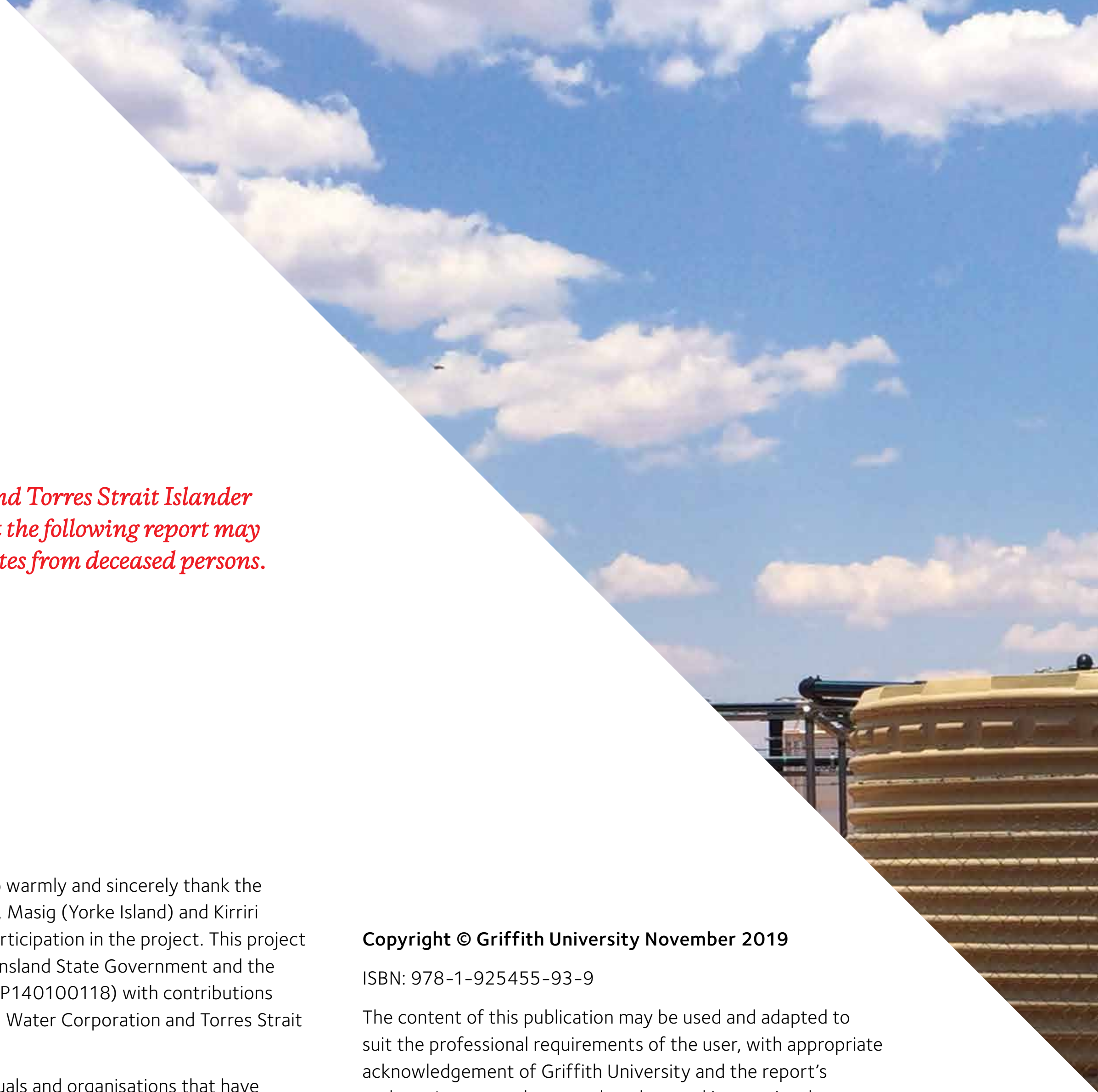
Exploring community-based water management options for remote Australia.

FINAL REPORT
for the Remote and Isolated Communities Essential Services Project

Beal, C.D.; Jackson, M.; Stewart, R.A.; Fielding, K.; Miller, A.; Tan, PL.



Warning: Aboriginal and Torres Strait Islander readers are warned that the following report may contain images and quotes from deceased persons.

Acknowledgements

The project team would like to warmly and sincerely thank the people of Mapoon, Ali Curung, Masig (Yorke Island) and Kirriri (Hammond Island) for their participation in the project. This project was funded through the Queensland State Government and the Australian Research Council (LP140100118) with contributions from Ergon Energy, Power and Water Corporation and Torres Strait Island Regional Council.

There have been many individuals and organisations that have assisted with numerous components of the project ranging from plumbers driving hundreds of kilometres across the NT desert, to federal organisations servicing Northern Australia, from champions within state departments who unflappably responded to so many questions, data requests, advice and feedback, to the individuals in community whose openness, generous participation and wicked humour will never be forgotten!

Specific thanks go to Cail Rayment, Des Jackson, Sue Larsen, Robyn Grey-Gardner, Chris Pfeffer, Morris Ling, Toni Veronese, Cr Fraser Nai, Cr Aileen Addo, Hilda Mosby, Lee Ase, David Baldwin, Bernard Dorante, Wayne "Porky" Collinson, Patrick Burke, Patrick Pearson, Songhie Billy, Kevin Asai, Christine White, Dr Khoi Nguyen, Dr Helen Haydon, Katrina Kelly, Dr Hadi Zaminifard, Gemma Schuch.

It is hoped that the outcomes and insights from this body of work will help to foster further understanding of how we can collectively achieve safe, sustainable and reliable water for every individual in Australia, no matter how remote and isolated.

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Project Partners

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EXECUTIVE SUMMARY

The overall aim of this project is to develop an empirically-based and community-driven framework to facilitate the efficient use, and secure long-term supply of water and water-related energy in remote and isolated Aboriginal and/or Torres Strait Islander communities.

STAGE ONE

The research objective was to **gather baseline qualitative and quantitative data to characterise water consumption activities, attitudes and challenges** as well as water-related energy use in remote Aboriginal and Torres Strait Islander communities. The following are key insights from this stage:

- Not all remote Australian communities have access to a continuous ("24/7/365") supply of adequately treated drinking water.
- There are good opportunities to substantially reduce water-related energy through community water demand management strategies.
- Household health hardware is variable across remote communities and needs to be pragmatically considered when developing community water demand management strategies. For example, around one quarter of all homes surveyed reported having toilet, shower and outdoor tap leaks.
- Rainwater is generally more valued than 'town' water (e.g. the treated mains supply) as a drinking water source. This is due to the perception of chemicals in the treated water being detrimental to people's health and also the frequency of "boil water" alerts in some communities.
- The distrust of 'town' water and preference for rainwater by some residents may present barriers to changing water conservation behaviours e.g. continued use of 'town' water (less valued) for high water use activities (e.g. outdoor use).
- There is a trend for households that use more outdoor water to be less concerned about water security in their community.
- Outdoor water use is inextricably linked to health and wellbeing, yet it is a key contributor of unsustainably high water demand in remote communities.

STAGE TWO

The research objective was to **trial and evaluate co-developed community-based water demand management (CWDM) strategies** in four remote Aboriginal and Torres Strait Islander communities (including mainland and islands). The following are key insights from this stage:

- To help address the range of high water use drivers, behaviours and attitudes, a suite of both community and council/service provider-led water conservation actions is needed within a broader water demand management program.
- Water reductions up to 40% of pre-CWDM trial consumption were achieved — though long-term reductions will require sustained and positive efforts from councils/service providers e.g. they need to include the "why" and "how" of water conservation in their on-going messaging to community.
- Water-related energy reductions between 25% and 65% of pre-CWDM trial were estimated.
- Community responses to the CWDM trial clearly illustrated that councils/water service providers need to more fully engage in a positive and informative way with individual householders.
- Individualised water use feedback, including comparisons with the water use of other households was a popular CWDM strategy from the trials in all four communities—from both the community and council/service provider perspective.

STAGE THREE

The research objective was to **identify suitable and pragmatic community water demand management strategies** to promote long-term, efficient use of water in remote communities. The following are key insights from this stage:

- There is a need to co-design any CWDM program with Indigenous representation from the start and for collaboration to be truly effective, government must budget sufficient community engagement costs into any water demand management program.
- Successful and long term water demand management strategies require a suite of tools to be implemented over time. This is especially true for CWDM in remote Indigenous communities. Each community also has different limitations and opportunities for achieving water efficient outcomes and these must be understood and respected.
- WDM strategies can be grouped into five main approaches: Education, Encouragement, Engineering, Economics and Enforcement
- Transitioning to a more community focussed WDM approach may initially require a mix of Education/ Encouragement strategies and Engineering/Enforcement strategies; with a reduction in these latter two strategies over time.
- In the early-mid stages of implementation, communities need a "Safe to Fail" approach to allow some long-term behaviour change patterns to occur and to promote greater trust between local community members, councils/service providers and external parties.
- Indoor and outdoor water conservation messaging needs to avoid discouraging the use of water for key Healthy Living Practices essential for human health (washing bodies, washing clothes, washing bedding etc.).

1. INTRODUCTION

BACKGROUND AND RESEARCH OBJECTIVES

Many remote communities rely only on rainfall to provide groundcover for local community open space areas such as sports ovals, gardens and parks.

1.1 Remote water management challenges

Equitable access to acceptably treated drinking water is a fundamental human right embedded in the United Nations Declaration of the Rights of Indigenous Peoples. While many of us associate poor and inadequate supplies of drinking water with developing countries elsewhere in the world, there exist many remote communities in Australia that struggle to access clean (suitably treated) and reliable drinking water[1,2]. The reasons for this are complex and reflect the broader ongoing struggles to close the gap between Aboriginal and Torres Strait Islander people and non-Indigenous Australians. Adding to this is increasing essential service delivery challenges borne from a changing climate producing less reliable weather patterns, natural disasters and threats to infrastructure and general health and well-being in remote communities.

Community water management, whether in urban, regional, remote or isolated areas, needs to be resilient (i.e. able to bounce back from shocks/crises and adapt to change); and environmentally, socially and economically sustainable (i.e. able to maintain adequate and accessible water supply over the long term without compromising the needs of future generations). A two-pronged approach of water supply solutions (e.g. supply management and demand management strategies) are relied on to achieve these aims. In the case of remote Australian communities, both supply management and demand management approaches need to be tailored to the unique cultural, environmental, geographical, economic and political contexts of these communities — typically quite different to urban Australian settings. In this respect, building genuine, two-way relationships with the community is essential and this includes co-designing strategies to secure the long-term, reliable water supplies that are critical to generational health and wellbeing of remote communities[3].

A reliable energy supply is of paramount importance to the continuous supply of treated drinking water in off-grid communities. There are currently hundreds of off-grid communities relying on diesel-powered water supply in Australia. A significant challenge for supplying water and energy to remote and isolated communities is the necessary subsidies from state government in accordance with uniform tariff policies. Drawing on a community-based approach to water demand management may assist in reducing the shortfall between cost and revenue to supply these essential services. In turn, the economic savings from a reduction in water and energy-related costs (arising from a successful CWDM) can have both direct and indirect benefits back into the community such as reinvestment into infrastructure, education and health.

1.2 Research objectives and approach

The Remote and Isolated Communities Essential Services (RICES) project was a response to the need to work with Aboriginal and Torres Strait Islander Australians to explore suitable CWDM strategies. Applying a strengths-based, community focus to water demand management in remote communities will inherently capture the breadth and depth of First Peoples' knowledge and connections to water and country[3]. This report does not claim to offer *the solution* to improving the sustainability and resilience of remote water supplies, but rather seeks to offer some *pragmatic options* for CWDM approaches (Stage 3). Many of these approaches have been empirically tested, co-designed with local remote community participants and evaluated by a range of local, state and federal Aboriginal and Torres Strait Islanders stakeholders and non-Indigenous stakeholders.

The overall aim of this project is *to develop an empirically-based and community-driven framework to facilitate the efficient use, and secure long-term supply, of water and water-related energy in remote and isolated Aboriginal and/or Torres Strait Islander communities*. Note that for this research, the term 'remote' refers to the distance from the nearest Urban Centre as classified by the Australian Bureau of Statistics[4]. The term 'isolated' refers to the potential for minimal or no access into or out of the community during certain times (e.g. flooding during the wet season).

To achieve the aim, there were three key stages to the project as depicted in *Figure 1* that reflect the three key objectives of the project:

STAGE ONE: The research objective was to **gather baseline qualitative and quantitative data to characterise water consumption activities, attitudes and challenges** as well as water-related energy use in remote and isolated Aboriginal and Torres Strait Islander communities.

STAGE TWO: The research objective was to **trial and evaluate co-developed CWDM strategies** in four remote and/or isolated Aboriginal and Torres Strait Islander communities (two mainland and two island communities).

STAGE THREE: The research objective was to **identify suitable and pragmatic community water demand management strategies** to promote long-term, efficient use of water in remote communities.

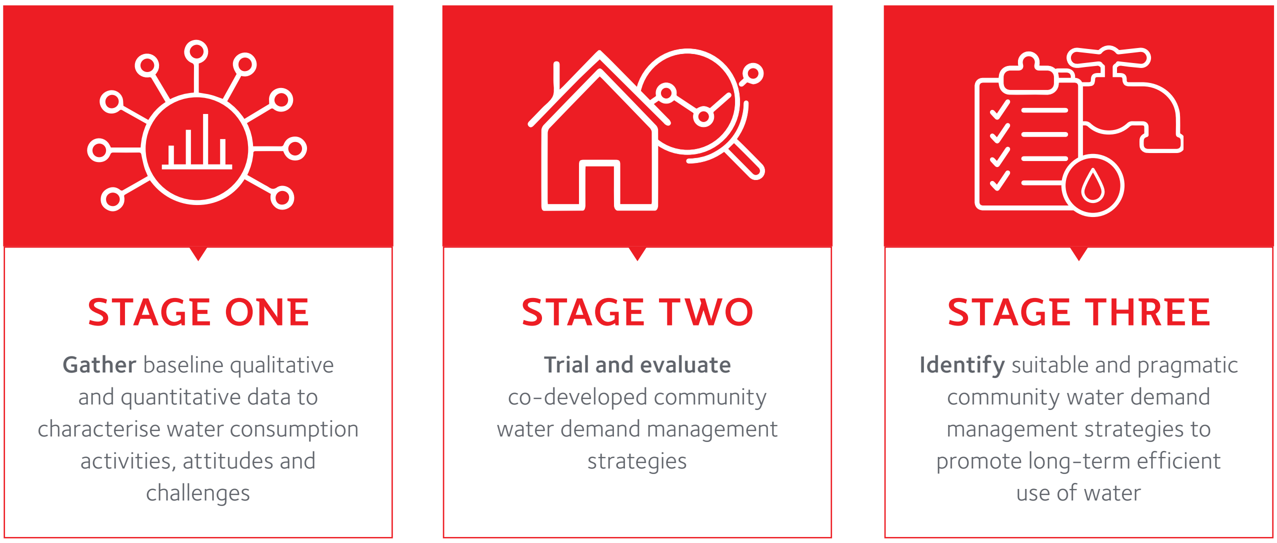


Figure 1. RICES method overview

Note: As part of the RICES project scope, a focussed body of PhD research was conducted in one of the Torres Strait Islander communities with a focus on the processes of collaboration with the community to develop a transitional water governance framework[4]. A number of publications from the PhD research are in progress and will be available in late 2019 and 2020.

2. STAGE ONE

BASELINE DATA GATHERING AND ANALYSIS.

For the first time, high resolution smart water meters were used to understand water end-uses in participating remote community households Source photo (C. Beal)

Characterising and understanding water and water-related energy use in remote communities.

A participatory action research approach was taken in the project where community and stakeholder involvement was sought for each key step of the research activities. Based on discussions with local project industry partners, several Aboriginal and Torres Strait Islander communities were approached about their willingness to be involved in the project. Following agreement from local council members and local community representatives, four communities across the Northern Territory and Queensland participated in the project between 2015 and 2019.

A total of 330 people from 77 households were involved *(Figure 2)*. The communities were selected based on a range of geographical, technical and social/cultural criteria. Participation in the project was voluntary, with participants signing an informed consent form. Participants were recruited through door knocking, public workshops or they approached council and/or the RICES team. An interpreter (e.g. community-based Indigenous Engagement Officer or Environmental Health Officer) was present for the recruitment and main participant interview and survey process.

The project methods, including participant recruitment, survey methodology and implementation, data generation, storage and management, was reviewed by the Griffith University Indigenous Research Unit and cleared by the Human Ethics office (GU Ref No: ENG/15/14/HREC). As part of this ethics approval, individual participants are not identified.

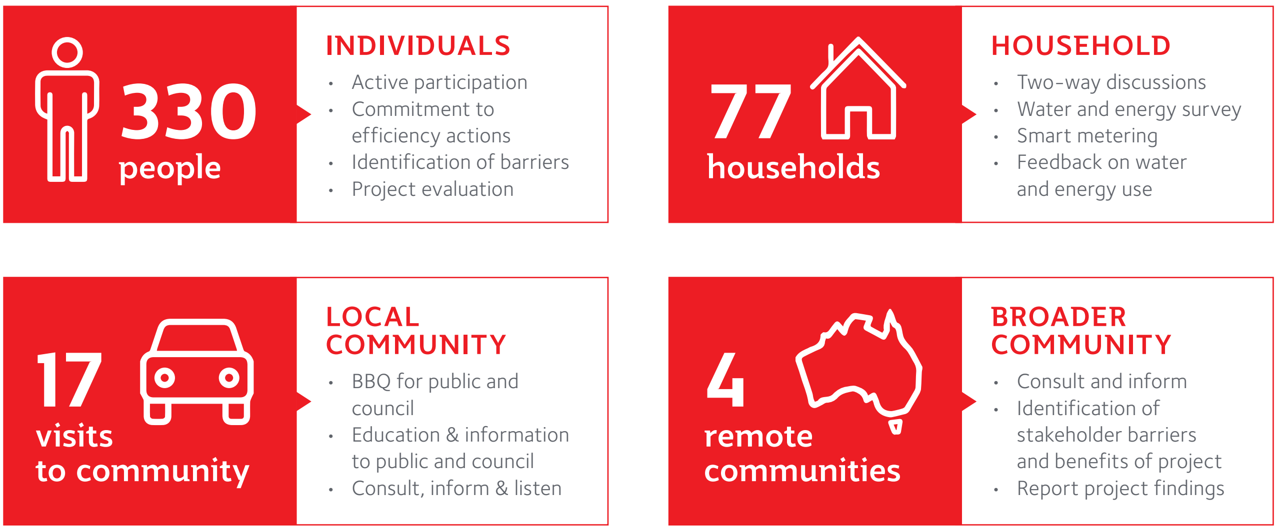


Figure 2. Overview of activities in the RICES project

Table 1: Summary information for participating RICES communities

PARAMETER	C1	C2	C3	C4
Population[1]	444 (59)	269 (58)	254 (121)	268 (92)
Number of Households[1]	70 (12)	71 (17)	58 (23)	78 (25)
Governance arrangement[2]	Non-indigenous regional council	Indigenous shire council	Indigenous regional council	Indigenous regional council
Main water supply and treatment	Groundwater – Advanced filtration and chlorination	Groundwater – Sand filtration and chlorination	Surface/sea/rain – Desalination and chlorination	Surface water – Sand filters and chlorination
Approx. distance from nearest: Small town[3] Major City[3]	 180 kms (by road) 1,160 kms (by road)	 67 kms (by road) 630 kms (by air)	 165 kms (by boat/air) 965 kms (by air)	 2 kms (by boat) 800 kms (by air)
Access	Road / air	Road / air (only option in wet season)	Air / boat	Boat

Notes:

[1] *Approximate from 2016 ABS Census. Numbers in parenthesis indicate RICES project participant numbers*

[2] *Indigenous refers to Aboriginal or Torres Strait Islander Councils within Queensland*

[3] *Refers to towns with urban features and populations > 2000 people (small) and >100,000 people (major) (ABS 2016)*

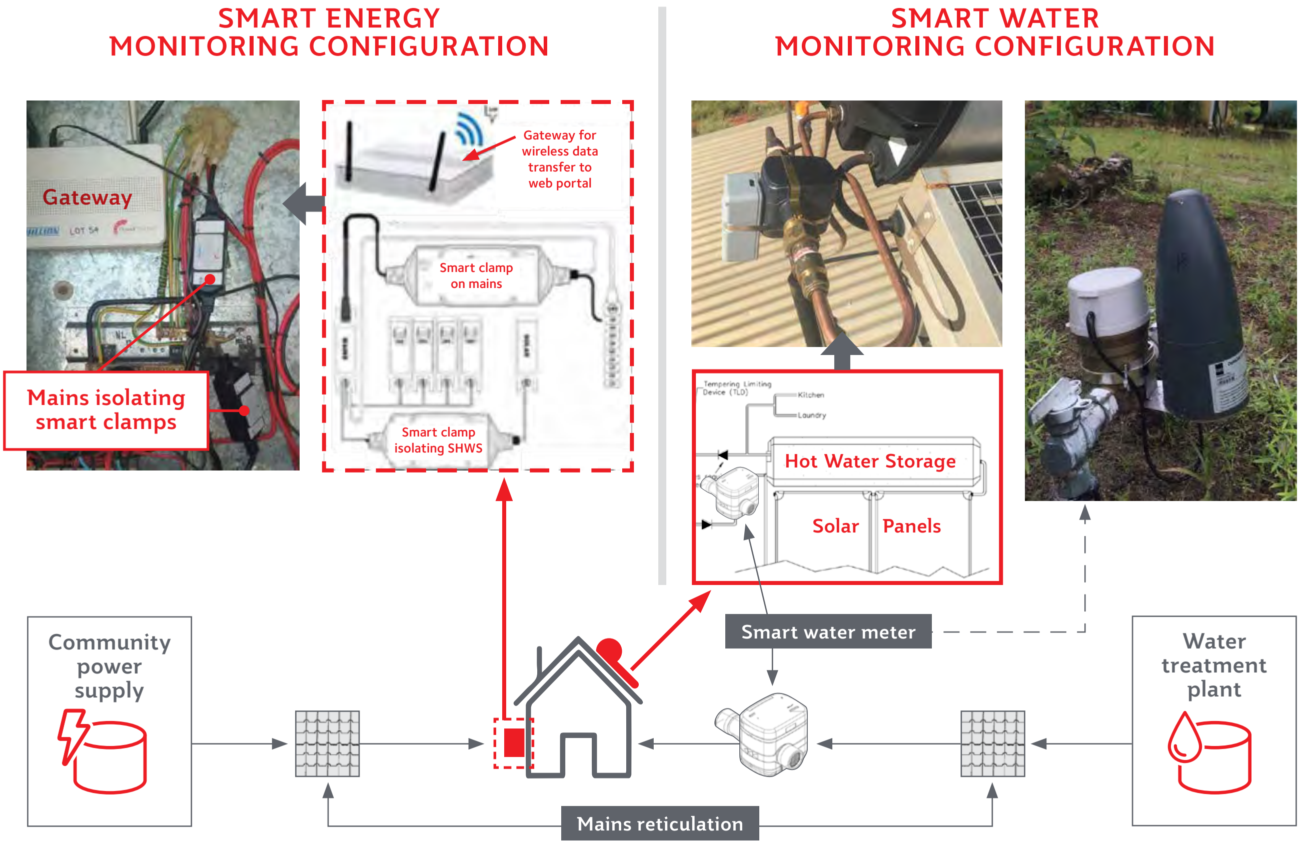


Figure 3. Smart energy and water metering configuration for participating households

2.1 Smart metering to capture baseline water and energy consumption

Residential-scale water consumption was monitored using state-of-the-art, high resolution, digital water meters and logging equipment installed at all the participating households. Smart energy meters were also installed to measure total household energy and hot water-related energy for a sub-sample of houses in each community. The configuration of the meters is shown in *Figure 3*. Using the high resolution datasets from the participating households, a sample of received data was extracted from the database for two, two-week periods selected to represent the wet and dry seasons, and disaggregated into all end-use events (e.g. shower, clothes washer, tap, leaks, outdoor, bath, toilet) using the flow trace software *Autoflow*[5]. Concomitantly with meter and logger installation, a water fixture/appliance stock (e.g. clothes washer, toilet, shower) survey was conducted at each participating home which facilitated the disaggregation of trace flows from each home and also provided a valuable snapshot of water consumption practices within each home. (For further details on this mixed method approach see [6]).

"We water only 10-15 mins a day in the wet but all night in the dry, then turn off the tap in the morning"

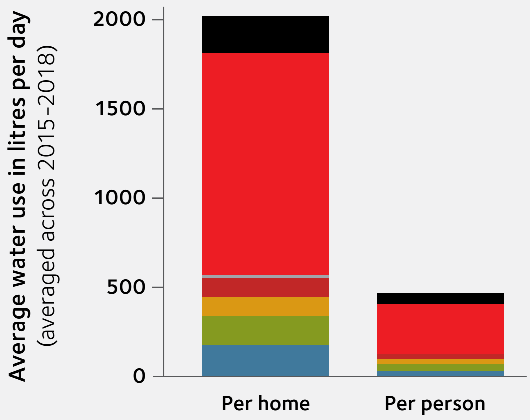
– RICES participant, Cape York community

2.2 Water and energy consumption results

2.2.1 Water

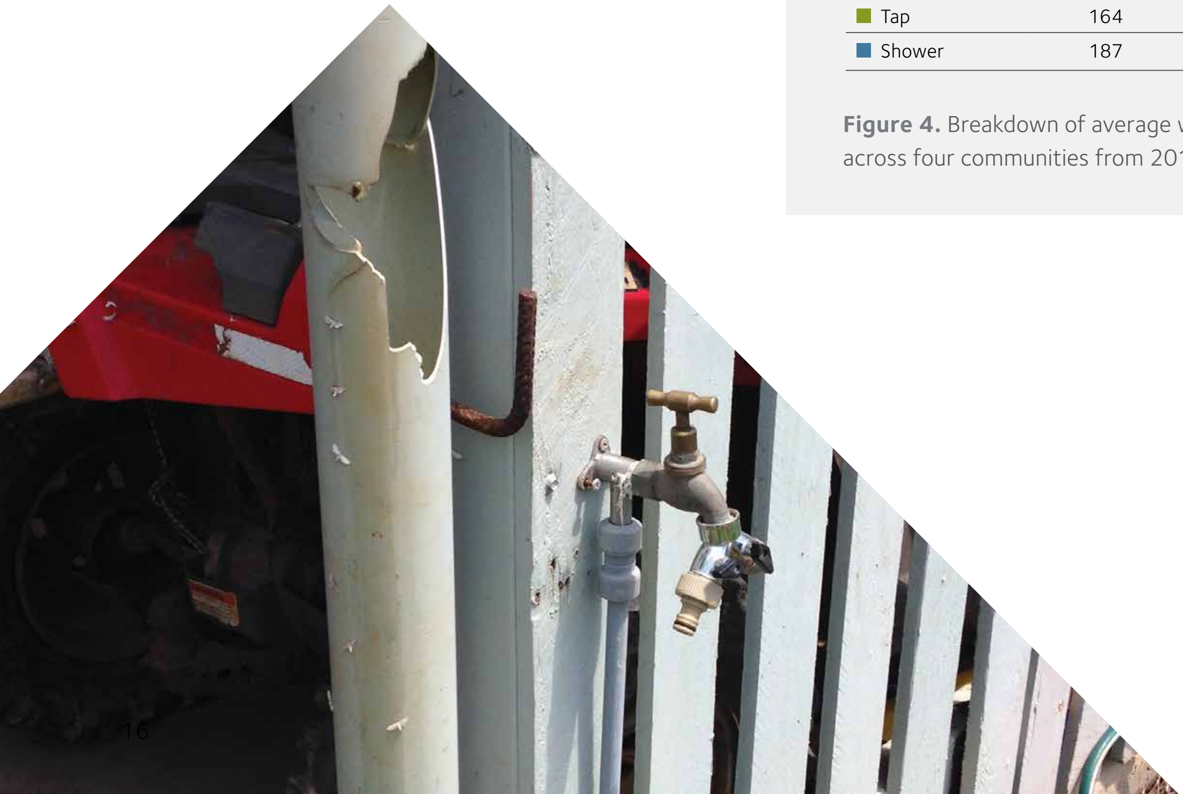
Over the four year monitoring period, across the four communities, per household water use averaged 2,017 litres per household per day (L/hh/d) and 467 litres per person per day (L/p/d) *(Figure 4)*.

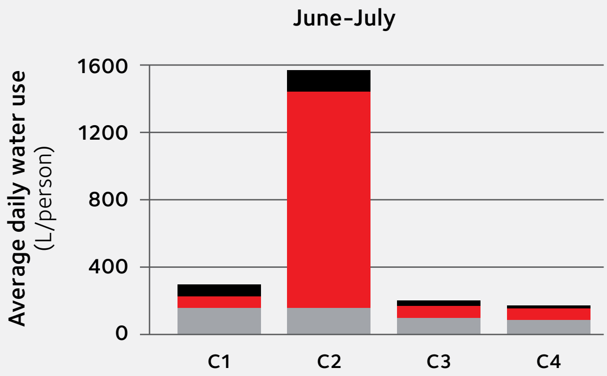
A breakdown of average water end uses for the monitoring period shows that outdoor water use, leaks and showers were the main activities on both a *per household* and *per person* basis. Overall, outdoor water use comprised the majority of consumption, averaging 60% of total use, with an average of 50% used in summer (wet) and 70% in the winter (dry) months.



	Per home	Per person
Leak	205	51
Outdoor	1235	281
Bathtub	13	2
Toilet	111	26
Clothes washer	102	25
Tap	164	37
Shower	187	44

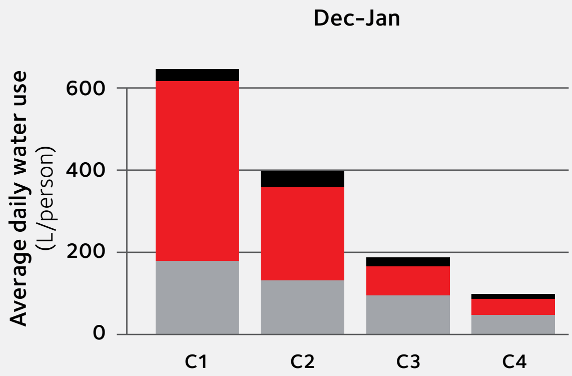
Figure 4. Breakdown of average water end-uses across four communities from 2015 to 2018





	C1	C2	C3	C4
Leak	74	120	39	6
Outdoor	74	1293	68	75
Indoor	142	154	93	83

C1 Arid zone, Central Australia (NT) – no water restrictions
C2 Tropical zone, Cape York (QLD) – Water restriction notices (not enforced)
C3 Tropical zone, Torres Straits (QLD) – Controlled access to main water supply
C4 Tropical zone, Torres Straits (QLD) – Water restriction notices (not enforced)



	C1	C2	C3	C4
Leak	71	34	19	9
Outdoor	399	237	69	40
Indoor	175	129	96	44

C1 Arid zone, Central Australia (NT) – no water restrictions
C2 Tropical zone, Cape York (QLD) – no water restrictions
C3 Tropical zone, Torres Straits (QLD) – no water restrictions
C4 Tropical zone, Torres Straits (QLD) – no water restrictions

Figure 5. Spatial and temporal water end-use breakdowns

Comparing water use both spatially and temporally provides more understanding of the patterns of use at different times of the year. In this respect, water use (mainly outdoor) varied over time between each community. Outdoor water use was higher during prolonged periods of dry weather, which is usually associated with the winter months in Northern Australia *(Figure 5)*. Indoor water use was less variable than outdoor use over time, with shower and tap comprising a majority of total indoor use. Results show that outdoor water consumption and to a lesser extent leaks, should be the focus of water conservation efforts rather than indoor use. Appendix A presents daily average water use for each community over the period of the RICES project.

In many Torres Strait Islander communities there are severe water restrictions during the dry season (May to November) and this can result in the treated, piped water supply being physically turned off by the council for up to 16 hours a day (i.e. controlled access to the mains water supply). This is not the case for the C2 community which has 24/7 access to treated drinking water, although water restriction notifications are issued in the hot and dry winter months in Cape York. For the C1 community, the opposite is true where the hot, dry period is in summer (Dec-Feb) which typically sees high water use, especially for outdoor use *(Figure 5)*.

"The water-related energy use in remote communities is especially critical to manage due to the high diesel fuel requirements and vast distances from reticulated power supplies".

– Torres Strait Island council officer, QLD

Table 2. Total and hot water system (HWS) energy use for each community*

KWH/D PER HOME	C1 (N=2) ARID MAINLAND		C2 (N=4) TROPICAL - MAINLAND		C3 (N=5) TROPICAL - ISLAND		COMBINED (N=11)	
	TOTAL	HWS	TOTAL	HWS	TOTAL	HWS	TOTAL	HWS
MEAN	27.6	6.5	26.8	1.2	23.1	0.3	24.9	2.1
MAX	75.1	29.6	11.5	18.3	58.6	15.8	63.7	29.4
SD±	12.6	6.7	23	2.1	11.3	1.3	7.7	4.1

** Note C4 did not have energy meters installed in households*

2.2.2 Energy

In Australian remote and isolated communities, power supply is typically provided by diesel-fuelled generators and water supply by energy-intensive systems (e.g. desalination, pumped groundwater) such that high water consumption is inextricably linked with high energy consumption. Reducing water consumption will also lessen associated economic and environmental costs associated with diesel-generated electricity.

Total energy and hot water-related energy use was monitored throughout the year in a few of the participating households for C1, C2 and C3 between 2015 and 2018. Data across the monitoring period is presented in Table 2 and shows that total energy use ranged from around 23 to 28 kWh per home per day, which is somewhat comparable to the reported range for Brisbane urban residential use but substantially lower than reported for Melbourne urban residential use[7]. The hot water-related energy consumption ranged from 2% to 30% of total energy, with energy intensities ranging between 0.1 and 5.1 kWh/kL across the 3 communities. Although over 80% of project households had solar hot water systems (HWS), the functionality of these systems were highly variable with systems often in poor condition and the electric boosters frequently reported as not working.

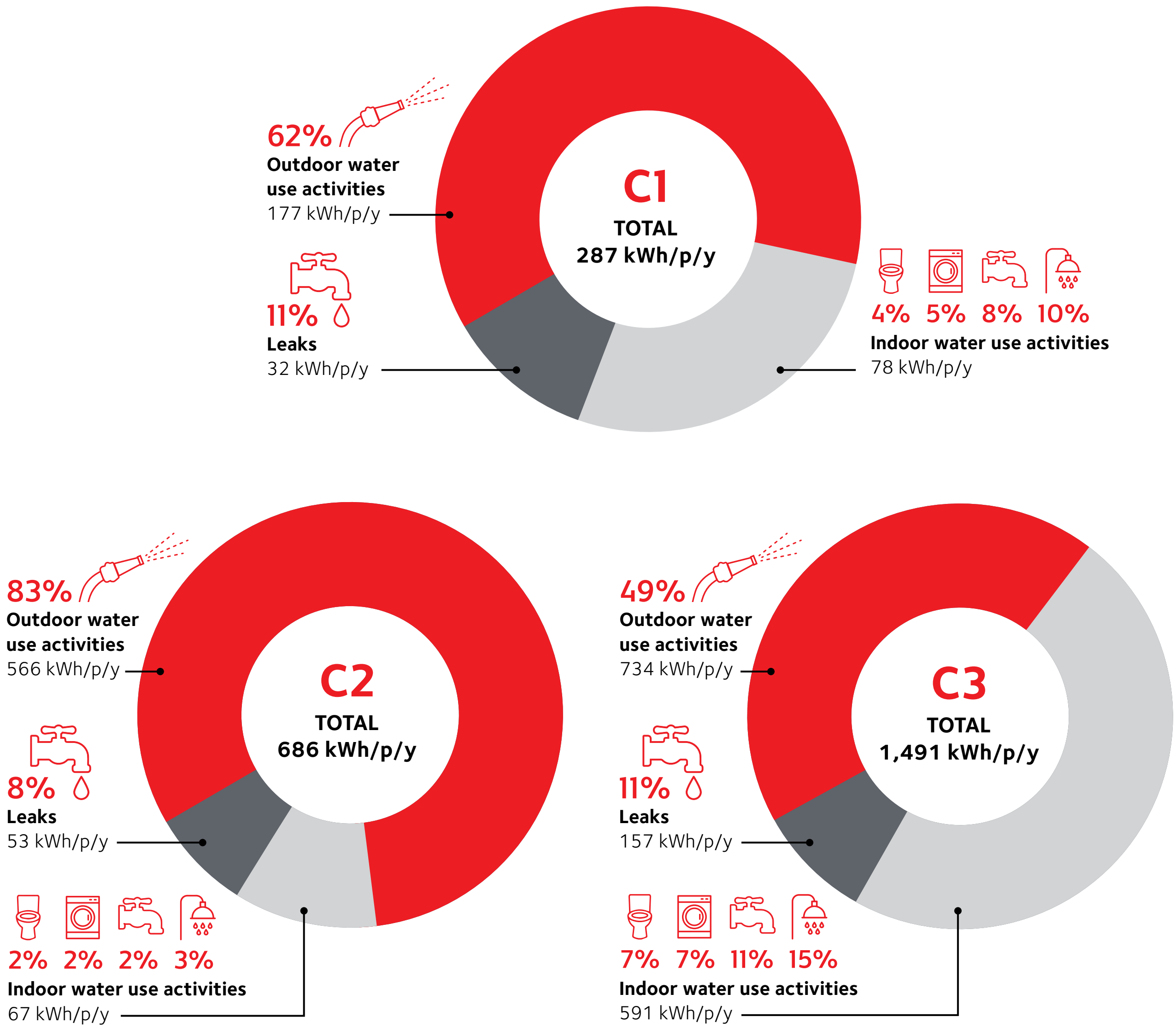


Figure 6. Estimated annual energy (kWh/p) for water end-uses in C1, C2 and C3

Based on this data, the average breakdown of estimated annual energy demand from the main residential water end-use components was calculated, and is shown in *Figure 6*. Calculation parameters and assumptions based on industry partner and local council monitoring data are detailed in Appendix B with further detail in previous publications[8]. Note that the calculations consider bore extraction (C1 and C2 only), desalination (C3 only), treatment and distribution (C1 and C2 only) but *do not* consider thermal and efficiency losses, so are not considered an exact dataset but are considered to provide a reasonable accuracy for general comparisons. The energy source for C1 is the main electricity grid whereas C2 and C3 are isolated systems and rely on diesel fuel to power the community generators.

Annual estimates of water-related energy use varied between water end-uses, with outdoor water use comprising between 49% and 83% of total water-related energy demand. *There are clear opportunities to lessen the annual power load in isolated systems through improving outdoor water use efficiencies.* This is particularly so in the spring/summer period in Northern Australia leading up to the wet season where a combination of increasingly warm weather and prolonged dry period results in rising daily household energy use.

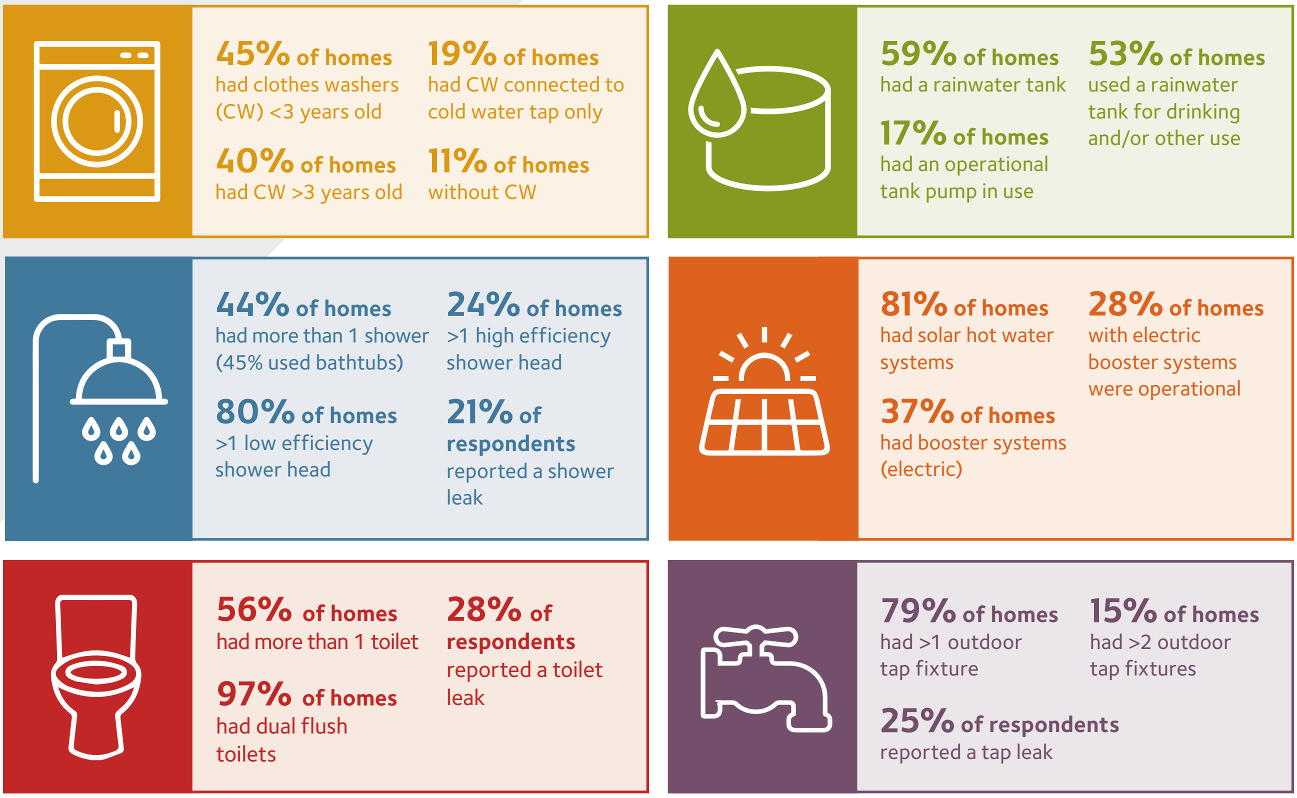


Figure 7. Snapshot of household health hardware in surveyed households

2.3 Household health hardware

2.3.1 Water-based health hardware snapshot

Household health hardware refers to the household infrastructure (e.g. beds, sinks), fixtures (e.g. taps, showers) and devices (e.g. clothes washer, kettle) that we interact with regularly for the purpose of maintaining and improving our health[9] (including physical, mental and general wellbeing). Throughout the RICES project, the research team did not request to enter the participants' households as this was not seen as appropriate or necessary for the scope of the project's objectives. However, a general audit of water-related health hardware was surveyed through self-reporting and researcher observations. This allowed the team to capture a broad understanding of the number and general condition of water-related health hardware which could then inform the practicalities of some CWDM strategies. For example, suggesting a CWDM strategy of "Only use a rainwater tank for outdoor watering" would be meaningless for communities that do not have rainwater tanks installed (e.g. C2). Or "Use the half flush not the full flush button in the toilet as much as possible" would not be helpful to households who only have single flush cisterns or, more commonly, the half flush button does not work.

> *"Housing and council need a joint leak efficiency program… they need to work together and stop passing on responsibility."*
>
> – Local Elder and RICES participant, Cape York

A snapshot of the main water-related health hardware in *Figure 7* indicates a variable diffusion of water efficient stock in RICES households. Dual flush toilets are common, though over a quarter of households reported leaks or poor operation. Not all homes had clothes washers, or were waiting for new ones to be delivered. A majority of homes had old style shower heads that can use in excess of 20 litres of water per minute with many indicating associated leaks. Solar hot water systems were frequently reported to be under-performing (inadequate hot water supply) with some households having poor access to hot water in the overcast days and evenings as only a small number of boosters were operational and/or installed (*Figure 7*).

"Who do you usually report leaks to?"

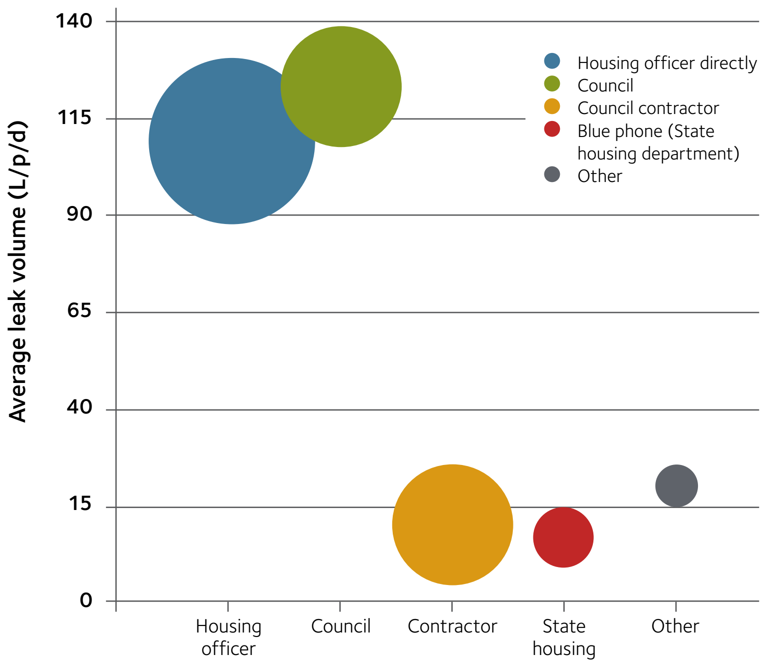


Figure 8. Leak reporting bodies and response satisfaction rates. Note: the size of the bubble indicates the number of respondents and the centre of the bubble indicates the average leak volume.

2.3.2 Leaks and maintenance / reporting

Leaking and poorly functioning health hardware is a common observation in remote community households and associated with this is the underreporting, or poor response to the reporting, of leaks and maintenance issues in households[9,10]. Respondents were asked about their observations of leaks from toilets, taps, showers, outdoor taps and hoses. Although there was likely to be some social desirability bias and underreporting in the responses[11], *around quarter of all homes surveyed reported having toilet, shower and outdoor tap leaks*. There was a number of leaking outdoor fixtures observed in all communities, often severe and prolonged (e.g. observed in same locations across several visits). When asked about whether participants reported known leaks, a majority (94%) said "yes", though when further prompted as to whether they were happy about how long the reporting body took to respond to the leak issue, the responses were mixed, with a majority either unhappy (41%) or didn't know (15%) *Figure 8*. The reporting body was typically the housing officer (for C1), council (for C2) or housing maintenance contractor (for C3 and C4).

"Depends if plumber happens to be on the island..."

"Plumber comes but it takes a long time. The volume of work for them is too big..."

"Sometimes 2 weeks turns into 6 weeks."

– RICES participants on leak response times

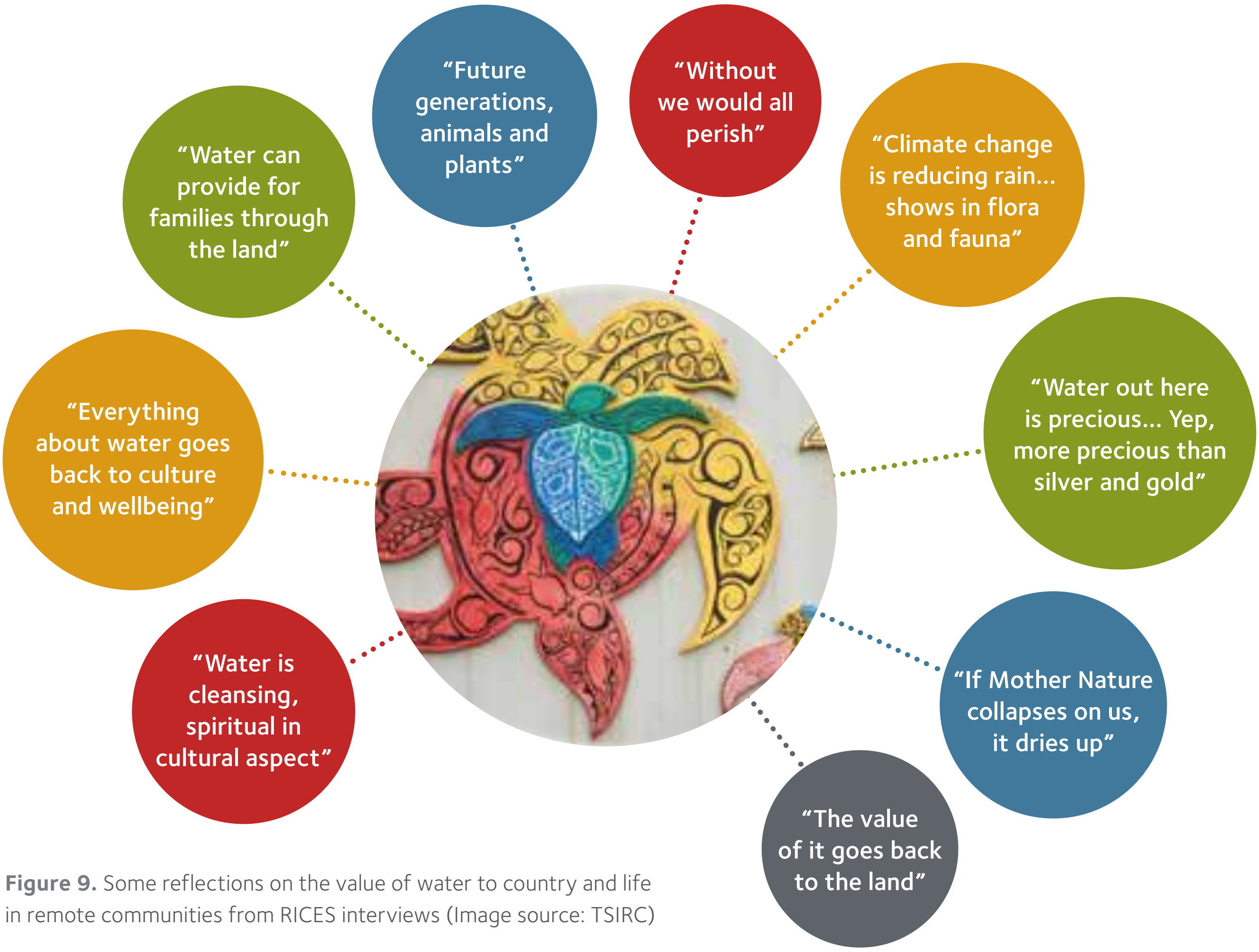


Figure 9. Some reflections on the value of water to country and life in remote communities from RICES interviews (Image source: TSIRC)

2.4 Water values: connections, perceptions and preferences

How water is valued in a community can either be a barrier or enabler for a successful CWDM program[12]. Valuing water is often linked to the price point put on water consumption, however, valuing water goes beyond whether the consumer pays for it or not; it also relates to the perceived availability (having "24/7" water), accessibility (equitable physical access to drinking water) and acceptability (safety, taste, odour) of water. It is therefore critical to know how the community values water, ideally assessed by direct engagement and encouragement of two-way discussions. The following sections touch on Indigenous connections to health and water, the perceptions of water security and drinking water preferences, as examples of how remote communities value water. This information was derived through surveys, community and stakeholder workshops, key informant interviews, participant semi-structured interviews across each of the four communities in QLD and NT between 2015 and 2018.

2.4.1 Connections to health and wellbeing

The exceptionally strong and ancient connections of Aboriginal and Torres Strait Islander people to water and country are well known[13] but perhaps not as well understood in terms of drawing on these connections to inform contemporary community water management approaches[3]. A common thread that emerged during discussions was how the connection to local water sources had become less tangible for locals due to, for example, depletion or poor quality of previous/historical water sources, piped water replacing manual collection, and the physical and spiritual barrier of the built environment in general. Despite these barriers, the cultural and environmental water literacy was strong as reflected in some of the quotes shown in *Figure 9*.

Eight factors that may be considered important to community health and wellbeing were presented and discussed with our project participants. These were health care, sports and recreation, cultural business, education, local jobs, power, rainwater (sourced from either individual or communal tanks), and town water (specifically treated mains supply). We then asked the participants to rank these health and wellbeing factors in order of importance from

Rank what is important to you for community wellbeing:

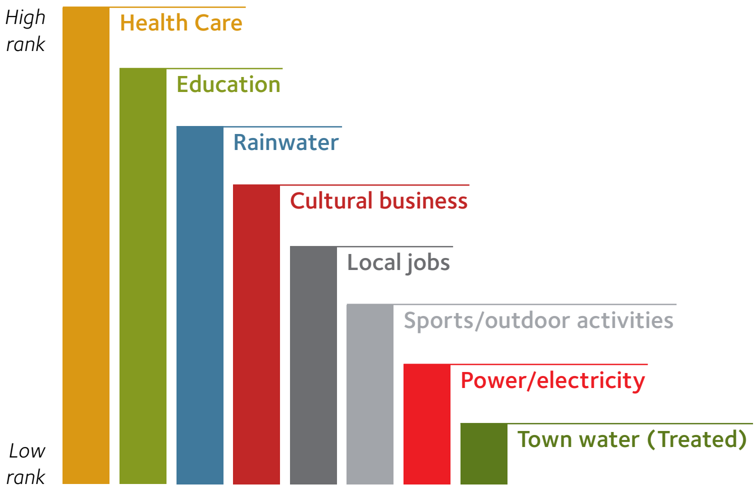


Figure 10. Typical ranking of health and wellbeing factors from surveyed participants

their own perspective (*Figure 10*). While there was some variability across respondents and communities, the most common ranking in order of priority is presented in *Figure 10* where health care, education, and rainwater (from individual rain tanks) were typically ranked in the top three and power, sports/outdoor activities and town water (meaning the main treated water source) and were typically ranked in the bottom three.

"Tastes funny —the chemicals they put in. Makes me feel funny and sick. Not only me but all the community" (NT)

"I don't trust town water—chlorine. It doesn't taste like rainwater… rainwater tastes like freshwater" (QLD)

"I drink rainwater from Aunty's house… fill up bottles. Sometimes I drink town water if feeling too lazy to walk" (QLD)

"I feel sick when I drink town water… can smell the chlorine and I worry about E. coli with all these boil water alerts" (QLD)

– RICES participants who don't drink town/mains water in their community

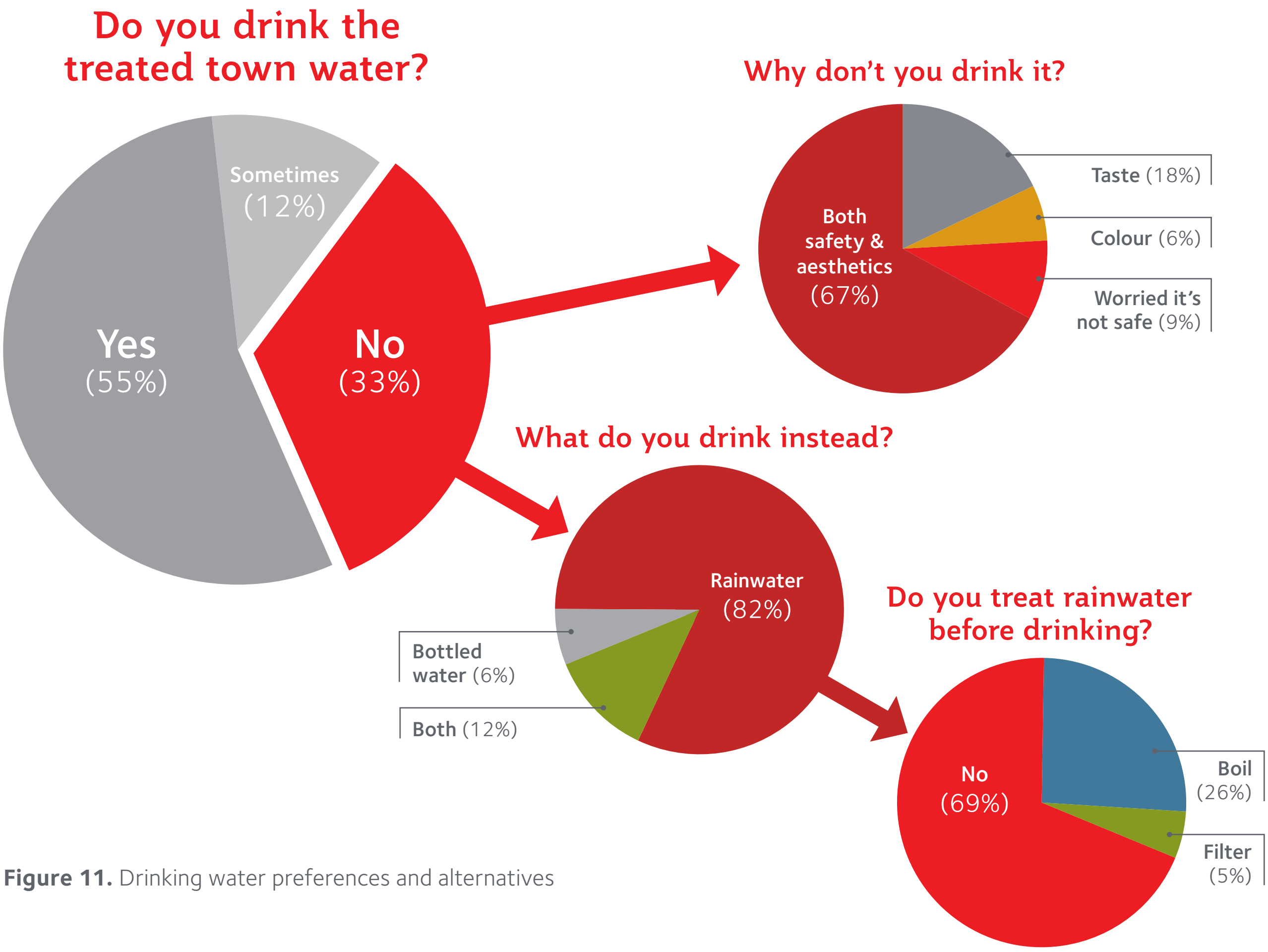


Figure 11. Drinking water preferences and alternatives

2.4.2 Drinking water preferences

All four communities valued and prioritised rainwater over town water. In the four communities, regardless of an alternative water supply, 55% of household respondents stated that they drank treated town (or mains) water and 33% stated that they did not drink the town water. This latter value became much higher when asking the same question to communities that had an alternative water supply (e.g. Torres Strait Islander communities who often have a rainwater supply). For these household respondents, 51% said that they did not drink the treated town water (data not shown). The reasons given for not drinking 'town' water were generally around taste, odour and safety concerns (*Figure 11*). For the group that said they did not drink town water, their preference for other water supplies was predominantly rainwater (when available) (*Figure 11*) and this was due to the taste and the perception that it was a safer option for them (the frequent "boil water" alerts for the inner TSIRC Island community was commonly cited as a reason for safety concerns).

The perception that the town water supply is not safe or palatable is a concern, especially in the Torres Strait Islander communities that were surveyed, as this is the only formally treated supply that is regulated for water quality compliance, e.g. removal of pathogens using chlorination. The rainwater supplies, that are overwhelmingly preferred as a drinking water source, are typically not treated (e.g. no removal of pathogens) yet are often considered safer by community, primarily due to (i) the absence of added chemicals and (ii) the preferred taste and odour (see quotes on this topic). The lack of trust may also impact on how the community values the water and hence may influence their motivations to conserve water and engage in CWDM activities. A further lack of trust may stem from council issued "boil water" alerts that can be common for some remote communities' water supplies, due to high turbidity during wet weather and exceedances of drinking water quality parameters. Some real-time feedback and communication about drinking water safety from service providers/councils could help to build more trust with the community and inform them of the importance of drinking a safely managed supply.

“Plenty water underground. Just issues with treatment” (NT)

“Went to a Land Council meeting, they said plentiful water” (NT)

“There is a heap of water, historically in Dad’s time, used to be freshwater springs” (QLD)

– RICES participants who NEVER worry about community running out of water

2.4.3 Perceptions of water security

We asked the project participants how concerned they were about their community's long-term water security and then examined the responses relative to their outdoor water use over time (*Figure 12*). Average daily outdoor water use was statistically lower in households that indicated a strong concern for security of community water supplies compared to those that never or only sometimes worried (*Figure 12*). Drawing on behaviour change theories, it is reasonable to assume that people who are more concerned and aware of their community's water security would be more likely to use less water (as shown in *Figure 12*) and also have intentions and motivation to engage in water conservation behaviours[14]. This group would also be more likely to respond positively to a range of CWDM strategies. Conversely, respondents that were less concerned about their community's water security had higher outdoor water use (average of 600-700 L/p/d) and would be less likely to engage in water conservation behaviours.

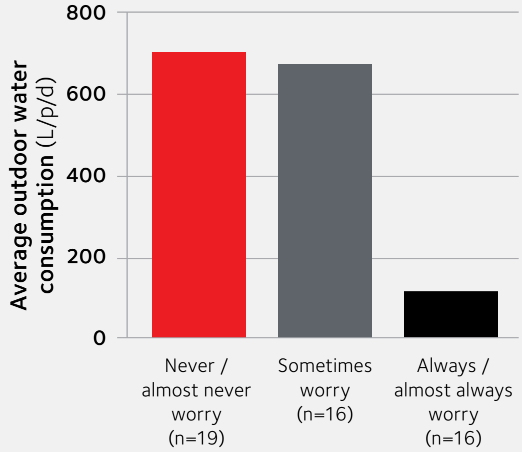


Figure 12. Relationship between outdoor water use and water security concerns

"I want to go and turn taps off. Everybody will suffer" (QLD)

"We have big families on the islands and I worry about them" (QLD)

"I'm not overcrowded but for some people…we got used to carrying water from the well. Try not to rely on things "out of the box" (QLD)

– RICES participants who ALWAYS worry about community running out of water

Figure 13. High outdoor water use activities are often inextricably linked to health and wellbeing in remote communities

2.4.4 Health and well-being drivers of water use

From analyses of the survey responses, participant discussions, water end-use analysis and council consultation it emerged that several key drivers were contributing to the observed high outdoor water use activities (*Figure 13*). Following baseline analysis, further discussions were held with all participants about their individual water end-use breakdown activities and to identify more specifically the drivers (i.e. reasons and motivations) behind their high outdoor water use. The identified drivers of high outdoor water use are closely linked to necessary day-to-day functioning e.g. health (dust control suppression, house and personal cooling, food preparation, cleaning dusty verandas and windows, boats and hunting and fishing equipment) and well-being (group celebrations and festivities, tombstone openings, sorry business, children's play, watering gardens, trees and establishing ground cover)[2].

"If we don't wet the ground outside the dust makes my son's asthma worse" (QLD)

"Families with lots of kids in hot season need water to help keep them cool, especially when we have no power for air conditioners" (NT)

"We use the hose to kill the dust and to keep windows and veranda's free of dust" (QLD)

"We put sprinkler up on roof to cool house down. It means the air con(ditioning) works much quicker" (QLD)

– **RICES participants responses on outdoor water use for health and well-being**

2.5 Key insights from Stage 1

- Not all remote Australian communities have access to a continuous ("24/7/365") supply of adequately treated drinking water.
- There are good opportunities to substantially reduce water-related energy through community water demand management strategies.
- Household health hardware is variable across remote communities and needs to be pragmatically considered when developing community water demand management strategies. For example, around one quarter of all homes surveyed reported having toilet, shower and outdoor tap leaks.
- Rainwater is generally more valued than 'town' water (e.g. the treated mains supply) as a drinking water source. This is due to the perception of chemicals in the treated water being detrimental to people's health and also the frequency of "boil water" alerts in some communities.
- The distrust of 'town' water and preference for rainwater by some residents may present barriers to changing water conservation behaviours e.g. continued use of 'town' water (less valued) for high water use activities (e.g. outdoor use).
- There is a trend for households that use more outdoor water to be less concerned about water security in their community.
- Outdoor water use is inextricably linked to health and wellbeing yet it is a key contributor of unsustainably high water demand in remote communities.

3. STAGE TWO

TRIALING AND EVALUATING COMMUNITY-BASED WATER DEMAND MANAGEMENT STRATEGIES

Tap timers were offered to the RICES participants as part of the CWDM trial. These were popular with many participants, especially those that self-reported as high outdoor water users.
Source photo (C. Beal)

Community engagement

One-on-one discussions

Texts, phone calls, letters, social media

Workshops with community and stakeholders

Public information sessions & BBQs

Monitor household water use	• Smarter meters replaced existing water meters • Baseline water use recorded • Council provided with de-identified data	see Figure 15
Individual feedback of water use	• Each home received pie chart of water use • Identified high water use activities • Discussed areas for efficiency	see Figure 16
Benchmark water use	• Each home's water use was compared with other homes in the project to provide a point of reference	see Figure 16
Co-design household CWDM strategies	• Co-design of water efficiency strategies that were feasible and suitable for each home based on water use and family setting	see Figure 17
Commitment / pledge	• Each home pledged to try out at least one water efficient device and one water efficient behaviour	see Figure 18
Prompt / encourage	• Each home recieved prompt during CWDM trial • Reminder of water efficient behaviour • Encourage continued efforts	see Figure 19
Monitor household water use changes	• Post CWDM water use compared with the baseline for each home • Identified savings to water and water-related energy use	Section 3.2.1
Individual feedback of water use post-CWDM trial	• Each home presented with before and after water use • Discuss areas of savings • Identify best area of water savings	see Figure 20
Participant and council evaluation of trial	• Feedback from homes on preferred efficiency behaviour and device • What worked and what didn't and why!	Section 3.2.2

Figure 14. Key steps of the pilot CWDM in the four communities

3.1 Trialling community-based CWDM strategies

Stage 2 of the RICES project involved the trialling and evaluation of CWDM strategies that were informed by the baseline stage and co-designed with project participants with input from council staff, water managers, state government and RICES industry partners. The key components of the trial are summarised in *Figure 14* and are:

- community engagement
- smart water meter monitoring
- individual feedback of water use
- benchmarking participant water use
- co-designing CWDM strategies with participants
- commitment to try water efficiency device
- prompts and encouragements
- monitoring changes to water use
- individual feedback of water use pre & post trial
- participant and council evaluation of the CWDM trial.

The CWDM trial was broadly based on the community-based social marketing approach[15] though was steeped in participatory action research principles to fully allow for a community-based approach to be taken[16]. As depicted in *Figure 14*, community engagement was a major component across all stages of the CWDM trials and included individual and group activities, combined and separate community and stakeholder events and the use of a range of social media and face-to-face communications. Some examples of community engagement before, during and after the CWDM trial are shown in *Figure 15*. For examples of the other components of the trial see *Figures 16 to 21*.

The trials were carried out in four communities between 2017 and 2018 during the dry season when water use is typically at a peak. In-depth research has been conducted in one of the Torres Strait Islands between 2016 and 2019 which drilled more deeply into the processes of collaboration with the community[3]. Further findings from this work will be available in late 2019/early 2020.

Figure 15. Examples of community engagement during the RICES project

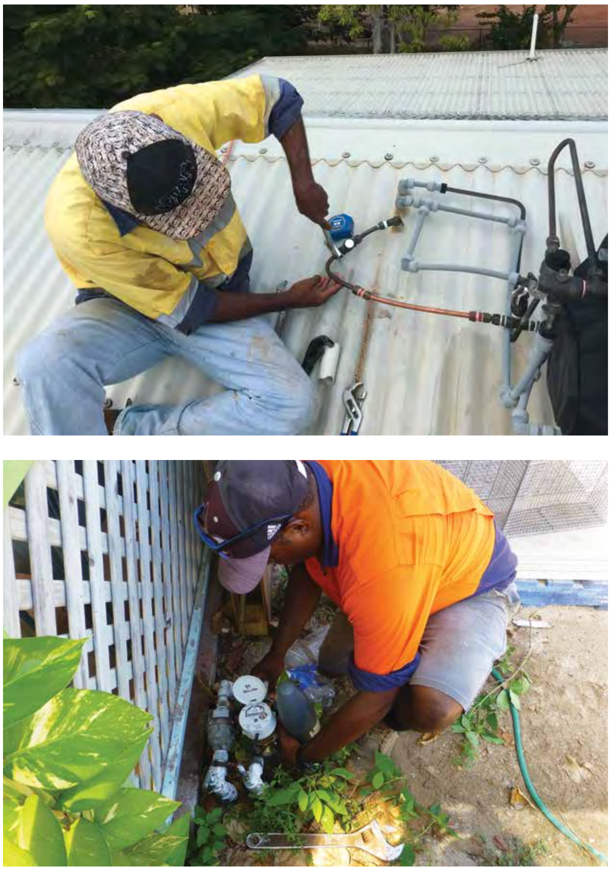


Figure 16. Installing smart water meters.
(Source: M. Jackson. Photo used with permission from participant)

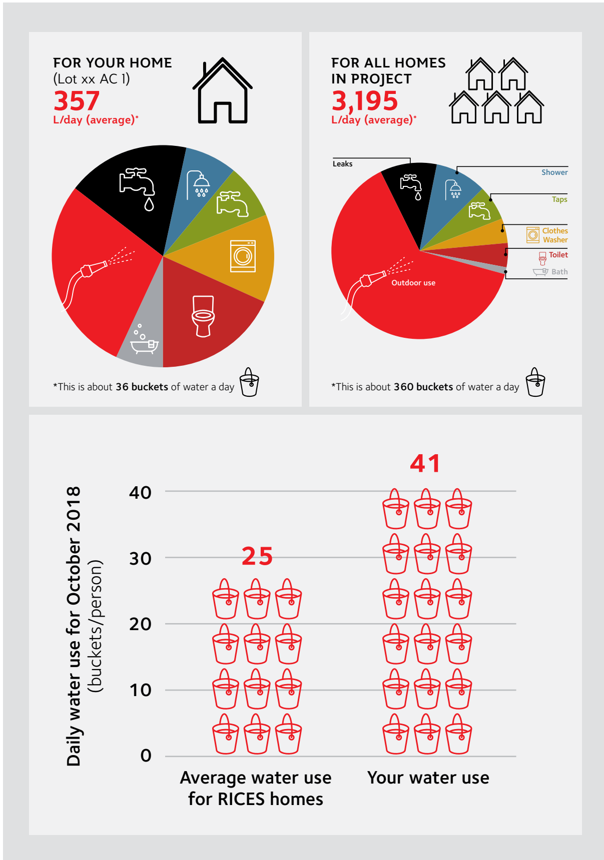


Figure 17. Examples of household water end-use feedback and benchmarking

Figure 18. Co-designing suitable water efficiency strategies.
(Source: C. Beal. Photo used with permission from participant)

Figure 19. A pledge to try a water efficiency behaviour and device. *(Source: C. Beal. Photo used with permission from participant)*

Above: Outdoor water use is a major contributor to total water demand in remote communities, for example water is commonly used to establish and maintain ground cover. Source photo (C. Beal)

Figure 20. Prompt/encouragement postcard sent to participants

Figure 21. Presenting water use pre and post trial and getting feedback

3.2 Evaluating the CWDM trials

3.2.1 Quantitative evaluation—water and water-related energy savings

WATER

Overall, there was a 33% reduction in average water demand following the CWDM trial (Table 3). Comparisons of water end-use 12 months after the CWDM trials for C2, C3 and C4, at the same time of the year (thus controlling for weather influences) indicated a reduction in water use across most end-uses, in particular leaks and outdoor use (see inset stacked bar charts in *Appendix A*). The average water use readings for C1 indicated a slight increase in water demand following the CWDM trial. This slight increase (12%) in water use could be due to a number of factors including the hot and dry weather at the time of the trial, the absence of some participants during the trial period, and the consequently very low sample size toward the end of the project which reduced the reliability of the data. The overall water use trends for each community over the life of project are provided in *Appendix A*.

Table 3. Summary of water use data for pre and post CWDM trial periods (L/p/d)

	AVERAGE DAILY USE PRE-TRIAL	AVERAGE DAILY USE POST CWDM TRIAL (until end of project)	AVERAGE PER PERSON REDUCTION POST CWDM TRIAL	% REDUCTION PRE AND POST CWDM TRIAL
C1 (n=2-9)[1]	420	476	-	-
C2 (n=17)	881	772	109	12
C3 (n=22)	355	218	144	39
C4 (n=20)	256	131	125	49
OVERALL[2]	**497L/p/d**	**374 L/p/d**	**126 L/p/d**	**33%**

[1] Due to meter malfunction there was only a small number of metered homes (e.g. by end of project n=2)

[2] Excluding C1 where there was insufficient data post CWDM trial resulting from unoccupied households and meter malfunction.

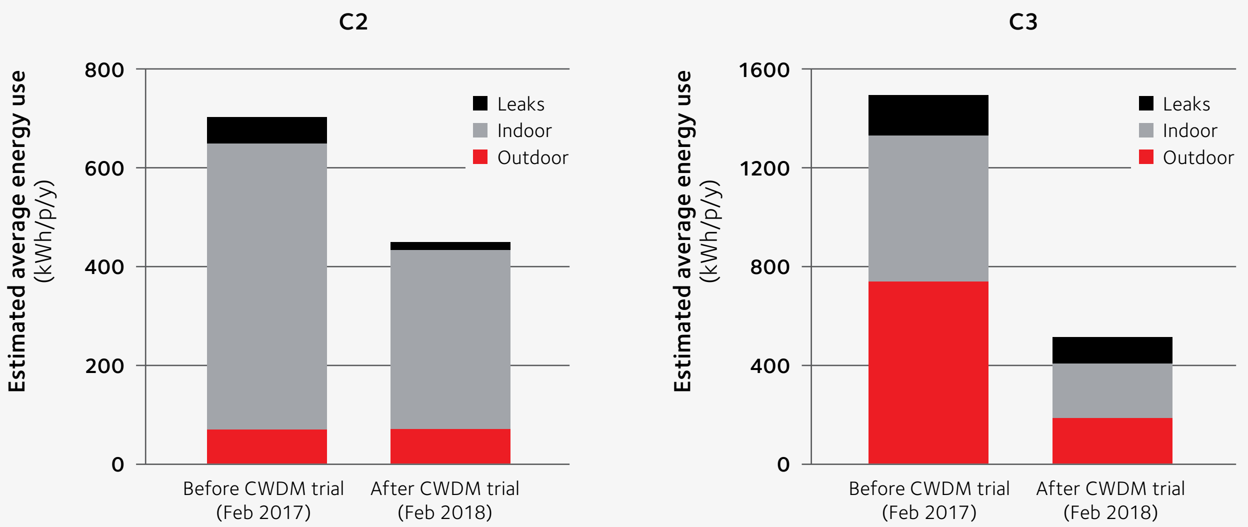


Figure 22. Average estimated water-related energy use and savings pre and post-trial for C2 and C3

WATER-RELATED ENERGY

Water-related energy use was also impacted as a result of the reduction in water consumption in most of the RICES communities following the CWDM trial. For example, in C2, a 24% reduction in bore pumping energy immediately following the CWDM implementation (data not shown) was recorded from daily council monitoring. In C3, where desalination is relied upon to supply the community with treated water, an estimated 65% reduction in annual per capita energy resulting from reduced water use was calculated *(Figure 22)* (assumptions used in these calculations are provided in *Appendix B*).

"It's possible that we can save tens of million in water supply infrastructure by applying…[RICES] findings for demand management practices".

– Senior engineer, North Qld Indigenous council, QLD

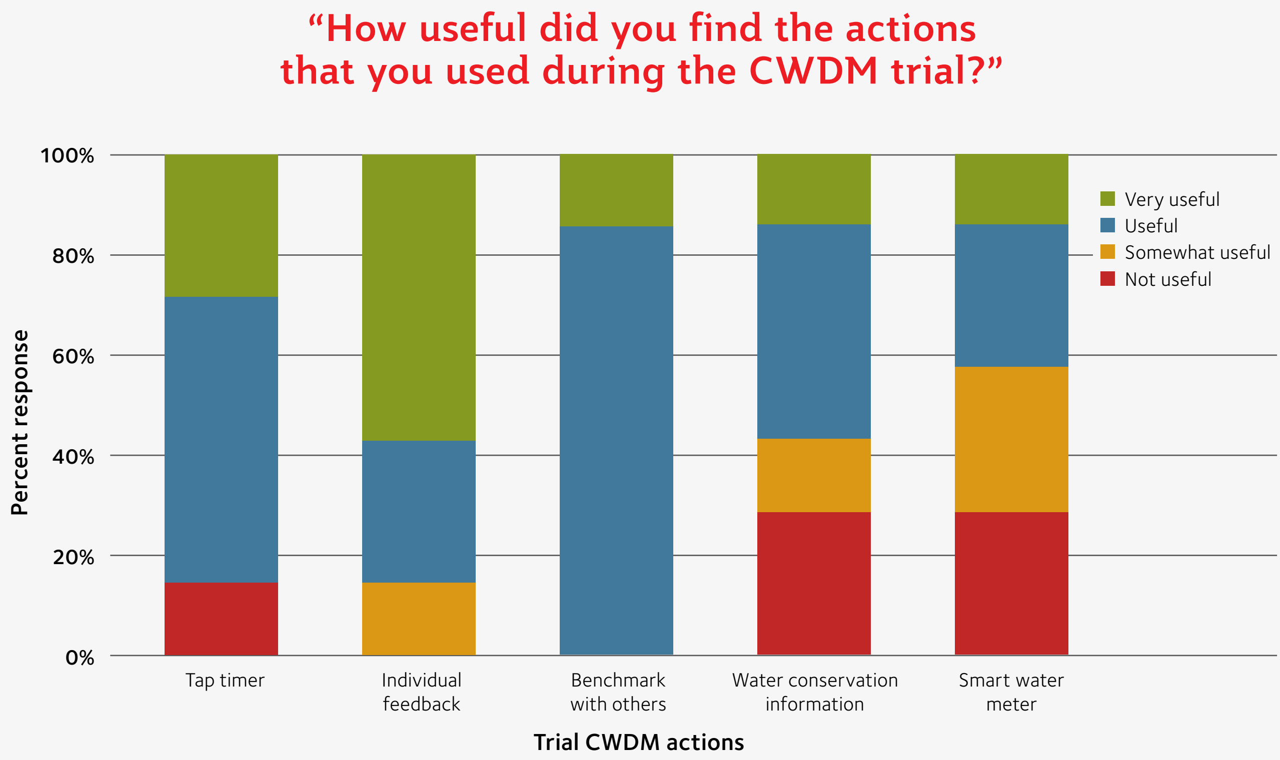


Figure 23. Household participant responses (C4) for trialled CWDM actions in TSIRC community

3.2.2 Qualitative evaluation—feedback from community

The RICES team sought feedback about the appropriateness and usefulness of the CWDM strategies that were trialled. Feedback of actual water consumption data and benchmarking of individual household water use with others in the community scored very highly as favoured demand management options from RICES participants *(Figure 23)*. Participants were also generally in favour of community-based CWDM strategies including 1) council-led community workshops; 2) schools water conservation education; and 3) social and traditional media community announcements about current (real time) community water use and ways to save water (especially during the dry season).

> *"This is the first time someone has actually given us some idea of how we use water and ways we can save water… not just telling us to stop using it".*
>
> – RICES participant and Traditional Owner, QLD

3.3 Key insights from Stage 2

- To help address the range of high water use drivers, behaviours and attitudes, a suite of both community and council/service provider-led water conservation actions is needed within a broader water demand management program.
- Water reductions up to 40% of pre-CWDM trial consumption were achieved—though long term reductions will require sustained and positive efforts from councils/service providers e.g. they need to include the "why" and "how" of water conservation in their on-going messaging to community.
- Water-related energy reductions between 25% and 65% of pre-CWDM trial were estimated.
- Community responses to the CWDM trial clearly illustrated that councils/water service providers need to more fully engage in a positive and informative way with individual householders.
- Individualised water use feedback, including comparisons with the water use of other households was a popular CWDM strategy from the trials in all four communities—from both the community and council/service provider perspective.

4. STAGE THREE

PRIORITISING APPROPRIATE COMMUNITY-BASED WDM STRATEGIES FOR THE FUTURE

An open community workshop on prioritising future community water management actions and needs. Photo source: M. Jackson

Identifying appropriate CWDM strategies and future policy directions

4.1 Identification of suitable CWDM strategies

Based on Stages 1 and 2 of the RICES project, a range of CWDM options were either tested, or raised with participants for discussion during community visits. Drawing on these insights from the research, there are a range of CWDM options that have been identified as appropriate for further piloting in mainland and island communities. These have been broadly categorised into: **Education; Encouragement, Engineering; Economics; Enforcement** and are presented in *Table 4*. These 5 E's are a useful way to understand the complexity and diversity of approaches to demand management and have been used elsewhere in other settings, e.g. healthcare[17], and can be readily adapted to water management. It is important to consider that different demand management approaches offer different levels of "effectiveness" i.e. short-term versus long-term impacts on water consumption and thus overall water supply security. Previous research in this area suggests that long-term gains from *demand-side* approaches that target permanent change in behaviours, including on-going community engagement and encouragement, are at least, if not more effective as the more costly *supply-side* engineering approaches.[12, 18, 19]

It is important to recognise that most of the CWDM strategies listed in *Table 4* have been discussed with the RICES project participants and council officers. These discussions aimed to test likelihood of engagement by community members, usefulness in terms of change outcomes and acceptability within Aboriginal and Torres Strait Islander culture and alignment with cultural protocols. It is acknowledged, however, that these strategies may not be culturally or otherwise appropriate or workable across the breadth, depth and diversity of Australian Indigenous communities and language groups. Additionally, not all of the CWDM strategies in isolation would work with all households in a community, but used in combination there is increased likelihood of a long-term change in how water is valued and used in communities.

In general, CWDM activities that involve feedback on household water use, and education and encouragement around how, why and when to save water, were popular with participants and are relatively low cost. Providing feedback on water use, and benchmarking with other households, can still be done without smart meter water data, but this would require more training and coordination by councils and service providers—though still at a generally low cost.

There was general support for the idea of creating local "water champions" in the community; to provide regular communication and feedback, and to promote a proactive community approach to water conservation. It was, however, seen as important that this responsibility not be devolved from council/service provider to community members, and that leadership be shown by responsible parties to improve communication and coordination. Many participants agreed that sharing water stories with friends and family, and even as a school activity, for example as part of a water savings educational program, was an appropriate and effective way for the Elders and Traditional Owners to transfer some of their traditional stories of accessing and saving water. This approach would also highlight the existing strengths of traditional (existing) water literacy in the community, with a view to further embedding local Indigenous knowledge into water conservation strategies. Applying Indigenous water knowledge to remote water drinking supplies is essential to inform and strengthen contemporary approaches to management—which are often largely technocratic and reactive.

Broader roll out of smart water meters was considered as a positive and viable option by most of the participants, despite some low water users not rating these as useful CWDM tools during the CWDM trial. Smart water meters are critical for obtaining timely and accurate data without the need for manual meter reads. Smart meters would allow high water use properties to be identified and subsequently managed. As highlighted often in the report, these small number of properties typically consume a large volume of the overall water demand. For example in C4, 6 households (30%) were responsible for over 50% of average total water use during the monitoring period from June 2018 to March 2019. Managing high water users in near real-time can only be achieved with accurate monitoring where the opportunity for automated alerts to the householder, as well as council, can be possible.

Table 4. Water demand management options identified from local community and stakeholder groups during RICES project.

CWDM CATEGORY	CWDM STRATEGY / TOOL	HOW / WHY?	WHO TO INITIATE?	IDEAL TIMEFRAME
Education	Schools education program	Regular "waterwise" discussions by special guests (Elders, council), utilising existing materials (e.g. Queensland Government waterwise packs), incorporating local water stories in science projects	Teachers, council / service provider, Elders.	Once a term.
	Community water conservation workshops	Provide information on each community's water use, how to report leaks, benefits of water conservation, how to save water in the garden and around the house, use of council-provided tap timers, maintaining rainwater tanks. Important that timing aligns with town community meetings – not just local council meetings.	Council / service provider working with community leaders to organise sessions.	Ideally twice a year but just before dry season as a minimum.
	Water supply system community information boards	Informative community sign/infographic that explain the local water cycle and the community water supply system. Many participants emphasised the value of having a basic knowledge of the water service delivery chain (e.g. source, treatment and distribution and wastewater management). Understanding this in the context of people's household use and community water storage capacity will help to motivate water conservation practices and will complement other council information strategies (such as current water levels). The signs could be designed by art and science students at the local school, local artist, and/or My Pathway (or similar) initiative.	Council / service provider. These type of initiatives may attract state government subsidies / funding.	Ongoing.
	Basic water hardware maintenance and repair training	There was some support for local capacity building in the area of basic plumbing skills training for locals to reduce the workload of plumbers (e.g. fix basic leaks, and undergo simple repairs). There may be opportunities to channel this type of initiative through My Pathway (or similar) program.	Council / service provider with support from external funding.	Ongoing. Would need to pilot the concept and ensure budget sufficient for managing risks.
	Elders to promote water conservation	Elders of the community taking on a water saving role and engaging with the community - share knowledge and stories and importance of water saving. Share stories of what the elders did to save water when they were young.	Council / service provider working with teachers and Elders.	Ongoing – esp. before / during dry season.
	Social media, and radio announcements	Regular updates and messages about community water use (the community daily or weekly water use target and where they are in reaching that target) and tips for saving water. Local shops often have a television (or screen) where announcements could occur. For TSIRC communities, this could be part of inter-island competitions/communications.	Council / service provider working with media.	Weekly across communities.
	Gamification and behavioural and educational/ awareness tools	Behaviour change, education and encouragement tools related to water issues using gamified approaches and persuasive technologies for water management.	Council / service provider with support from external funding.	Ongoing.

Table 4. Water demand management options identified from local community and stakeholder groups during RICES project.

CWDM CATEGORY	CWDM STRATEGY / TOOL	HOW / WHY?	WHO TO INITIATE?	IDEAL TIMEFRAME
Education	Individual household water use feedback	Regular feedback in simple graphical format of each household's water use. Both per person and per household. Daily average for the week or month. An example could be an image of a person surrounded by 10 L buckets representing the quantum of water (e.g. 100L used = 10 buckets).	Council / service provider.	Monthly.
	Leak checking and reporting	Sessions, potentially coinciding with community workshops and/or town community meetings, around the "how, who and why" of leak reporting. Feedback from community to council about the limitations / positives of leak response and repair processes.	Council / service provider with community participation.	At least once a year, prior to dry season.
	Local water stories	During workshops, school talks, public meetings – have session on local water stories by Elders, respected community members – "how we got water in our day and why it is important to value our water now".	Council / service provider working with Elders.	Ongoing – esp. before / during dry season.
Encouragement	Benchmarking	Use of simple benchmarks to help individual households compare their water use with others (see Figure 17).	Council / service provider.	Monthly if possible.
	Community notices	General notices about water use, targets, notification of workshops etc.	Council / service provider and community groups.	Ongoing.
	Regular council updates on water use	Maintain a current weekly water use notice board at council and the local shop. Social media could also be used for this. Need to keep current, consistent and needs to be engaging to community.	Council / service provider	Weekly.
	Social media, and radio announcements	Regular updates and messages on all islands water use and tips for saving water.	Council / service provider working with media.	Weekly.
	"24/7 water" campaign. For TSIRC or similar communities	Outer islands where water is temporarily disconnected (i.e. physically turned off at stages throughout the day) during dry season. Launch and maintain a "Toward 24/7 water" program that encourages community to change high water use behaviours to achieve the long-term benefit of receiving 24/7 water. This would be a key element of a broader strategy for reducing the need to physically turn off treated town water supplies during the dry season (or when supplies are critically low). This would need to be one of a suite of CWDM tools that would need to be implemented including other Encouragement and Education strategies (see above), permanent water conservation measures and as required official restrictions (not disconnections)	Council / service provider working with media and community groups.	Ongoing. Outer islands of TSIRC or any community where town water is temporarily disconnected at stages during day.

Table 4. Water demand management options identified from local community and stakeholder groups during RICES project.

CWDM CATEGORY	CWDM STRATEGY / TOOL	HOW / WHY?	WHO TO INITIATE?	IDEAL TIMEFRAME
Engineering	Smart water meters e.g. digital meters that automatically record, store and remotely transfer water use data	Community roll out of smart meters. Remote data collection and training of officers in simple analytics to generate individual monthly reports and weekly community-wide reports. Smart metering technology offers automated reporting of water use, identification of high water use, meter tampering and messaging to households and council (e.g. leak/high water use alerts).	Council / service provider. Identify options for state/federal government funding scheme for pilot/main roll-out.	Ongoing – pilot trial to test efficacy of technology, data analysis, community response, council use of data, training needs etc.
	Early leak detection	Leak detection alerts generated from smart meters.		
	High water use alarm	High water use alarms generated from smart meters.		
	Can include: Tap timers, soaker hoses, flow restrictors, removable tap handles	Council initiatives to provide or subsidise water-efficient technology. For example, providing tap timers to households and as needed to high water use households (budget needs to be included for this). RICES data shows that tap timers can be very effective, especially for high outdoor water users. Explore subsidies / sponsorship from large hardware chains in return for advertising etc. Need to educate both council and residents on benefits, use and maintenance - could be part of conservation workshops Education strategies.	Council / service provider and potential private industry / government sponsor or funding assistance.	Once yearly depending on success. Suggest pilot trial to identify barriers and opportunities of this strategy.
	Rainwater tanks	Consider changing council policy on rainwater tanks. Provision of tanks to offset expensive, treated water for garden use. However, this is complicated as many residents prefer rainwater as their main drinking water source. This is linked to how they value the treated, mains water. Needs to be investigated further with community and state government.	Council / service provider, State Health, Housing and Public Works departments.	For future consideration – across all communities and islands in new homes.
	Potential recycling of greywater for irrigation	There is huge potential for using recycled water for outdoor water use activities but this is not always seen as culturally acceptable by the community or feasible by the service provider or council. This may be a future option and will require assessment of risks and benefits and strong community engagement and education.	Council / service provider, State Health and Water regulators.	For future consideration – across all communities and islands in new homes.

Table 4. Water demand management options identified from local community and stakeholder groups during RICES project.

CWDM CATEGORY	CWDM STRATEGY / TOOL	HOW / WHY?	WHO TO INITIATE?	IDEAL TIMEFRAME
Economics	Charging high water use households	Note this was sometimes unpopular with community, based on survey results, especially for identified high water users. In some of the RICES project communities there is a system in place that currently does charge high water users, though the quantum and process of enforcement around this was uncertain by both council and community, thus did not seem to be very effective. Could consider reassessing this system to occur after other CWDM measures have been ineffective with "repeat offender" high water users. Would need cost-benefit analysis and social evaluation to identify impacts, ability to pay and actual potential to deliver any efficiency savings. Would also require a good communication and education program combined with options such as offering tap timers.	Council / service provider, option for subsidies from state government.	As needed – last resort for "repeat" offenders that have had options/ exposure to other CWDM strategies.
	Budget item for CWDM	Commitment to an annual budget item across all remote Indigenous communities for CWDM activities. Studies clearly demonstrate the long-term cost savings and capital infrastructure offsets by introducing water demand management in alignment with other water supply security measures. This budget item could ideally be integrated into the CSO requirements as well as infrastructure plans.	Council / service provider. State / federal government.	Annually.
Enforcement	Permanent outdoor water conservation measures	Introduce and maintain a culture of "permanent water conservation measures" much like the South East Qld strategy during the end of the Millennium drought, and having a target daily water use (say 220 – 250 L/p/d). Not terming them "water restrictions" but rather focussing on a message about council and community expectations around outdoor water use times, days and duration etc. Would align with many of the Encouragement and Education CWDM approaches.	Council / service provider to lead & encourage, community to engage.	All year round.
	Outdoor water use restrictions	Discussions with community and council strongly suggested that water restrictions on C4 (which did not include physically turning off the tap, just reducing time and duration of outdoor watering) is generally acceptable. Ultimately the range of other CWDM measures listed will ideally limit the need to have water restrictions, but the short-term restrictions are usually an effective measure to reduce demand during times of low baseline water supply. However water restrictions will need to be accompanied by consistent and clear communications to community by council for this to maximise the effectiveness.	Council / service provider.	Leading up to the dry season, and during on as need basis with intention to reduce this as a "last resort" option only.

4.2 Policy and planning considerations for future CWDM programs

Although the RICES project identified similar contributors and barriers to effective demand management across the communities, each community also had locally-specific limitations and opportunities for achieving water efficient outcomes. The drivers and barriers can relate to geography, culture, economics, and social governance structure. Therefore, successful and long term water demand management strategies require a suite of tools to be implemented over time. Drawing on this, water management policy in remote communities needs to broaden beyond the current model to consider the following:

- Knowledge of the existing enabling environment (e.g. available funds, resources, expertise, past programs, community will and buy-in) and how this can assist or impede new water demand management directions? This will identify the realistic goals and manage expectations for both community and external parties. This is essentially **the "fit for purpose, fit for place" rule that is critical for setting a pragmatic and truly community-based CWDM approach.**
- Co-designing water demand management program with Aboriginal and Torres Strait Islander people representation from the start – not just consultation but **involvement from the inception of the program.**
- Government must **budget into any water demand management program sufficient costs for relationship building and community engagement** (including repeat travel and in-community events).
- As part of the collaborative approach, **government needs to draw on local Indigenous knowledge** about weather patterns, water supplies, historical water literacy around water conservation, water quality and relationships with water to make a demand program relevant, culturally appropriate and beneficial to local community.
- **Local capacity building where community members have the opportunity to become trained and knowledgeable in water management processes** e.g. this may include future consideration of a traineeship enabling Environmental Health Workers to carry out minor plumbing repairs in emergency situations in remote Aboriginal and Torres Strait Islanders communities that do not have ready access to a licensed plumber (as per the existing Western Australian model[20]).
- There **must be an open policy of "Safe to Fail"** for the community-based approach to demand management. Not just financially (again this needs to be budgeted into programs) but also technically (e.g. water efficient devices may not be immediately used) and socially (communities may not initially engage strongly with education workshops). Research shows that unrealistic expectations, inadequate budgeting and an insufficient enabling environment are key ingredients for poor outcomes from water management programs in Indigenous communities[3]. Allowing some room to fail would include (but not be limited to) the following approaches:
  - having a flexible budget;
  - realistic expectations for outcomes;
  - identifying and learning from 'poor' outcomes;
  - setting realistic timelines for programs; and
  - conducting a pilot CWDM program prior to a main roll out.

4.3 Re-thinking water restrictions and disconnections

Water restrictions (either fully controlled disconnections or through public notices with no strict enforcement) is currently the main demand management approach in remote Indigenous communities. It is generally agreed that water restrictions, especially ones that involve disconnection of town water supply for periods during a day such as in C3, are currently considered the only effective option to ensuring there is sufficient water supply during the dry season. Limiting access, however, to a community's only treated drinking water source could be detrimental to health and well-being and is not a preferred option based on feedback from C3 participants. **Therefore, water demand management strategies beyond the enforcement measures is likely to yield a more equitable, sustainable and resilient water supply.** This further emphasises the need to consider alternative options for managing the long-term security of remote Australian water supplies using community-based Education and Encouragement approaches shown in *Table 4*.

4.4 Balancing water conservation and public health

This report focusses on community approaches to ensure safely managed drinking water supplies are used in an efficient and sustainable way. Equally important however, is ensuring an adequate supply of safely managed drinking water for positive environmental and public health outcomes in communities. For example, while it is essential that excess outdoor water use is curtailed through leak management and appropriate outdoor water conserving behaviours, there still needs to be a reliable supply for water use activities associated with health living practices, such as dust and temperature control[9]. Similarly, RICES results show that indoor water use is also used for healthy living practices such as washing bodies, clothes, bedding and towels[9]. **In this respect, water conservation messages should be very clearly directed towards leak reporting and repairs of water-based health hardware rather than indoor water consumption reduction in general.** The intersection between managing demand to ensure sustainable water supplies, while continuing strong health promotion messages around using water to encourage healthy living practices is a challenging element of demand-side management in remote communities. Nevertheless, there are excellent opportunities to address this type of challenge through a community-based water management approach (and this will be a focus of future research by the authors).

4.5 Key insights from Stage 3

- There is a need to co-design any CWDM program with Indigenous representation from the start and for collaboration to be truly effective, government must budget sufficient community engagement costs into any water demand management program.
- Successful and long term water demand management strategies require a suite of tools to be implemented over time. This is especially true for CWDM in remote Indigenous communities. Each community also has different limitations and opportunities for achieving water efficient outcomes and these must be understood and respected.
- WDM strategies can be grouped into five main approaches: Education, Encouragement, Engineering, Economics and Enforcement.
- Transitioning to a more community focussed WDM approach may initially require a mix of Education/Encouragement strategies and Engineering/Enforcement strategies; with a reduction in these latter two strategies over time.
- In the early-mid stages of implementation, communities need a "Safe to Fail" approach to allow some long-term behaviour change patterns to occur and to promote greater trust between local community members, councils/service providers and external parties.
- Indoor and outdoor water conservation messaging needs to avoid discouraging the use of water for key Healthy Living Practices essential for human health (washing bodies, washing clothes, washing bedding etc.).

5. CONCLUSION

SUGGESTED FRAMEWORK FOR COMMUNITY-BASED WDM APPROACH

The suggested framework toward a community-based water demand management approach for remote Aboriginal and Torres Strait Islander communities is shown in *Figure 24*. There are five elements to this framework:

The pathway is deliberately simple and broad; recognising that each community will require tailored WDM programs, co-designed with local community and stakeholders. The five key elements are considered critical, overarching principles for transitioning to a more community-based approach to not only water demand management but to overall security and resilience of water and water-related energy supplies. The suggested pathway acknowledges that creating sustained behaviour change is not a simple and short-term process in any community, particularly in remote settings that require strong cultural, historical, governance, geographical and environmental considerations.

Framework for a community-based water demand management approach

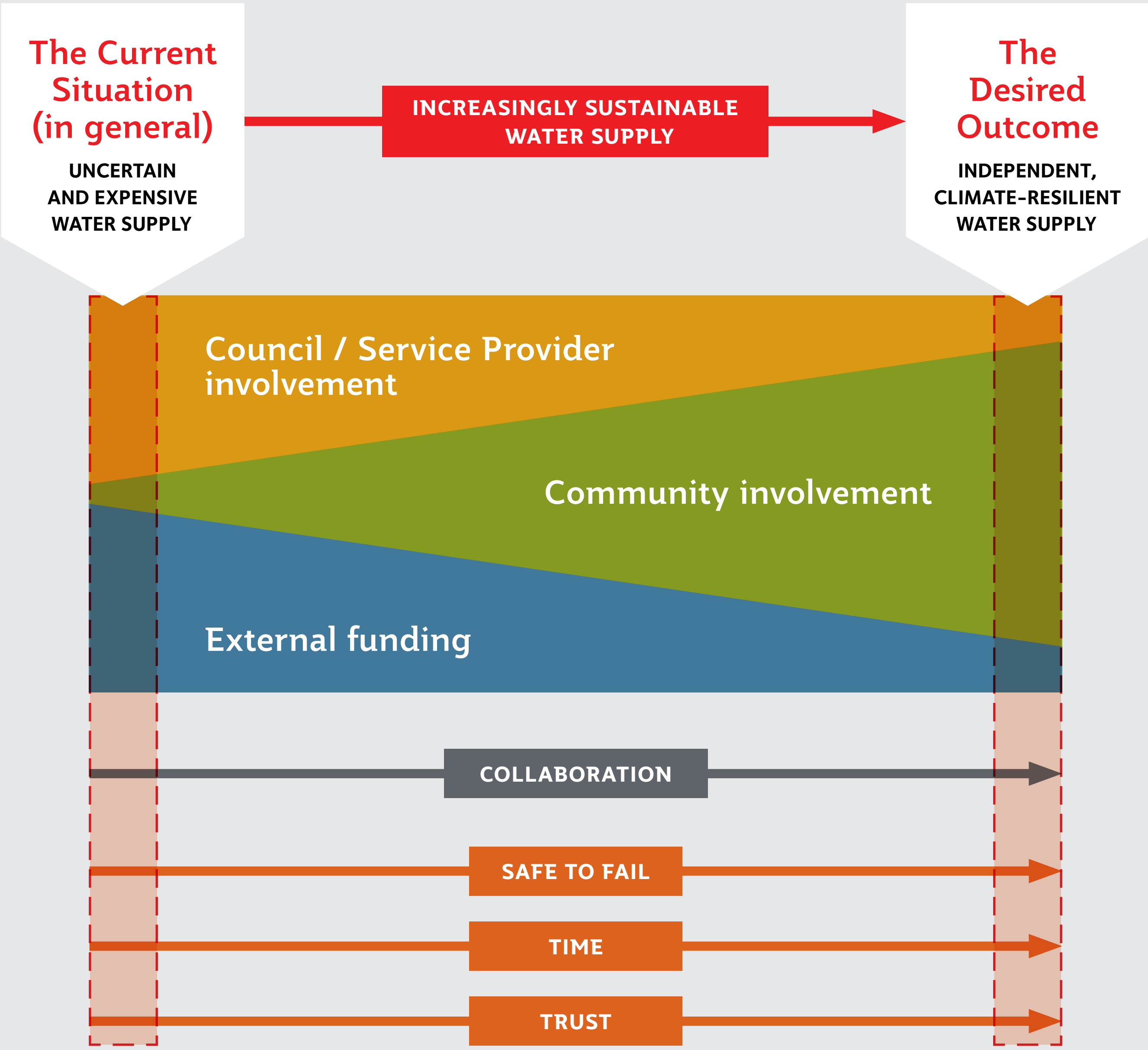


Figure 24. Framework community-based water demand management approach

Key elements of the framework

Community involvement

Community-based water demand management tools can be less expensive and require community involvement and commitment. **The framework relies on an increase in these types of CWDM tools over time.**

For example:

Education measures (school water efficiency programs, community workshops, water stories from TO's and Elders, feedback of individual household water use, water conservations tips and notices)

Encouragement measures (benchmarking household water use, inter-island competitions, water use and weekly usage community notices)

Council / Service Provider involvement

Council / Service provider-based tools can be expensive, punitive and not necessarily reliant on community engagement. **The framework assumes less need for implementing these type oftools over time.**

For example:

Enforcement measures (turning off mains water supply, water restrictions, fining high water users)

Economic measures (water rates, charging high water users)

Engineering measures (high water alarms, smart meters, water-efficient technologies — tap timers, flow restrictors, removable tap handles)

Collaboration

Ongoing collaboration between council/service provider and community is essential.

As an Aboriginal and Torres Strait Islander community transitions to one that has an independent, resilient and sustainable water supply, there must be an equal and ongoing relationship between community and council/ service provider to ensure optimal engagement with the CWDM tools.

For example:

- ✓ Council ensuring up-to-date water use notices are up on the community board
- ✓ Community observing any water alerts about low supply, temporary restrictions to outdoor use
- ✓ Residents, non-residents and council use of tap timers and other water efficient devices
- ✓ Running (council) and attending (community) local workshops and water conservation education activities

External funding

Capital and operating costs to local and state government and external providers.

As the water demand management tools that are adopted in communities transition from Enforcement / Engineering / Economics to more community-based tools, there will be a concomitant reduction in the reliance on money, resources, energy demand and associated direct and indirect expenses of high, ongoing water consumption.

Safe to fail, Time and Trust

Over time as the emphasis on council / service provider based approaches reduce and there is room for community-based approaches to "fail and improve", there is likely to be an increase in trust and confidence within the community that they have a sustainable, resilient, and ultimately independent water supply.

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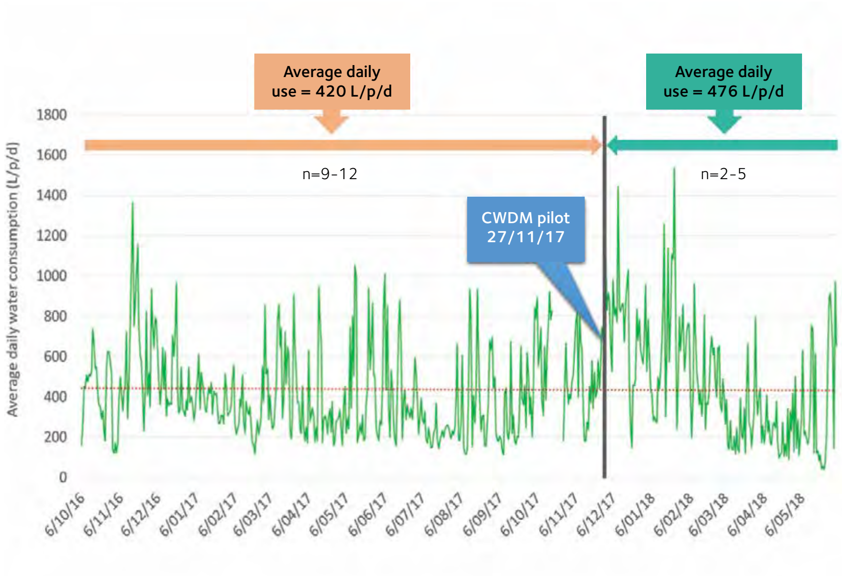
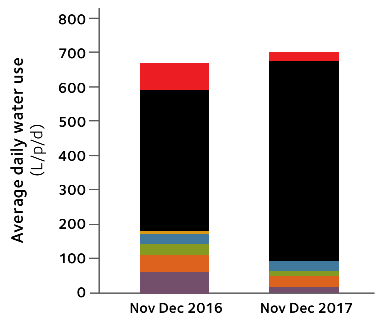
APPENDIX A

WDM trial water consumption data

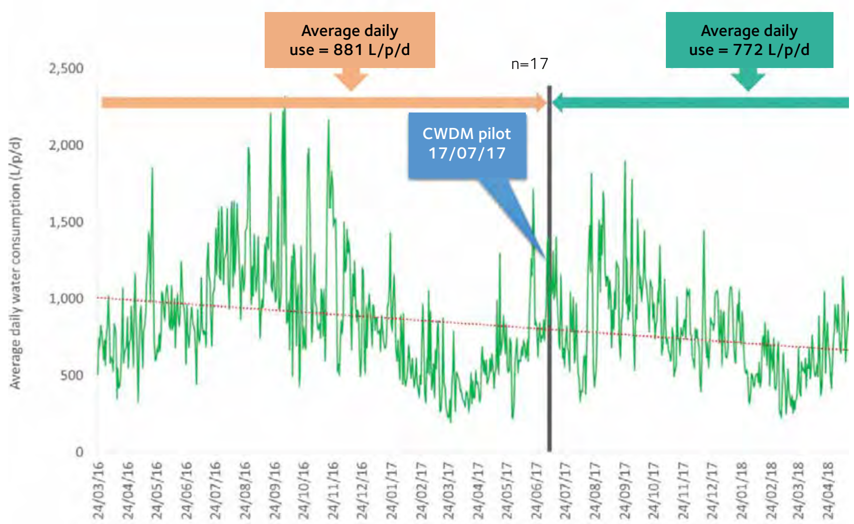
Community – C1

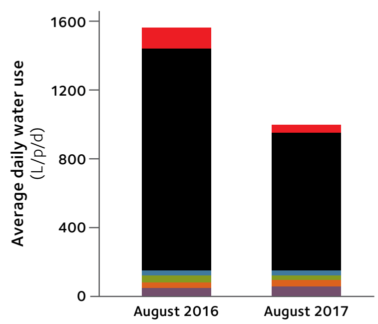




	Nov Dec 2016	Nov Dec 2017
Leak	71.4	20.1
Outdoor	398.5	562.0
Bathtub	5.3	0.0
Toilet	28.8	27.9
Clothes washer	30.3	15.3
Tap	49.3	29.8
Shower	61.1	20.8

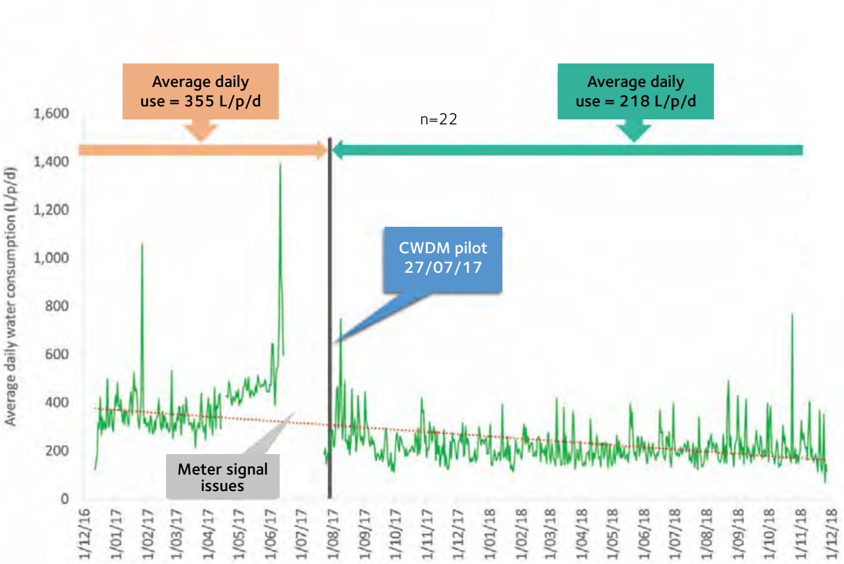
Community – C2

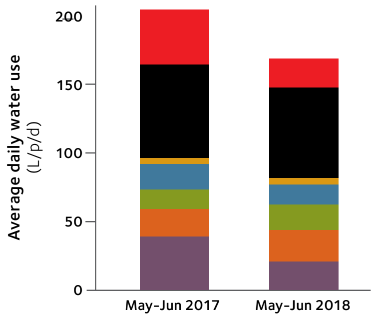




	August 2016	August 2017
Leak	120	41
Outdoor	1293	805
Bathtub	2	1
Toilet	31	29
Clothes washer	39	33
Tap	33	35
Shower	49	58

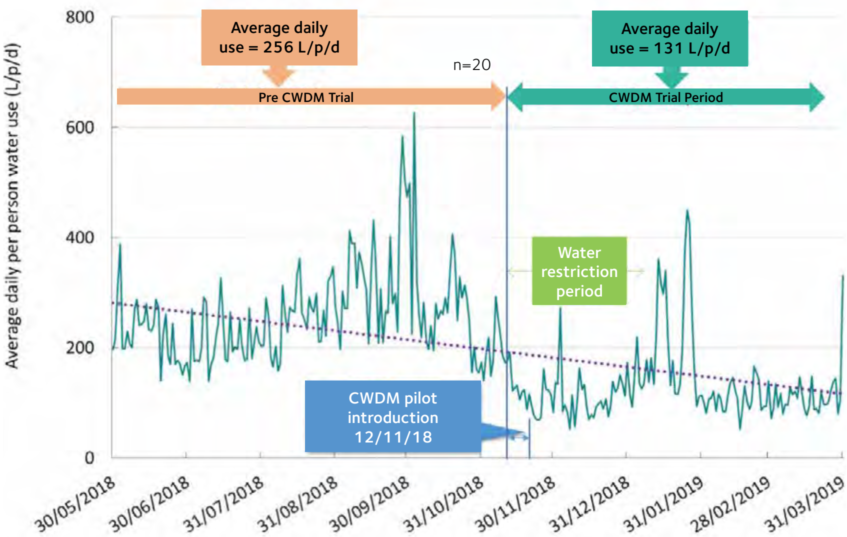
Community – C3

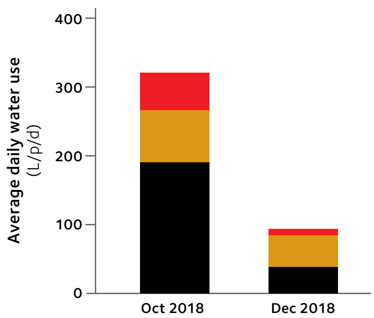




	May-Jun 2017	May-Jun 2018
Leak	39	20
Outdoor	68	67
Bathtub	4	4
Toilet	18	15
Clothes washer	14	19
Tap	20	23
Shower	40	22

Community – C4





	Oct 2018	Dec 2018
Leak	55	9
Indoor	74	44
Outdoor	191	40

APPENDIX B

Modelling parameters for estimating energy demand

Table B1 Summary of modelling input parameters and assumptions[8]

INPUT PARAMETER	C1	C2	C3	UNIT	COMMENTS / SOURCES
Desalination plant	N/A	N/A	5.00	kWh/kL	Data provided by service provider and estimated from monitoring data.
Bore pumps	0.58	0.36	N/A		Water and energy consumption data provided by service provider.
Transfer/ recirculation pumps	0.15	.302	0.25		Water and energy consumption data provided by service provider.
Water treatment plant	0.15	0.15	0.15		Estimated from Site 2 monitoring data
Diesel for powering generators	0.30	L/kWh		L/kWh	Ergon Energy

Right: Masig Island from the air. Photo source C. Beal

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